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Dynamics, tensions, resistance in solar energy development in Tunisia

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Abstract
This article takes a critical look at the management of energy transition, showing that the instrumental approach often favoured in public action is hampered not only by divergent interests, but also by the unexpected effects arising from the implementation of this policy and its instruments. It uses Tunisia as a case study by focusing on two instruments (Prosol and Prosol Elec) designed to foster the development of decentralized solar technologies (water heating systems and photovoltaic panels) at the households and small firm level. The success of these instruments in triggering commercial development of these technologies resulted in unexpected effects on intermediary actors, the devices installers, affected by the clogging of the subsidy schemes. They implemented several adaptation strategies, such as bypassing or exiting the instrument and politicising the debates around it, leading to several adjustments. The study shows that instruments they are the product of a specific local milieu structured by power relations and material traits. It acknowledges that local resistances should not be reduced to orientalist understandings, and stresses the need to go beyond management-focused approaches of energy policies, in order to make way for unexpected transformation processes.

Key words: energy transition; decentralized solar energy; water heating system; policy instrument; Tunisia

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Abstract

This article takes a critical look at the management of energy transition, showing that the instrumental approach often favoured in public action is hampered not only by divergent interests, but also by the unexpected effects arising from the implementation of this policy and its instruments. It uses Tunisia as a case study by focusing on two instruments (Prosol and Prosol Elec) designed to foster the development of decentralized solar technologies (water heating systems and photovoltaic panels) at the households and small firm level. The success of these instruments in triggering commercial development of these technologies resulted in unexpected effects on intermediary actors, the devices installers, affected by the clogging of the subsidy schemes. These actors implemented several adaptation strategies, such as bypassing or exiting the instrument and politicising the debates around it, leading to several adjustments. The study shows that instruments are the product of a specific local milieu structured by power relations and material traits. It acknowledges that local resistances should not be reduced to orientalist understandings, and stresses the need to go beyond management-focused approaches of energy policies, in order to make way for unexpected transformation processes.

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Much work and thinking have been devoted to the public policy instruments employed for the development of renewable energy. Feed-in tariffs, power purchase agreements, subsidies for installation and other mechanisms to support investment in renewable energy technologies are common types of instrument, predominant in the European context but also applied in many other places. The approach in terms of policy mixes, by scrutinising the combinations of specific instruments and the complexity of contexts and rationales, has advanced the understanding of public policies associated with energy transitions [1]. Much of the research relates to the goal of managing energy transition and is interested in evaluating the success or failure of these instruments, by focusing on outcome indicators and the effectiveness of policy strands [2].

Recently, however, a series of studies have sought to shift the line of questioning on energy transition, in an approach that defines itself as "critical" [3]. In particular, Labussière and Nadaï critique approaches that focus on the study of the trajectories of transition, because a "notion such as 'trajectory' fails to provide an alternative to reasoning in terms of ends and means", and such a "conception leaves the hierarchy of ends undetermined and transfers the 'strategic management' of technological means into the hands of a small number of actors, resulting in democratic deadlock" (p.17) [3]. Instead, they seek to place the transition process at the heart of the analysis, thereby broadening the spectrum of analysis to take into account more entities (human and non-human) affected by and affecting these processes, whether deliberately or involuntarily. In this approach, the study of the instruments of energy transition designed to encourage investment that favours renewable energy technologies, ceases to be solely a matter of assessing whether they are able to achieve the objectives for which they were conceived, and how to improve them. It also aims to understand how one type of instrument is chosen, for what purpose, and which entities, technologies and actors it involves not only at the start but also during their deployment, and how its implementation leads to changes not only in investment and installed capacities, but also more broadly in the arrangement of the actors and the associated entities. To this end, we employ the notion of milieu proposed by Labussière and Nadaï [3]. By "suggesting that instruments deploy along with a 'milieu' – meaning a set of actors, devices, knowledges, and practices – which is part of their functioning, and which grows with them and influences their becoming", they envisage the milieu as a set of "collectives concerned with the effects of the instruments". In addition, we adopt a dynamic approach to the instruments of public policy proposed in particular by sociologists of public action [4]. The notion of "resistance to the

instrument" [5] offers a way to understand the dynamic relations between the specific effects of one or more instruments and the milieus they form.

A second originality of our approach is the choice of case study. Most of the analyses focused on instruments relate to European countries, such as Germany, France or Spain, which have used these tools to encourage private investment in the development of renewable energy capacities (in particular wind and photovoltaic power). However, similar instruments have been proposed, adapted and implemented in many countries of the Global South. In these contexts, though, critical approaches in the sense suggested above have received very little development. Numerous studies discuss energy transition in the countries of the Global South in terms of underexploited or poorly exploited potential, for example the potential for solar power in the Sahara. From an often normative perspective, the research emphasises the contradictions that hinder the deployment of these technologies, for example the excessive impact of fossil fuel subsidies [6–9]. It also points to the purported mismatch between the investment incentives and the excessive risk bonuses, linked to foreign investors' perception that these markets are poorly regulated or exposed to geopolitical risks [10,11]. Recently, however, such analyses have come under fire because, according to Souza et al., they reflect a eurocentric view embedded in an "institutional Orientalism" incapable of understanding the true nature (and legitimacy) of local reluctances, reducing the countries of the Southern Mediterranean to zones of danger that threaten Europe with terrorism. Moreover, such perceptions also underplay the fact that the implementation of policies to deploy solar energy technologies has also been hampered by the contradictions of European policies [10,12,13]. Whether normative or critical, these analyses implicitly or explicitly share a relational approach to Europe and the Global South (in this case the MENA region countries). The contribution of Souza et al., however, with the idea of 'deprovincialising' the study of energy transition, calls for an epistemological readjustment.

In this article, we propose moving a notch further in this direction and to use the critical approach to the instruments to study energy transition in one country of the South, by focusing on the processes affecting local milieus and abstaining from interpretation in terms of the "success" or "failure" of the deployment of renewable energy production technologies. Our case study considers Tunisia. This country has remained until now understudied as regards energy transition. Local scholars, in close connection with the local administrations and the German cooperation agency, have hailed the success of the PROSOL and PROSOL Elec programs, which have incentivized individual solar thermal heating systems, and later the individual installation of photovoltaic panels [14–16]. Their studies assessed the

increase in installation triggered by the new instruments, but concealed the negotiations and choices that led to the design of this policy. In other studies, we have approached energy transition in Tunisia with a focus on public policy making at the national level and in the city of Sfax [17–19]. Here we focus on individual solar thermal heating and photovoltaic systems so as to show that the implementation of these instruments fits within a model of public policy that entails a "collective" made up of a set of actors (beneficiaries as well as intermediaries and promoters), of technologies, of socio-economic objectives and of financial instruments. This collective is inseparable from a precisely situated milieu structured by power relations. In focusing on the processes of change driven by these systems, we also show that – beyond the results in terms of equipment installed – they provoke a series of unexpected effects that elicit resistances. These effects reveal the profound reconfigurations that affect the milieu concerned, in both socio-economic and political terms.

In the first section, we specify our analytical framework, first how we use of the notion of instruments and resistance to instruments in a dynamic perspective and then its connection with the notion of the milieu, before describing the field investigations conducted in Tunisia (1). The next section presents the main actors, figures and policies framing Tunisia's energy system (2). Following sections examine the processes governing the assemblage of the instruments in question at the end of a process of learning and dissemination (3), then the effects of mutual determination between the instrument and its milieu (4), adopting a diachronic approach. The concluding discussion examines the issues and contributions of the proposed approach as invalidating 'orientalist' understandings of Tunisia; as a call from broadening the temporal scope of energy transition analysis; and as pleading for the necessity of connecting policy instruments the milieus in / for which they are built, a lesson that is far from confined to the Tunisian case.

1. Understanding the dynamics of instruments and their interaction with the milieus

The purpose of this section is to describe our analytical framework, in which two main approaches are combined. Through an empirical analysis focusing on a set of particular devices, it seeks to understand public action in Tunisia in terms of an instrument, in that this instrument represents a "relatively independent and explanatory variable of public policy" [20]. This kind of approach stems from the discipline policy studies, whose contribution to energy studies is

recognized [2]. However, it has yet to be fully integrated into meta-theories of energy transition [21]. A public policy instrument "constitutes a device that is both technical and social, that organizes specific social relations between the state and those it is addressed to, according to the representations and meanings it carries. It is a particular type of institution, a technical device with the generic purpose of carrying a concrete concept of the politics/society relationship and sustained by a concept of regulation." (p.4) [4]. We thus adopt an approach to instrumentation that is non-deterministic and non-functionalist, that attributes a central role to instruments in government activity [4,22]. It needs to be characterised by identifying the actors associated with that public policy and the goals of the policy, and by describing the technical mechanisms (knowledge tools employed, forms of relationship established between the actors). In this form of analysis, the instrument is never a closed system, it is inseparable from contextualised modes of appropriation that take the form of deployments and reformulations of resistance at different levels [20]. By deciphering the dynamics specific to the choices of the instruments employed to support solar energy, and the dynamics of their effects, we try to reveal the complex milieu that produces them and that they at the same time produce, on the understanding that, as Varone and Aebischer argue, "each policy tool generates its own "political economy" and constitutes a (quasi) independent system of action in and of itself" [23]. We draw in particular on the proposition advanced by Cointe and Nadaï who, on the subject of the instruments of support for solar energy in France, emphasise the benefit of analysing energy transition in terms of its relation to a public policy and to the "milieu" associated with it. The instruments are then envisaged "as evolving with, and within, a "milieu" that they sustain but also depend on", which "requires a detailed account of the networks and assemblages through which they operate" [24].

This approach leads one to divide the analysis into two main phases. First, the close connection between the instrument and its milieu needs to be characterised in order to show that it produces something specific and is the basis of a policy style. This means identifying the specificity of the Tunisian instruments, in particular compared with those habitually used in Europe, and identifying what social, economic and political characteristics explain this specificity. We postulate that the framing of renewable energy policy in Tunisia by a specific instrument lastingly structures the subsequent stages in the development and widening of this public policy to other technologies, via a process of learning and replication.

Despite this grounding in the milieu, instruments are not exempt from overflow effects clearly demonstrated in the literature on Germany or France, because of the way the technology is adopted by the actors in the conditions permitted by the instrument. As in those contexts, one

of the consequences is a "politicisation" that arises from the formation of collectives of actors that did not previously exist, and a series of adjustments in the instrument [25–27]. To bring the analysis of these dynamics to a deeper level, the notion of resistance to the instruments [28] helps us to understand what – in the different stages of the instrument's career – is a result of opposition and contestation, and what comes from unexpected, surprising or pernicious effects. Le Bourhis and Lascoumes in fact identify three spaces of resistance, which are the stages of design, implementation and appropriation by the target populations. In focusing on the first two spaces, we seek to show that the instruments of Tunisian energy policy are determined by different forms of resistance that operate at different levels. The utility of this analysis goes further than a reflection on the characterisation of public policies in Tunisia. We argue that taking these resistances into account at different moments and levels in a public policy casts a radically critical light on the idea of energy transition. Indeed, although in the standard view this notion seems to be based on a clear and controlled distinction between an initial situation and a target situation, the elucidation of unexpected and deviant effects shows the fundamentally unstable nature of the management of energy transitions.

Understanding the instrument's career implies, methodologically, that the study must take into account not only the initial moment of conception/negotiation but also the dynamic interactions between the (un)expected effects and reformulations of the instrument. To do so, our approach mainly relied on qualitative data. This is partly a choice by default. Indeed, statistics and official reports from the Tunisian administration we first tried to gather proved « incomplete or nonexistent for some variables » [29]. Official websites offer few detailed and up-to-date data. Annual reports from the national electricity utility contain very little information about the development of solar technologies. The website of the agency dedicated to the promotion of renewable energy has been out of order for years and previously, displayed no update beyond 2012. Verbal agreements, in several interviews, to send us updated and detailed datasets were seldom fulfilled. The energypedia portal, implemented by the German cooperation agency (GIZ), eventually provided secondary data we used in this study, without being able to process our own treatments and calculations.

Thus, we mainly relied on qualitative data, defined as "a range of techniques for collecting and analyzing data about the opinions, attitudes, perceptions and understandings of people and groups"[29]. Over five campaigns from 2012 to 2016 in Tunis and/or Sfax, we conducted 35 semi structured interviews with representatives of public agencies, foreign funding entities, contractors and the organizations that represent them in discussions at national level, as well as various observers (consultants, etc.) of Tunisian energy policies, in a few cases with the same

person (Table 1). We generally did not record the interviewees, particularly in administrations. Some civil servants requested not to be quoted. This feeling of wariness most probably relates to the legacy of authoritarianism in Tunisia. In several cases, these interviews were combined with field visits to solar panel production or deployment sites. These surveys were preceded and supplemented by monitoring of the general and specialist Tunisian press, the websites of the institutions concerned and specialist discussion sites. In this study, we do not address appropriation of SWH by the inhabitants. This was done elsewhere [17].

Table 1- Interviews carried out (by year and category)

2. A Stalled Energy Transition in Tunisia: Actors and Policies

Tunisian energy policy is characteristic of a "state-centric approach" [21], according to which "the goals of energy policies are dictated by national interests" (p. 181) [21]. Indeed, national institutions proved dominant in defining energy policy orientations in respect of national interests such as securing supply-demand balance and energy autonomy, or else employment concerns. STEG (Société Tunisienne de l'électricité et du gaz), Tunisia's historical electricity and gas production and distribution operator, played a central role in the project to build national independence at the time of decolonisation. The electrification of the country was one of the levers of development policies, and endowed this public company, set up in 1962 with a monopoly on production,[1] transmission and distribution, with a great deal of legitimacy [18,19]. Since 2000, the problem of Tunisia's energy autonomy has been a major preoccupation for the Tunisian authorities, since the country is now in a situation of structural energy deficit because of the depletion of its oil and then gas reserves. In 2013, the deficit amounted to 2,5 M toe (28% of primary energy consumption) [16]. This is one of the major reasons that prompted the development of an energy management policy, entrusted to ANME (National Agency for Energy Management), which included goals such as the rational use of energy (energy efficiency, cogeneration) and the promotion of renewable energy. Nonetheless, STEG has remained in a position of strength. Strongly attached to the company's monopoly position, its successive bosses have ensured that the laws encouraging the promotion of renewable energy place strict constraints on the private actors likely to invest in the sector. A long negotiation took place between 2012 and 2014, culminating in an energy transition act that finally provided

[1] Nonetheless, since 2001, the commissioning of a cogeneration plant run by a private operator has significantly breached this production monopoly.

for the opening up of the market to private investors [18,30]. The government plans that electricity from renewable sources will represent 14% by 2020 and 30% by 2030 [16]. However, the adoption of the act was delayed by a referral to the Constitutional Council and the implementing orders only began to be published in 2016. STEG negotiated every step of the conditions of investors' access to the grid and the act gives it significant powers of oversight.

The change of terminology in this energy policy needs to be emphasised here. As ANME's name itself indicates, the watchword in the Tunisian government's approach until recent years was energy "management". The French word, most in use locally, is "maîtrise", and its Arabic translation is "tahakkum", which has the same root as the word "hukuma", i.e. government. The shift to a policy of "energy transition", with the postrevolutionary governments, was strongly influenced by a set of ministers in charge of the energy portfolio having a strong professional record in France and the involvement of German advisors.[2] Their action in favour of the promotion of renewable energy is thus associated with a movement of opening up to private investment: energy transition is a sign of a wish not only for a diversification in the energy mix, but also in the governance of the sector, entailing an erosion of the central position of STEG.

The current electricity mix for Tunisia however shows that these plans have not materialized yet. Electricity is mainly produced from natural gas (95%). Renewable energy sources account for about 5% of electricity generation, mainly through hydroelectricity and wind farms owned by STEG (245MW installed). In 2015 installed PV panels only represented 25 MWp. Other targets of the energy policies have been energy efficiency, with a reduction in energy intensity by 25% from 1990 to 2014, and cogeneration (77 MWe) [16]. When compared to countries with similar characteristics, Tunisia energy transition is lagging behind. Tunisia has not implemented its framework for private producers to access the grid yet, nor any feed-in tariff, by contrast with the instruments adopted in Europe or in certain neighbouring countries such as Morocco, Jordan and Egypt [31,32]. In contrast to Morocco, Tunisia policy has until now mainly supported decentralized small-scale energy production [33], which we study in the following sections.

[2] The two ministers successively responsible for the issue were executives in the French energy sector, one in a subsidiary of Total, the other a professor at the National Institute of Nuclear Sciences and Technologies. The GIZ, German cooperation Agency, has an office in Tunis since 1999 and has strongly supported ANME and the Ministry of Industry about energy issues.

3- Stabilisation and replication of solar energy instruments

The first step in the analysis was to identify how these mechanisms of support for solar energy were gradually constructed and implemented through the "Prosol" and "Prosol Elec" programmes, relating respectively to the production of thermal solar energy and photovoltaic power. This understanding of the policy design requires a step back to cover the non-linear career of the instrument, which was marked by moments of latency, of acceleration, of jamming and of attempted adjustment. The implementation of the Prosol Elec programme, following the success of the Prosol programme for the installation of solar thermal water heaters, reveals a learning effect and a Tunisian policy style for solar energy that employs the levers of financial incentives and regulation (through the management of installations).

Prosol: a pioneering instrument

The first attempts to encourage the solar thermal sector by means of solar water heaters (SWH) go back to 1985, but the development of this sector was not linear. It went through three stages [16,34], corresponding to successive adjustments between the choice of a technology, its manufacturers and installers, its users, and the legal and financial mechanisms associated with its adoption. In the first stage (1985-1990), encouragement for the use of solar thermal energy relied on technologies developed by Tunisian industries, based on customs protections. However, inadequate technological quality, both in product reliability and maintenance capacity, as well as continuing high costs, soon led to the sector running out of steam. A more significant restart occurred in 1996, thanks to a Global Environment Fund (GEF) incentive programme, still aiming to develop the local industry but also involving facilities for imports. Despite the installation of some 80,000 m² in 8 years, the number of installations declined after 2002. The main reason given for this is the cessation of the GEF programme, but other obstacles played their part, in particular a regulatory framework that was considered to offer too few incentives because of the complexity of the procedures and a level of subsidy that was too low for residential customers, the main target of the programme. The second restart, in 2005, finally led to a spectacular take-off. This system produced positive results, evidenced by strong growth in new SWH capacity with installation of around 80,000 m² a year from 2007, and a total of 816,000 m² installed by 2015, with 139,000 installed devices, which makes approximately 4% of the electricity subscribers[16].

This success reflects the stabilisation of a sociotechnical collective which combines appropriation of the technology and adaptation to the specificities of the Tunisian market, in particular household incomes (see Table 2). The Prosol mechanism is based on a funding system designed for the socio-economic conditions of Tunisian households and for the training of local installers. Households wishing to fit a SWH were selected on the basis of their history as customers without payment incidents. They could receive subsidised credit and a loan that that they repaid through their electricity bill, relieving them of the need to advance the initial investment. This condition was important in opening the technology to a population with limited revenues, which would not have been able to come up with the funds in advance. These loans were provided by various international partners, such as the French Development Agency [35]. Moreover, the National Energy Management Agency (ANME) trained the installers and certified the equipment, after defects were found in some of the imported equipment. These support mechanisms should be understood as reflecting the desire to combine energy targets with equally important objectives for local employment, a factor strongly emphasised since the Tunisian revolution of 2011. A joint study conducted by the German cooperation agency and ANME [36] estimates that SWH installation, which offered an opportunity of the versification for plumbing and heating professionals, accounted for a major proportion of the estimated 3500 jobs across the whole renewable energy and energy efficiency sector. In addition, the development of the sector led to the emergence of a milieu of local industries assembling mainly imported products, and above all to the creation of small and medium-sized businesses specialising in assembly and supply for the local market, consisting of some sixty units essentially located in Greater Tunis. This milieu of industries and assemblers was notably encouraged through a variety of preferential customs mechanisms [37]. Because of its success, the Prosol programme was extended in 2010 to the service sector (hotels and collective buildings). Initially conceived to encourage the use of solar thermal energy, the instrument would also be extended to the photovoltaic sector.

Table 2: **Flowchart of the Prosol and Prosol Elec subsidy system**

Extending the scope of the instrument: Prosol Elec

In 2009, ANME launched the Prosol Elec programme, an adaptation of the main features of Prosol to photovoltaic technology. The Solar Roofs initiative consisted in permitting the installation of photovoltaic panels (some 100 m² maximum) on roofs of residential buildings, offices or other business premises. The installation includes a net-metering system whereby

electricity not consumed by the customer is sent to the grid and deducted from the electricity bill of the Tunisian Electricity and Gas Company (STEG).

In this programme, several of the mechanisms responsible for the success of the Prosol instrument were transposed to the photovoltaic sphere (Table 2). As in the case of solar thermal energy, acquisition of the equipment was encouraged through a purchase subsidy, amounting to 30% of the investment cost. This subsidy was funded by the creation of the National Energy Management Fund (FNME) by the act of 2009, and supplemented by various taxes, along with 10% added by the Italian cooperation agency. In addition, there was a contribution in kind by STEG in the form of an inverter (worth 2000 DT, i.e. 1000 euros). Customer financing was facilitated by a subsidised loan granted for a maximum of five years, provided by a bank that was a partner in the programme. As with Prosol, this loan was repaid via the electricity bill. In addition, ANME played a central role in the implementation of the instrument by licensing installers (here again with the aim of developing a new job sector on the Tunisian market) and through the approval of subsidy applications. Indeed, so that customers did not need to pay the subsidised component upfront, this amount was directly reimbursed to the installers, who were responsible for submitting the applications to ANME for processing and approval.

There is thus unquestionably a "family resemblance" between the two instruments, as recognized by GIZ consultants: "The PROSOL approach has also been used to support the development of grid-connected PV, which started in 2010 with the program PROSEL Elec. [...] PROSOL Elec is based on a financing mechanism which looks very much like his historical predecessor" [16]. This is observable through the readiness of ANME and its advisers and foreign funding entities to promote a system that was complex but widely seen as a "success story" and replicated in Arab countries and beyond (Morocco, Egypt, South Africa, Uruguay, Rwanda) (ibid., p.45),. The initial instrument was successively adapted to other types of user (industries, hotels, the service sector) and to another technology, photovoltaic, evidence of a learning process characterised by the combination of several actors, resource types and objectives. The aim was both to adjust to the financial capacities of a modest target population and to develop a promising job sector by structuring its capacities through the training and licensing of producers and installers. ANME achieved this objective by enrolling foreign funding entities into the instrument, together with the national electricity operator – STEG – which had direct financial access to customers through their electricity bills, supporting the lines of credit, and which itself contributed to promoting the system by the donation of inverters. The milieu also comprises local lending institutions, and local installers and industries that

helped to build the market by approaching customers and preprocessing their applications for submission to ANME.

The presentation of these two instruments also reveals how they differ from European instruments, where the primary focus is on tariffs, whereas in Tunisia the central factor is the equipment subsidy. This might seem surprising in that Tunisia is extensively exposed, through different public policy transfer systems (via ADEME – France's Environment and Energy Management Agency – or the MEDENER network),[3] to European influence. In this context, understanding this specificity means grasping how Tunisian renewable energy policy fits into the country's broader energy policy, and its connection with a whole series of other public policies (employment, national independence, etc.), i.e. with an ensemble of political values and choices. This lays emphasis on the fact that an instrument is inseparable from the complex environment in which it is deployed, as will be explored in the next section.

4. The resistance of/to the instrument: reciprocal determination effects between the instrument and its milieu

Public policy analysis distinguishes between recipients (the "target groups" of policies) and beneficiaries (who are favoured or injured by its implementation) [38]. This distinction is useful in deciphering the Tunisian situation, where the choices made were the result of the wish to combine solar production with social and economic policy (employment, pressure on household budgets). They also result from the wish that this production should fit in with the existing grid management system, in other words should avoid disrupting it. Nonetheless, the success of these systems led to a jamming process that had multiple and interwoven consequences. The failure to anticipate the impact of these policies on producers of solar panels, whose regulation via a licensing system proved ineffective, reveals the importance of the intermediate actors whose activity was directly challenged. The analysis of these effects offers a concrete illustration of how an instrument and its milieu – i.e. the entire network of actors, institutions and their social, economic and political interrelations – are self-determining and self-generating.

[3] The MEDENER network, set up in 1997, consists of 12 national organisations on the northern and southern shores of the Mediterranean and exists to promote energy efficiency and renewable energy in that region.

The influence of STEG in favouring self-consumption

The design of the instruments in the Prosol family certainly expresses a process of stabilisation in a set of actors, apparently under the aegis of ANME. Yet, they also illustrate the central role of STEG in the sector and its capacity to impose its views. As regards the PROSOL system, STEG's intervention in the mechanism stems from its direct interest in the operation: solar water heating is a way to reduce energy demand, and therefore a way to limit the investments required to increase production capacities. On the other hand, STEG's participation in the PROSOL Elec instrument was not so well accepted. It was made conditional on the system being limited to an auto-consumption objective. In fact, the net (or two-way) metering system allows the customer to sell the electricity they produce to STEG. However, this electricity is deducted from their consumption, which means that it is produced at the same price as the electricity sold and therefore – by contrast with European practice – does not include a subsidy on the purchase price. Moreover, if the balance is positive, the remuneration takes the form of a credit on the following year's consumption, not a cash payment. In any case, the customer's installed capacity is limited by examination of their consumption with the intention of ensuring that they do not produce more than they need.

As demonstrated in a previous work [18], STEG's desire to maintain its monopoly and its dominant position can be explained by the ideological attachment of many actors, from senior executives to the electricity union and some of the public, to protecting the interests of the public sector and, more broadly, of the nation, from the supposed greed of commercial investors. In addition, these actors also want to preserve the fringe benefits obtained from the maintenance of the company's hegemony.[4] STEG's detractors criticise its alleged reluctance to open up to new, unfamiliar technologies, its attachment to the past, and even its incompetence, and acknowledge its historical role only to support their claim that it is outmoded.

However, other lines of argument are advanced by the actors, emphasizing the materiality and technologies of the grid. In particular, STEG's representatives and other observers argue that the electricity grid has little capacity to incorporate renewable energy, and that this will require a significant reinforcement programme that will take time and demand substantial investment (networking technology, etc.). Moreover, and above all, while STEG itself has developed wind production capacity of 245 MW and many of the projects referred to in our interviews in 2012-13 by Tunisian private actors related, for the immediate future, to wind power, the company's

[4] For example, employees enjoy various advantages and social benefits (free electricity, vacation programmes…) and informal benefits (according to one executive, some 20% of people hired are children of "Stéguistes", Interview, Tunis, 13 January 2016)

representatives emphasise the problem of the intermittency and aggregation of power produced by turbines located in regions with the same weather conditions[5]. This characteristic obliges STEG to plan investment in backup thermal production capacity to duplicate the wind power potential, but with higher fixed costs since it is for time limited use. This reduces the benefits of wind power. The development of photovoltaic capacity could be a wiser choice because of its greater stability (especially if it is installed in the south of the country) and because of its capacity to meet summer and day-to-day peak demand. In the 2000s, however, photovoltaic was still considered too expensive to justify investment. In this sense, STEG's action can be interpreted as reflecting a "network intelligence",[6] i.e. the attempt to avoid the potentially destabilising effects of an uncontrolled or poorly controlled opening up to private investment. By contrast with the instruments used in Europe to encourage the take-off of the renewable electricity market, with feed-in tariffs and the freedom to make investment decisions, the Tunisian instrument directly includes arrangements that protect it from the risks of overflow, i.e. a rate of installation so high that it represents a very heavy financial burden for consumers and the public purse [26]. Whichever interpretation is preferred, the implementation of the Tunisian instruments reflects not only the government's specific policies, but also the impact of a set of material characteristics and political traits distinctive to the Tunisian energy milieu.

Effects of clogging: exit from and bypassing of the instrument, and politicisation of the actors

However, the Tunisian instrument was not sufficiently well configured to escape all forms of overflow, as illustrated by the development of the Prosol Elec programme. This underwent a sustained rate of expansion, with some 9475 buildings equipped between 2010 and 2015, representing installed capacity of 25 MWp (table 3). The total surface area installed outperformed by 30% the target, which was set at 5000 dwellings connected in 2014 representing 10 MWp, against 13.5 registered that year (Businessnews, 21/4/2009). Yet while we cannot speak of an explosion, the rate of photovoltaic panel installation was rapid and caused problems and tensions. These difficulties, which the press began to report in 2012, were linked with delays in paying the installers by ANME, which was unable to process applications for subsidies within reasonable timescales. In principle scheduled for settlement within 15 days, these payments could take up to six months, according to reports collected by us or cited in the

[5] "Aggregation refers to the fact that the random fluctuations in the production of unavoidable energy (such as that produced by wind turbines or photovoltaic panels), are statistically reduced when such production is injected into a single networked power grid." (https://fr.wikipedia.org/wiki/Foisonnement).

[6] Expression suggested by Alain Nadaï.

press[7]. This administrative bottleneck had serious consequences for many companies in the sector, which found themselves facing serious cash flow problems for which they received no help from the banks. This situation, which can be described as one of clogging, rather than overflow, directly prompted two forms of reaction by the photovoltaic panel installers: in their economic strategy and in their political expression.

Table 3: Prosol Elec PV installation (by number of project, capacity and year)

Economically speaking, the contractors in the sector vary greatly in their capacity for action. The vast majority are small businesses with little capital, which are put at risk by these delays because they lack the capacity to work with longer payment timeframes. Many of them have been driven, if not into bankruptcy, at least into abandoning this activity (Interview with the owner of a small company, Tunis, 2012). Others, on the other hand, have been able to adjust their business and sales strategy, and even to take advantage of the situation by acquiring markets. One of the consequences is that the big installation firms started to avoid the subsidised market and targeted the large capacity customers for whom big installations are already profitable, even without subsidy (subsidies are capped at 2 KWp). The big installers realigned their financial and profit plans independently of the subsidy, by increasing the prices of their products, which are aimed at customers with greater investment capacity (Interview with a company owner, Tunis, 2014). Table 3 clearly confirms this, with an increase of the average size by project from 1.8 KWp per client to 2.8 from 2010 to 2015, indeed beyond the 2 KWp threshold. The consequence of the malfunctions in the system is therefore an "exit from the instrument", i.e. redeployment of the product to different populations, and a reconfiguration of the group of intermediate actors represented by the panel of producers and installers.

Their reaction has contributed to a politicisation of the instrument. The most obvious manifestation of this was the "crisis" of 2014, when the representatives of the solar industry expressed their discontent somewhat heatedly. A confrontation in the press between the head of the Renewable Energy Trade Federation,[8] ANME and STEG, brought these tensions into the

[7] Les fournisseurs d'énergie photovoltaïque, 'Cri d'alarme des fournisseurs de solutions photovoltaïques', *La Presse de Tunisie* (2012). http://www.lapresse.tn/13122012/59559/cri-dalarme-des-fournisseurs-de-solutions-photovoltaiques.html (accessed December 19, 2012).

[8] There are two trade federations in Tunisia related to the renewable energy sector in Tunisia: the Renewable Energies Trade Federation set up in 2003, and the Electrical Industries and Renewable Energies Federation (headed by the director of Soften), both affiliated to UTICA (Tunisian Industry, Commerce and Crafts Union Federation). While each claims to represent the sector, neither of them really seems to play this role, whether vis-a-vis the solar industry business milieu, which seems relatively weakly structured, or in terms of an interface with the public authorities.

public arena[9]. The positions put forward by representatives of the companies in interviews, criticise an administration that is perceived as incompetent, too slow, too pernickety, or else guilty of corruption and favouritism. It is the central role of the administration as the regulator of the system – "ANME rules the roost" (interview with the manager of a small company, 2012) – which is the issue, notably in its power to artificially circumscribe the contours of the sector through the licensing system. Indeed, some heavyweights in the sector, which account for most of the market, were calling for the system to be purged and for accreditation to be withdrawn from installers who had not been active for more than a year. They accused ANME of maintaining a large contingent of installers, regardless of performance, to send a political signal to foreign funding agencies and to legitimise its role. On the administration side, the existence of a degree of clogging was recognised, as well as the need for improved productivity (Interview with a manager of the PROSOL Elec program, ANME, 2014), and a failure of anticipation, in the event excessively timid forecasts regarding the demand for inverters and two-way metres, which were supplied free of charge in the early years of the programme (Interview with the Renewable Projects manager, STEG, 2014). However, the lack of flexibility in the adjustment of these orders automatically led to delays in connecting new users. But the main reason advanced by the administration was that the support programmes run by the international funding agencies (MEDREC, Italian cooperation agency) have dried up and have not been renewed, and that the FNME, funded by a tax on car registrations and air conditioners, is not enough to cover total demand. The Ministry of Finance not only refused to include any subsidy in the budget, but managed these funds very prudently to the point of not releasing all the amounts collected (Interview, Consultant on Renewable Energy, 2016).

Le Bourhis and Lascoumes [5] (p.508-509) provide a classification of resistance practices based on Hirschman's Voice/Exit/Loyalty typology (1970). These resistances take the form of bypassing (Exit) on the part of panel installers who reposition their business by becoming independent of the instrument, and of protest (Voice) by the same actors, in raising the alarm about the damaging effects of the instrumental mechanism on their businesses. The slowdown in the system, by provoking a reaction from the panel installers, revealed the existence of these intermediate actors who hold a key role in the implementation of the instrument, conceived in terms of an exclusive focus on its final beneficiaries, i.e. the users-producers.

[9] 'Les entreprises du secteur du solaire photovoltaïque victimes de leur dynamisme', *Webmanager Center*, 2014 <http://www.webmanagercenter.com/actualite/economie/2014/04/08/148560/energie-les-entreprises-du-secteur-du-solaire-photovoltaique-victimes-de-leur-dynamisme> [accessed 9 April 2014].

Debates about energy policy: the instrument's uncertain future

The other factor that has led to modifications in the instrument is market changes. Given the downward trend in the price of PV panels and the upward trend in electricity prices, investments in this field are becoming increasingly advantageous and are on a steadily rising curve. In consequence, representatives of the Energy Ministry and of ANME announced a medium-term objective (2017) of eliminating purchase subsidies, at least for the biggest users/producers. The change in the solar energy market has therefore prompted a readjustment in the nature of Tunisian public intervention, reflected in a resetting of the conditions for the allocation of financial subsidies, and in the process of reconfiguration of the target populations. In 2014, for example, a representative of STEG whom we interviewed criticised the terms of the buyback of photovoltaic electricity under the self-production system. As he noted, the planned rises in electricity prices would soon result in the situation where STEG would be buying electricity from home producers at a price markedly higher than the cost price. This increase in electricity prices, designed to reduce subsidies, coupled with the downward trend in the cost price of PV, would have the effect of introducing an obligatory purchase price.[10] According to the manager of Renewable energy projects at STEG (Interview, 2014), this would be highly – even excessively – profitable for this segment, leading to a financial transfer that would have to be borne by STEG. This argument can be understood as an attempt to put a check on the instrument to avoid its producing the same effects as in Europe, as he made clear during the interview.

Apart from the mechanisms for the payment and allocation of the subsidy, the crisis around Prosol Elec contributed to the development of a broader debate on the legitimacy of the instrument itself, and more generally of energy policy, which had an impact on the discussions about the revision of the renewable energy law on which parliament voted in 2015. Several interviewees at ANME and among the contractors saw the Tunisian government as having so far been too cautious in its approach and felt that a different instrument was needed to achieve a scaling up in the development of capacity. In the debates running up to the vote, there were voices raised on behalf of a renewable electricity purchase price system that would provide greater incentives. There were calls for a broadening of the base of the FNME through higher taxation on vehicles and air conditioners, but also on the KWh, on diesel and on imported second-hand equipment, on the part of actors who also believed in the need to encourage some

[10] The KWh is currently bought at the same price as it is sold by STEG.

kind of transfer of subsidies, previously focused massively on hydrocarbons (electricity production from gas or diesel, fuel subsidies), towards support for renewable energy. The monitoring of this mechanism and its nonproliferation would be guaranteed by a system of planning of annual energy needs, combined with the allocation of zones of high potential, and a distribution of this land resource between the national operator and the other operators.

As we ceased observing this debate after 2016, we cannot say how it evolved. However, it has to be noted that the internal conflict concerning the regulation of the instrument has been externalised and echoed in the debates on the relevance of the instrument and on the priorities of the financial mechanisms of energy policy. This suggests the existence of a certain *communication of resistances* between the spaces of public policy implementation and conception. The economic milieus of renewable energy production have invited themselves into a debate and a conflict of interests where the national operator's resistance and will to maintain its position of omnipotence in defining the world of energy policies does not disguise the fact that this omnipotence is increasingly under threat. Although the effects of the Prosol Elec crisis on debates about energy policy should not be overstated, positions hardened at the time of a legislative reform that took place in the specific political and social context of postrevolutionary Tunisia.

Concluding discussion

In examining Tunisia's incentive policies for solar energy, this article confirms that "the academic discipline of policy studies has much to offer to energy studies" (Hope et al., 2016). The study of the Prosol and Prosol Elec programmes as flagship instruments of the country's solar energy support policy sought to reconstruct the specific trajectory of these instruments by looking at both their design and their implementation, paying particular attention to the unexpected effects that they produced rather than criteria of effectiveness or relevance in the measures adopted**.** The findings are useful to advance in three directions.

First, they bring new light in the debate about the nature of resistance to energy transition in the South of the Mediterranean. The so-to-say stalled energy transition in Tunisia, except for the decentralized solar energy technologies, and the different path followed by Morocco, which developed a system based on CSP and PV centralized plants, illustrate the pitfalls of explanations that overemphasize "orientalist" narratives linked to geopolitics, violence and unreliable governments. They indeed usually overlook the real determinants of local choices, in particular the balance of power and the political economy that lay behind the technopolitics

of energy transition. In Morocco, this points to the alliance of foreign investors with the king's circle interests [39,40]. In Tunisia, the main reason hindering the move towards centralized renewable energy technologies is the reluctance of the national utility, STEG, to opening the grid to private interests. STEG's representatives advance technological factors, such as the grid's capacity and the cost of intermittency, but other factors also weight: the corporatist defence of jobs colludes with a self-perception of STEG's executive and unionists as the historical leader of Tunisian energy policies and their will to tightly control the transition. STEG has backed the decentralized solar technologies and their supportive instruments devised by the ANME insofar as this matched STEG's interest too.

The hailed "success story" of both instruments is an argument that strengthen a weak institution (ANME) in a political conflict. Because the instruments involve the monitoring of the installers, hence their census, it allows ANME (and its main partner, the German cooperation agency) to showcase the positive economic effect of the take-off of the decentralized energy technologies. As the instruments may cause delays and hurt private companies, and as some call into question the relevance of the instruments as the technologies seem to become mature, the instruments' role is not solely to foster technological change but also to legitimize weakened institutions.

The study then brings inputs in the discussion about the assessment of the temporal dynamics of energy transition. Sovacool has recently pointed to the need to disambiguate the definition of energy transition the dynamics of which one might want to analyse [41]. Our study illustrates one of his conclusions. If, at the macro level, Tunisia seems not to have started an energy transition, the two decentralized technologies however experience a promising take-off as they are gaining a growing market share. But on another side, the study also highlights that focusing only on the narrowed time frame of the technology take-off and its market share alleviates some important learning. In order to fully understand the instrument's career, the timeframe of study indeed needed to be fairly longer, given that this policy has a chaotic history marked by periods of inertia before it was ultimately implemented. It also required exploration beyond the energy field alone in order to resituate these choices within a particular economic, political and social context. Indeed, these solutions are the result of an assemblage of political preoccupations, including boosting employment, maintaining the operator's control of the grid, and a particular focus on the financial circumstances of households. Specific to the Tunisian context, these priorities explain the choice of measures to support the acquisition of equipment rather than the feed-in tariff methods implemented in other places. The study also showed the transposition of the mechanism designed for solar thermal energy (Prosol) to photovoltaic technologies (Prosol Elec): the accelerated inception of the latter cannot be dissociated from the jerky course of its

predecessor. Accelerating the pace of energy transition is difficult because it entails the management of complex assemblage of a milieu, a milieu that itself is transformed over the course of the transition, with the risk of creating new conditions disturbing and potentially reorienting the way the technology is appropriated on the market.

This leads to a third input this case study brings to policy studies as applied to the field of energy. The analysis of the implementation of the Prosol programmes has revealed the up and down career of an instrument and its avatars that have encountered several forms of *resistance* brought about by "unexpected, surprising or perverse effects" [5]. However, the resistance is not to the mechanism itself, which has in fact been well received by its target population, users-producers. In fact, it is precisely its popularity that has undermined its performance. The success of the instrument led to a bottleneck in the subsidy system. As a consequence the solar panel installers saw their businesses threatened. As intermediate but nevertheless essential actors, these installers then emerged as a 'new' target of the instrument. Their reactions were diverse, expressed either through exit from the instrument, or through a voicing of their complaints, both forms of *resistance*. The effect of the resistances to the instrument has therefore been to "reveal" essential actors who had not been taken into account in its initial development. The consequences of the slowdown went well beyond the strict instrumental mechanism, contributing to a debate over energy policy and its possible new priorities, and thereby challenging the legitimacy of the dominant players. In line with Nadaï and Labussière [3], the examination of the career and effects of the instrument reveals complex forms of causality and response characterised by the interwoven influence of market rationales that extend well beyond the Tunisian borders, strategies of adaption by the local economy, and processes of politicisation that alter the outlines of Tunisia's energy arenas. It showed the relevance of the notion of the *milieu* as applied to the instrument and of the effects of reciprocal influence between an instrument and its milieu.

Although this research was not conducted with the aim of producing policy recommendation, its results suggest that public authorities should look carefully at any controversy that arises during the implementation phase, not just as the proof of the resistance of incumbent actors. It may also entail to critically examine how institutions lead the implementation, recognizing that they have a vested political interest in pursuing a policy that not only achieved desired technological effects but also strengthen their legitimacy, as is the case with ANME. Energy transition does not only bring new technologies, but it is likely to transform society as a whole, and very often this fires back.

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The development of solar energy in Tunisia: management by instruments and resistance to energy transition

Table 1. Interviews carried out on the field

Category of stakeholder	2012	2013	2014	2016	Total général
ANME	5	2	2		9
Aid Agencies	3	1	1	1	6
Consultant	1			1	2
Private company	2	2	4	1	9
Ministry and other public institution	1	1	1		3
STEG	2	2	1	1	6
Total	**14**	**8**	**9**	**4**	35

Source: Authors

Table 2. Flowchart of the Prosol and Prosol Elec subsidy system

Stage	PROSOL (solar water heater)	PROSOL Elec (photovoltaic panel)
1	Agreement btw customer and installer, following advertising campaign and sales prospection by installer	Agreement btw customer and installer, following advertising campaign and sales prospection by installers
2	Application submitted to STEG district's office: check of the customer's profile (payment history)	Application submitted to STEG district's office: check of the customer's profile (payment history+ adequacy of consumption level to panel capacity)
3	ANME checks that installer is in its register, and approves subsidy	Installation – STEG provides an inverter (for free)
4	Installation	Once installation is working, ANME receives the application from the installer. Checks that the installer is registered, validates subsidy then paid to installer by FNME and MEDREC.
5	File transmitted to the bank, which pays the installer for the advanced sums (cost of device + work). The bank is beneficiary of a concessional loan from international aid organisations (AFD and other).	Upon validation, the bank reimburses advanced sums to the installer
6	Customer pays the credit on STEG bill. Every 6 months, STEG repays the bank with the amount of the credit reimbursement collected on the bills.	Customer pays the credit on STEG bill. STEG repays the bank with the amount of the credit reimbursement collected on the bills

Acronyms: STEG: The Tunisian Company for Electricity and Gas; ANME: National Agency for Energy Management; AFD: French Agency for Development; MEDREC: Mediterranean Centre for Renewable Energy

Source: authors synthesis based on Attijari Bank; AFD 2008; STEG 2010.

Table 3: Prosol Elec PV installation by number of subscriber, capacity and year

	2010	2011	2012	2013	2014	2015	2010-2015
Number of subscribers	139	451	1262	1468	2663	3492	9475
Installed capacity (KWp)	258	876	2760	3537	7344	10228	25003
Cumulated Capacity (KWp)	258	1134	3894	7431	14775	25003	25003
Average Capacity per subsciber	1,9	1,9	2,2	2,4	2,8	2,9	2,6

Source: Lehr and al. [16]