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Innovation territories and energy transitions: energy, water and modernity in Spain

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Abstract

This paper engages with debates about the need for a deeper theorisation of the political and spatial aspects of socio-technical transitions by examining the relevance of the concept of political technology for this body of theory. Political technologies are systematic and applied frameworks deployed to advance specific strategies to transform governments and societies. Looking at the role of political technologies within processes of systemic innovation, I propose that political technologies develop within socio-technical regimes in purposive attempts to transform them. From this perspective, socio-technical transitions emerge in relation to the visions that inspire them, the forms of knowledge that enable their implementation and how they relate to access to resources and innovations.

To illustrate the argument, the paper presents a case study of a socio-technical transition that took place in Spain with the consolidation of the electricity industry and the development of a national electricity network during Franco's dictatorship (1939-1975). Such transition was possible within the framework of a politics of building hydraulic works, whereby certain spaces where designated as reservoirs of water. The way in which such networks were constituted still resonates with Spanish energy policy today.

Keywords: Territorialisation, political technologies, energy transitions, hydropower, Spain

Acknowledgements

1. Introduction

In Spain, energy transitions go hand in hand with political debates. In 2013, the Spanish government restructured the energy sector passing a law that taxes electricity self-generation for all consumers connected to the grid. For those who had invested in renewables at a small scale this measure constituted a tremendous shock because it effectively meant that self-generation would be more expensive than buying electricity directly from large utilities. The decision was puzzling because, to date, Spain had played a leading role in the transition to renewables, for example, by being the first country in Europe to require the installation of photovoltaic panels in newly built developments. The government argued that this was a key measure to address the energy deficit, that is, the perceived gap between production costs and the income from the fees collected from consumers. Academic Mañé Estrada (2013) has described this as an unethical measure that, apart from compromising the development of renewable technologies, extracts surplus value from already impoverished energy consumers. In her words, the new law demonstrated that the major energy companies, acting as an oligopoly, had effectively 'captured the state', so that it operated to advance their particular interests.

In Spain, the politics of energy are grounded on a carefully calculated narrative of an energy deficit. The energy deficit has become the problem to solve, rather than the symptom of decades of energy policy. Yet, as a narrative, it has supported a process of energy sector restructuring which will likely maintain the paradigm of a centralised electricity network dependent on fossil fuels and nuclear energy, instead of contemplating the possibilities opened by a distributed electricity network that could incorporate a variety of energy sources, especially renewables. This represents both an attempt to redirect electricity rents to the main electricity utilities in the name of a putative energy deficit and to control the use and diffusion of new technologies. While in the short-term the justification is an economic one, the long term vision is one in which big producers continue to control the technologies for electricity generation and distribution.

This example illustrates the overarching theme that inspires this paper, about how socio-technical transitions unfold over space in tandem with complex political projects. The case of Spain shows how political and economic powers intervene in socio-technical transitions through attempts to control the territories over which sustainable innovations are allowed (or not) to unfold. In the case explained above, the use of renewables is sanctioned within existing provision systems but the law limits renewables when they are not fully integrated in the dominant energy markets. Critics such as Mañé Estrada argue that this regulation regime focuses on supporting large utilities to invest in windfarms and hydropower plants but effectively prevents small-scale generation with, for example, photovoltaic panels. In this way, the new regulation curtails access to new technologies to entrepreneurial citizens thus maintaining the dominant regime of electricity provision dominated by a few utilities. The socio-technical transition from fossil fuels to renewables in Spain depends on the political decisions that have led to restructuring the energy sector.

Socio-technical transitions relate to the spatial production of inequality in terms of access to both energy resources and innovations with the potential to challenge incumbent regimes. Political technologies refer to technologies, applied frameworks to think systematically about the world, which can be deployed to advance political projects, that is, deliberate attempts to

transform society and space (Collier, 2014; Lakoff & Collier, 2010). For example, in the case of the restructuring of the energy sector in Spain, the calculation of the energy deficit is a key political technology which casts responsibilities for energy production as part of a national project. Territories, in particular, are political technologies which helped in the formation of nation states (Elden, 2010a). Where innovation has been crucial to develop territorial logics, such as with the construction of electricity networks, innovation territories are political technologies which link processes of socio-technical change with broader political projects.

For the best part of the 20th century, energy utilities in Spain were able to shape both energy and territorial policies, from structuring distribution networks to designating spaces and populations in relation to energy generation needs. The 1940s in Spain marked a transition from a fragmented landscape of energy production with multiple private electricity providers to the concentration of production in a few large companies driven by public investment and the constitution of a national and centralised energy distribution network. These developments paved the way for a new transition two decades later from a distributed system of medium-sized hydropower plants to large thermal energy plants. Overall, these events marked the consolidation of the transition from small-scale generation to a unified energy network in Spain during the period of Franco's dictatorship, from 1939 till 1975. The transition towards a centralised energy network is a paradigmatic example of how technological transitions are linked to political technologies that map such transitions over specific locations.

Historical studies of socio-technical transitions have drawn on the multi-level perspective (e.g. Geels, 2002, 2005, 2010) as a heuristic to map dynamics of change. In this paper I argue that the notion of political technologies may address some of the blind spots of the multilevel perspective and cognate theories, in relation to politics and space. This is done, in the tradition of the multi-level perspective, with a historical analysis of energy transitions in Spain, written in a manner that emphasises its linkages to political and spatial projects. The case illustrates the deployment of political technologies for socio-technical change in relation to: 1) visions of modernity, technology and nationalism; 2) mechanisms of technological calculation; and 3) a system of inclusions and exclusions affecting both spaces and technologies over a given territory. Characterised by these three aspects, innovation territories emerge as political technologies that shape the dynamics of socio-technical transitions.

2. Political technologies and socio-technical transitions
In the last years an interest in politics has shaped debates within the field of transitions to sustainability (Avelino, 2009, 2011; Hendriks & Grin, 2007; Meadowcroft, 2009, 2011; Shove & Walker, 2007; Smith & Stirling, 2010). Questions of power, management and purposive change have always been integral to studies of socio-technical transitions. In debates about transitions to sustainability, tied to the analysis of transitions in-the-making, much research has focused on the governance and management of transitions (e.g. Elzen, Geels, & Green, 2004; Grin et al., 2010; Loorbach & Rotmans, 2006; Smith, Stirling, & Berkhout, 2005). Transition studies have thus studied the actors who intervene in transitions, their capacity and motivations and how they are able or not to steer transition processes in particular directions (Smith & Stirling, 2010; Smith Stirling, & Berkhout, 2005). However, scholars have called for both a deeper theorisation of power (Avelino, 2011) and an understanding of how socio-technical transitions relate to spatial transformations, with specific political consequences (Coenen et al., 2012). Coutard and Rutherford (2010) emphasise how

systemic change impacts are spatially differentiated. What is missing in most analyses of socio-technical transitions is a specific consideration of how socio-technical change is territorialised, that is, how it is purposively ordered over space, and the political consequences of this process.

Innovation territories are a type of political technology that relates socio-technical transitions to the deployment of a political project over space. The notion of political technology builds upon Foucault's theory of the art of government as 'the conduct of conduct', that is, the governance of individual subjectivities so that individuals and groups regulate and order their actions and social relations (Foucault, 1991). Governmentality refers to an apparatus of techniques that aligns institutions, actors, procedures and rationalities to maintain the social order (Dean, 2010). Such techniques can be thought of as political technologies because they play a key role in coupling a set of practices with a regime of truth (McMahon, 2015). They are 'technologies' because they consist of systematic frameworks to think practically about the world in order to determine how to change it: they involve a process of rationalization (Collier, 2014; p. 4). They are 'political' because they are directed towards the regulation of communities and institutional regimes (Boyd et al., 2014).

An institutional regime consists of an ensemble of norms, procedures and conventions that regulates conduct. Political technologies enable the exercise of political power by transforming or maintaining such regimes (Frankenberg, 2014). Moreover, these institutional regimes give meaning and enable the deployment of political technologies (Ibid). In this reading, political technologies are most often thought of comprising government administration, legislative and regulatory practices, and other security practices conducted by any public or private actors at the service of the state. Alongside statisticians, lawyers and politicians, engineers and experts play a key role in the construction of the state. Because political technologies draw attention to the production of applied knowledge, they are intimately linked with processes of social and technological innovation.

This notion of institutional regime, as structuring power relations, stands in contrast with the notion of socio-technical regime, the unit of analysis in transition theories such as the multilevel perspective. Socio-technical regimes are understood as complex arrangements of technologies, resources, beliefs, practices and norms which appear as stable structures and resist change (Dijk, Orsato, & Kemp, 2014; Geels, 2002; Kemp, 1994). Like institutional regimes, socio-technical regimes can be seen as an ensemble of norms and procedures, with the explicit inclusion of technologies, material objects and the institutional frameworks that embed them in social settings. However, socio-technical regimes relate to a particular system of use that organises objects and meanings for a quotidian purpose. In some sense, socio-technical regimes could be thought of as institutional regimes related to the regulation of conduct around a particular artefact, such as the car, the switch or the toilet. A socio-technical regime presumes the inscription of uses and norms of use. While institutional and socio-technical regimes are not strictly the same, there is a close relationship between the ordering of both types of regimes. Political technologies involved in the dynamics of socio-technical change represent intersections between both regimes. Analysing political technologies is thus a strategy for the study of the politics of socio-technical transitions.

In the context of the making of nation states, Elden (2010a) has defined territory as a political technology comprising techniques for measuring physical land and controlling strategic terrains. He regards territory "as something extensive and calculable, extended in

three dimensions and grounded on the geometric point" (Elden, 2005). While he traces the birth of territory in relation to the development of the modern state, he highlights that territory boundaries are not as important as how territories are calculated because the process of territory demarcation makes exclusion and control possible (Elden, 2005, 2010b). Calculative projects for the technical and the legal demarcation of territories signal economic and strategic projects of space ordering. Painter (2010) has described territories as the outcome of networked socio-technical practices. This means that the relationship between technologies and spaces cannot be reduced to how spatial patterns influence the formation of technologies or how technologies can explain the formation of particular spatial patterns as if any of them could be an explanatory factor for the other. Instead, the question is how is it that both territories and technologies are simultaneously constituted within particular arrangements and assemblages of material technologies and discourses.

Sometimes processes of socio-technical change are intimately linked to the constitution of a territory, in the strict political sense. This is exemplified magisterially by the technology historian Schiffer (2005) who analysed the pioneering use of the electric arc in lighthouses as a means to perform safe maritime practices. This technological change played a key role in international relations during the nineteenth century in countries such as England and France. Electric arcs in lighthouses became a political technology because of their symbolism as "conspicuous beacons of modernity" (Ibid, p. 294). Electric arcs in lighthouses were intimately linked to the formation of innovation territories.

Innovation territories refer to territories in which a political project of purposive change depends on socio-technical transitions. Socio-technical transitions are most often imagined on a national scale precisely because ideas of modernity in the West have been predicated over the explicit connection between socio-technical transitions and nation-building projects. In countries like Spain, for example, the constitution of a national territory has come hand in hand with technological transitions that enable the nation state to claim authority over particular peoples and places. In summary, political technologies relate to forms of authority that shape the possibilities of action for people and the territories in which they live (Foucault, 2010). The deployment of an active project of purposive change can be linked to a will to improve that expands into multiple spheres of life (Li, 2007). The success of different actors in deploying political technologies for governing is related to their capacity to make their case compelling and calculable (Bulkeley, Castán Broto, & Edwards, 2014). The formation of innovation territories, as political technologies, requires both a compelling vision and a series of techniques of calculation to link proposed practices to field truths in the Foucaldian sense.

Making compelling a case for innovation requires a series of persuasive arguments that organise an effective constellation of actors around a shared problematic (Bulkeley, Castán Broto, & Edwards, 2014). For example, when a transition is coupled with a particular identity project, such as building a nation in the name of progress, it will be constituted as an innovation territory. Thus, as sovereignty projects, innovation territories are linked to the production of compelling visions. While the notion of future visions is salient in studies of transitions to sustainability (Loorbach & Rotmans, 2006), political technologies also draw attention to the ways in which the constitution of technological assemblages is mapped onto the development of imagined territories over which such technologies are overlaid. In the context of nation states such as Spain, technological visions have inscribed national identities in innovation territories.

This process of territorial authority is also predicated upon the capacity of the state to establish suitable practices of calculation which align a compelling vision and a constellation of actors with the possibility to deploy such projects over space. The demarcation of field truths over space requires both a repertoire of accounting techniques, directed towards bringing field observations with compelling practices, and a series of subjectification techniques that facilitate the normalisation of those truth making practices. From surveying to economic valuation technologies, the constitution of innovation territories is most often related to the inscription of given locales in networks of global circulation but it also requires the enrolment of local actors. The effectiveness of a technology in a given socio-technical context depends on the constant rearrangement of alignments between ongoing discourses and material transformations (Moss, 2014).

Such rationalities pertain the deployment of technology and its insertion in existing planning systems and bureaucratic apparatuses. Political technologies thus draw spaces of exclusion and inclusion because they establish patterns of resource access and environmental impacts and predetermine who has control over the process of technological innovation. Who has access to technology is as relevant as who can influence the process of technological change. Overall, the concept of political technologies relates transitions studies to three issues: the creation of compelling visions of territorial and technological development; the calculations directed at translating such visions onto space; and the demarcation of areas of inclusion and exclusion in relation to a given technology (Figure 1). These aspects structure the analysis of the empirical case of the production of hydropower and hydraulic politics in Spain.

[Insert Figure 1 about here]

3. Hydropower and territorial regulation in the rivers Ara and Cinca in Huesca, Spain

The history of water politics in Spain is read as a national project around the 'hydraulic paradigm', that is, the idea that there is an injustice derived from the scarcity of water for irrigation which can be easily solved through large hydraulic works (Saurí & del Moral, 2001). Swyngedouw (1999, 2007) has described such water politics in relation to visions of modernity that emphasised the need to control nature and which later evolved into scalar tactics and strategies that matched Franco's fascist project and the dominant rhetoric of agricultural development. While state actors led the development of hydraulic infrastructure, a network of varied interests- hydropower,construction companies and farmers associations- worked together to promote and benefit from this strategy (Pavón Gamero, 2012).

Hydropower has played a key role in Spain's water politics project (Frolova, 2010). The hydraulic paradigm was coupled with a technological project that led to the consolidation of the electricity industry and the growth of electricity production (Arroyo Ilera, 2008). The alignment of fascist nation-building dreams with the interests of the nascent electricity industry led to the consolidation of territories of hydropower and fundamentally shaped the modernisation project in Spain. This was made possible through a transition from a fragmented landscape of electricity production to the consolidation of institutional and physical infrastructures of energy production and distribution. Such project also required the ordering of land and population, as the former was classified into different forms of production and the latter was relocated to reservoirs of labour.

The multi-level perspective can be applied to explain the transition towards electricity, which initially was promoted in niches, with the development of local distribution systems led by small private companies such as the pioneering company 'La Catalana' in Barcelona. Small private companies based their distribution on direct current systems and hence, forced companies to generate electricity close to the place where it was used. The introduction of alternate current distribution systems in the early 20th century enabled a move from distributed to centralised generation systems. This was the first step towards the consolidation of the electricity network in a few large companies with large generation facilities at a time in which more than 70% of electricity production was generated in hydraulic plants. The establishment of Franco's dictatorship and the raise of a hydraulic politics provided the perfect landscape for the consolidation of this socio-technical regime, and the spread of a centralised electricity system over the whole Iberian Peninsula. The deployment of a centralised electricity network in Spain was akin to the constitution of hydropower territories as political technologies, which would discipline both land and population to conform to the demands of Franco's regime. This is something that the multi-level perspective does not fully explain.

The constitution of innovation territories is particularly visible in Spain when looking historically beyond the constitution of electrical territories as a national project, focusing instead on how such project unfolded in particular locales, and the extent to which it was successful in translating modernity discourses to concrete locations. The analysis in the following sections focuses on the technological transition and the constitution of a highly symbolic hydropower territory in the river Cinca and its subsidiary, the Ara river, within a broader area called Sobrarbe. These rivers mark the heyday of hydropolitics in Spain and their dismissal at the end of the 20th century. The Cinca is today a giant reservoir with two gigantic dams- El Grado and Mediano- and a rosary of hydropower installations shaping its ecology. The Ara is today a wild river, but its history has been shaped by a hydraulic project originally conceived in 1917 and dismissed in 2001- a century of projecting hydraulic politics over space. The parallel histories of these rivers demonstrate the constitution of innovation territories through technological transitions.

This case study has been assembled from an heterogeneous set of materials, to reconstruct an historical account independent from dominant discourses of modernisation and electrification. This set of materials includes historical records held in the provincial archive of Huesca and the local archives of the villages of Mediano, Tierrantona and Fanlo. This is a highly fragmented collection of documentation from 1939-1975 relating to both the projecting of dams and the responses to them. Thus, the collection includes actual planning documents submitted by hydropower companies, notifications of expropriation, municipal edicts, letters to and from affected residents and other documentation that relates indirectly to the cases (for example, an extensive administrative record of the relocation of Mediano after flooding). These records were complemented with records from the archives of two regional newspapers (Nueva España/Diario del Altoaragón from 1936 to today; and Heraldo de Aragón from 1909 till today), which contained information about the context of hydropower development pre-1939 and provided some fragmentary information of regime-sanctioned views on dam construction from 1939 till 1975. The documents above contained no records of contestation to the building of dams, largely because the dictatorship's information apparatus censored any kind of opposition to mainstream views. Thus, alternative accounts of the implementation and impacts of the projects were assembled using documentation

published post-1975, including, for example, allegations and written communications against project documentation submitted during two periods of public inquiry in 1982 and 2001, some of which document some aspects of the history of the case. Informal unstructured interviews about experiences of displacement were conducted with 11 individuals that had lived in villages flooded by the dam. Secondary sources were also used, including a study of depopulation in the area of study that compiled both population records in church archives and ethnographic information about the structure of society before and after the construction of the dams (Cuesta, 2001). The narrative focuses on the constitution of innovation territories hydropower production. Following the rationale proposed in Figure 1, the following sections describe : 1) the constitution of compelling visions of hydropower territories; 2) the deployment of specific techniques of calculation to control territorial processes and how local residents where enrolled, forcibly or not, into the process; and 3) the demarcation of spaces of exclusion and inclusion, especially, with regards to the development of technology and the dynamics of transitions.

3.1. Compelling visions of hydropower territories
The transition towards a uniform electricity network in Spain meant a conjoining of 19th century ideals of supporting farmers through irrigation and the change of scale in energy production that took place after the Spanish Civil War (1936-1939). An agricultural modernisation vision followed the leadership of the Regenerationist movement at the end of the 19th century, an intellectual movement that sought to reimagine the political, social and economic system for a workable model of nation. The writings of one of its main thinkers, Joaquín Costa, constitute a call to move away from a decadent imperial history and focus instead on creating an educated, collective and reciprocal society. Costa addresses the farm labourer dispossessed by the corrupt redistribution of land and its concentration in large unproductive estates. Costa, with other regenerationists, conceives the small irrigated plot as the solution for the peasant, as it may allow for quality produce and diversification. The peasant is thought of as a servant of the plough; he needs to command it and to do so, needs to enlist the support of engineers and governments to harness the richness of Spain:

> "*We have immense reservoirs of water in the mountains, and we can spill them with mathematical regularity onto our country, crossing it with an arterial hydraulic system that mitigates its heat and thirst…*"

In this account, water is the blood of Spain and the labourer its muscle. Costa's discourse was directed in this way towards a nation building project (Swyngedouw, 1999). Solidarity between regions and between people to support the government in decisive actions was central to the Regenerationist discourse. Water works were also recognised as symbolising state power. This was a discourse that galvanised public opinion across the country, with ample calls for political leadership. The very constitution of hydraulic works as public goods, and the legal frameworks that made them possible, were very much under discussion during the first decades of the 20th century but this policy was not fully realised until the end of the civil war in 1939. In the late 1920s, extensive debates took place regarding the constitution of both irrigation fields and the ideal farmer that the uneducated labourer should transform into. The newly constituted hydrographic confederations, state organisations which governed river-basins, played a key role in constituting experimentation camps to demonstrate the operation of irrigation systems.

In the meantime, a parallel development was shaping the energy landscape. Experimental demonstrations of electrification in Barcelona and Madrid attracted investments and the first generation of small and private electricity companies quickly spread across the country. This was a wave comprising numerous companies of small capacity which represented the bulk of investments. Small companies were flexible enough to reach remote territories and thus, they contributed to extend electricity services over the national territory while bigger companies remained circumscribed to large urban markets such as Madrid and Barcelona (Balmas, 1995). The development of alternate current applications at the turn of the century made it possible to transport energy at great distances, and thus, led to the construction of the first large hydropower plants. Despite these advances in centralised generation and distribution, small providers remained active, particularly in areas where they could maintain the local supply with a relative small hydraulic installations. Towards the later 1920s the electrical sector underwent a profound transformation, tending towards the intervention of the state in investments in electricity networks and a change of scale in production that favoured larger hydraulic projects.

This transition accelerated when Franco took power in 1939 after the Spanish Civil War. In 1944, the 17 largest electrical companies of Spain, backed by a ministerial order, formed Electric Unity (UNESA). The main objective of UNESA was to combine existing networks into a unique national network, but it effectively constituted a unified market and established an electrical oligopoly. The achievement of this oligopoly was to match their interests with those of the associations of farmers and enrol the government in the construction of great dams to the point that hydraulic planning "was adjusted to the rhythm established by hydroelectric societies" (Arroyo Ilera, 2008; p. 43).

This amalgamation of discourses for electricity generation and irrigation was predicated on two assumptions about the relationship between environment, society and development which came to be acutely felt in the region around the rivers Cinca and Ara. First, there was a merge of public and private interests when the interests of electric companies were conjoined with the government's interest and the interests of irrigation farmers associations. Irrespective of their actual interests, their actions were underpinned by a common objective: building hydraulic works. Second, in line with a broad technocratic discourse of nature domination, there was an assumption about the possibility to 'sacrifice' certain regions in the interest of the national economy.

Such assumptions began to crumble in the 1970s, and hence began the questioning of the hydraulic paradigm. By the 1980s, when the vision of hydropower territories began to be questioned, hydropower had lost its share of the electricity production of Spain, passing from 78% of the market in 1940 to 43% in 1980. The discourses that made hydropower compelling during the dictatorship lost their power during the transition to democracy. The history of the Jánovas dam in the Ara river exemplifies this evolution. In 1944 Hidroeléctrica Ibérica IBERDUERO S.A., now one of the electric giants of Spain, acquired two concessions dating back to 1917 and 1923 from a small company "Applicaciones Industriales". However, the first plan of 1945, approved in 1950, did not materialise. The company redefined the project to draw further capital, trying to gain support from the traditional network of actors within the hydraulic paradigm. However, as elaborated below, the changing political and social landscape changed the terms of what was acceptable before the company could adapt to a changing landscape.

Iberduero presented a daring project in 1972 which increased the capacity of proposed dams and argued that road works and expropriations should be financed by irrigation groups and other supposed beneficiaries (except those benefiting from the hydro-electric concession). Iberduero argued that these measures were needed to adapt to changing electricity markets: economic exploitation of the dam required both an exponential increase of scale and the collaboration of the whole society for the public good. The administration remained silent during 10 years and when the period of public allegations was reopened in 1982 public support for hydraulic works had waned. Statements that during the dictatorship seemed reasonable, such as the possibility of financing hydropower projects by means other than private, were now put into question. The administrative records of public allegations[1] contain for example a letter from Santiago Marraco, then president of Aragón and a champion of the interests of irrigation farmers, in which he argues that Iberduero must, in any case, demonstrate the benefits for farmers and pay for works to channel the water to irrigation fields. The post-Franco democratic system also opened up the possibilities for new arguments about local development, the need to stop the rural exodus and the growing environmental impacts of dams. In the same administrative records, for example, there is a letter from the major of a local town, Ainsa, in which he presents an impact study and argues that the project has near to null local benefit, that the jobs created (estimated in 720 per year) are overestimated and that the environmental impacts will be unbearable. The newspaper pages of both the Heraldo and the Nueva España are full of letters of protest against the project.

Hydropower projects were compelling within a particular conjuncture of water politics but once such vision waned their potential dwindled, because making such large infrastructure projects profitable depended on making a compelling vision that would draw direct capital investment from the state.

3.2. Subject making and the calculation of hydropower territories
Within the hydraulic paradigm, the calculative effort was interpreted as a struggle that required the coordination of multiple technologies and objectives. In the 1950s and 1960s newspapers regularly reported on updates on the hydraulic development of plans, how they were funded and their implementation. Franco's nation-building project followed a narrative of war, and national territorial politics were interpreted as a battle: "In a battle, states draw a coordinated plan of all the elements that they suppose the enemy has. Once the plan is ready, the battle starts. In this plan… the Ministry of Public Works and of Agriculture have a great task in the execution and implementation of the Works. Hence the need for a coordination plan"[2]. Calculating- in the form of a plan- precedes the control of space. The hydropower 'battle' was fought against both nature and the local economies which were perceived as an obstacle to progress.
The constitution of hydropower territories was mediated by the figure of the engineer, as a director of territorial and technological ordering. In Spain, engineers were thought of as state-makers and, as portrayed in the local literature (Pallaruelo, 2011) and interviewees' accounts, as 'semi-gods' that could make and unmake the lives of people. Engineers of the territory, for example, organised in a quasi-military body with uniforms, discipline procedures and ceremonies (el Cuerpo de Ingenieros de Montes), planned how different areas were to be included in a national modernity project. Remote valleys such as those of the Ara and

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[1] Huesca Provincial Archive
[2] Nueva España, 24/11/1960; no 7465.

high Cinca were deemed not worthy of development and thus, engineers argued that such areas should be preserved for other uses such as electricity production and recreation. Cuesta (2001) has painstakingly described the process of depopulation in Sobrarbe in relation to its integration in a global productive system in which the territory was designated as both producing energy and constituting a 'reservoir of territory'. In both cases, spatial transformations were related to attempts to colonise the space and support other regions, through energy generation for the industrial development of distant cities. Engineers applied a logic of accumulation over such 'reservoirs of territory' which was materially represented in the construction of dams. Local geographers have described Sobrarbe as resulting from a process of endogenous colonialism (Pallaruelo, 1984), whereby actors not totally external to the territory exploited it for the benefit of uses elsewhere without any resulting benefit for local economies. Such ordering took place at every level from the consolidation of a national development vision to the disciplining of populations to conform to such vision. Spatially, engineers brought with themselves mechanisms of spatial ordering such as land surveying, communication infrastructures, demarcating and designating use zones and controlling the spread of specific services.

For example, in the early 1950s in Mediano, the dam works brought big social changes with the immediate growth of the population because of the arrival of salaried workers to build the dam. The works introduced cash-paid salaries which also brought in commodities and new lifestyles. Many interviewees remember, for example, the first purchases of cars in the area. Subsistence farming and the traditional social model which tied the fortunes of people to their houses became unviable. Former residents of Mediano also remember vividly the arrival of a new engineers' class, which lived in isolation from the rest of the village. These engineers, who were defining the futures of everyone living in the village, actively maintained their distance from the villagers. Though they lived in the same location, people hardly saw them. Engineers and their families had their own social clubs and attended a separated church service. Villagers saw them living in opulence, with lifestyles very different to those they were accustomed to. The conduct of engineers established a separation between villagers and any representatives of the state apparatus so that villagers affected by expropriation had nowhere to direct their demands.

There was no contact between those who established the fate of local area and those who were affected by those decisions. In this way, the ordering of space became accompanied with an ordering of population: population had to move from areas which "development could not reach" to those areas where they could bring their labour to fruition for the envisaged modernisation of Spain. This was done in two ways: first, through forcibly removing people from designated unproductive areas to those deemed to be productive; second, through the dismembering of the local economy. Dams flooded the most productive parts of the valley, leaving villagers to survive in fragmented estates of marginal land. Villages like Mediano, at the bottom of the valley, were also market towns and constituted nodes of communication for a constellation of smaller settlements that could not survive once the market town had disappeared.

Land expropriation was the key means whereby people were forcibly removed from their original villages. The process of expropriation was calculated so as to facilitate population migration. In the municipal archive of Mediano a note marks the expropriation of the first eight estates in 1940. Expropriations of the estates to be flooded, 68 according to a 'provisional list' sent to the municipality to warn residents, took place later. A gap of more

than 10 years between the time of the valuations (1942-1954) and the payment (1963) meant that the prices actually paid hardly corresponded to the value that the land held for residents. Valuation was a key means whereby certain interests were prioritised over others. Villagers' interests were only considered in relation to the possibilities to facilitate their rapid movement from the 'reservoirs' of space to the flat lands and cities where labour was needed. Measures to support the hardship of these villagers also served the state interest of space occupation. For example, an Act published on 26/5/1950 allowed the villagers to demand a full expropriation, that is, they could ask for the simultaneous expropriation of the most fertile land to be flooded by the dam and the marginal lands in highlands. Many Mediano residents bequeathed voluntarily all they had.[3]

Calculation techniques emerged together with the constitution of subjects who acted upon the project of modernity and left it unquestioned. This has been more apparent in the constitution of the ideal farmer in the colonisation projects that followed the construction of Mediano, in which farmers receiving irrigated land would be instructed to follow a series of measures for cultivation, including the use of fertilizers and pesticides which were regularly evaluated through visits from agricultural engineers who had the power to dispossess them from newly established plots. In Mediano, people were enrolled not just because traditional economies were ill suited for the insertion of the local economy in global economies but also because of the lack of alternatives for local development. Hence, many residents actively joined the flows of population to those areas which were considered productive.

In 1953 residents in the nearby villages of Arasanz and Pampalacios requested the full expropriation of all their possessions in the hope that the National Institute of Colonisation, which regulated new settlements, would give them a plot in one of the new colonisation towns. They argued that "*if they did not meet the optimal conditions to be a colonial farmer according to the requirements of the National Institute of Colonisation, then it should be considered that they are forced migrants from the area of the dams of Mediano and El Grado, and hence this is not a voluntary request, but one that they make forced by the current circumstances*".[4] The exchange of land in flooded areas for newly irrigated areas in the lowlands was common practice. A small group of former residents stayed behind and moved the village to what originally had been a neighbourhood of Mediano called Samitier. When they requested governmental support to reconstruct the infrastructures that the dam had destroyed, especially the provision of electricity, the civil governor of the province responded that this area was not designated as an area that could benefit from 'that kind of help'.[5] Thus, governmental support to access modern infrastructures and technologies depended both on the fit with the ideal model of colonising farmer and on the specific location for which the support was requested.

This was a calculative effort that attempted to control resources, spaces and populations in the name of the deployment of a hydraulic politics portrayed as the national interest and which effectively supported the development of an electricity oligopoly. Both people and water were a 'surplus' that had to be redeployed elsewhere. This effort enrolled many of its victims, especially those being displaced by hydraulic projects, creating subjects that could

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[3] As documented in a collection of letters dating from august 1951; Archivo Provincial de Huesca, Huesca.
[4] Municipal archive of Mediano.
[5] As explained in an exchange of letters between residents, the mayor of Mediano and the civil gobernor dated from the 25/05/69, 8/9/69, 1/10/69 and 31/10/69 and preserved in the Municipal Archive of Mediano.

be integrated in a new global economics of electricity and agriculture production. Thus, hydraulic politics need to be understood within a particular moment in the political history of Spain in which the triumvirate of state, energy companies and irrigation associations found a fitting narrative and a form of repressive state in which there was no questioning of both the goals of hydraulic politics and the technical assessments of the engineers. The political transition to democracy, however, brought an entirely new state of affairs for the the acceptability of social and environmental impacts. While dams continue to be built (although the rate has slowed considerably since the 1990s) there is a serious questioning of their inevitability. Thus, while the Mediano case illustrates the governmentalities that made it possible for the hydraulic paradigm to subsist for the best part of the 20th century, the case of the Jánovas dam in the subsidiary river Ara exemplifies the limits of the technologies of the hydraulic paradigm. At the end of the 20th century the arguments about what constituted progress and who had a say on it had dramatically changed in Spain. New forms of calculation had emerged which pointed towards a deeper examination of environmental impacts. The revised plan of Iberduero was finally suspended in 2001 with the publication of an environmental impact assessment that emphasised the negative impacts of the project over the territory.[6] A century too late, the assessment said nothing of the lives of those who were affected by the project, and how these changed over the course of a century in the constitution of hydropower territories.

3.3. Hydropower territories and the production of inequality
Innovation territories create inequalities which cannot be explained away as part of the project of spatial and social ordering. In 1951, Iberduero's revised plan for the Jánovas dam, including four jumps, was declared of public interest in a governmental order that established that "*the company will pay all the damage caused by the dam works and their use. The problems derived from the expropriation should be previously examined in their social and economic aspects, to compensate the local villagers with humanity and justice*…"[7] The list of affected owners was published in 1960, and affected villages were informed by letter in 1963.

Iberduero did not treat all the residents in the same way. Initially they attempted friendly agreements. Bigger landowners were offered the best deals which they took immediately but less fortunate villagers received worse offers. Residents did not know how land prices were calculated. By 1966 only five families remained in the town of Jánovas. Then Iberduero exchanged voluntary purchase tactics for violent threats. The company's employees visited the village regularly accompanied by the rural police, the Guardia Civil, and threatened residents with eviction. Letters as the following demonstrate the absolute disregard that some Iberduero employees had for the people displaced:

> "*Because of the works on the Jánovas dam, this enterprise has started the demolition of houses acquired through voluntary agreements, as stated in the contracts that we have in our hands. Therefore we notify you that to avoid any harm you should deliver the keys of your house in the company's premises. If the key is*

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[6] «BOE» núm. 36, de 10 de febrero de 2001, páginas 5188 a 5195 (8 págs.)
[7] Huesca Provincial Archive

not delivered, demolition works will go ahead regardless and this company will be exempt of responsibilities for any damage that the demolition could cause you"[8]

A campaign of physical destruction ensued whose objective was to make the village inhabitable. Iberduero's workers destroyed the houses acquired through voluntary expropriation and the common infrastructure to persuade the remaining families to abandon it. They even demolished a nearby house next to the school while a class was taking place. This was a campaign of terror.

In the meantime, no works took place in the dam. By then, Iberduero had proposed a larger dam more suitable to the growing generation needs of the company. What we see here is the constitution of worthless lives, which can be disturbed, ridiculed and threatened, in the name of progress. The separation of people from space, the undervaluation of their lives and the prioritisation of a technocratic project of electricity production were key elements in the creation of hydropower territories in both rivers Cinca and Ara.

What is less understood is the extent to which the politics of electricity shaped the possibilities to access technology. The innovation enthusiasm of the early 20th century had supported the creation of numerous small companies with private capital which developed small continuous current circuits. Electricity was generated near the place of use. In Sobrarbe, from the early 20th century, there was also a proliferation of "electricity factories", managed as common property, in neighbours associations or privately, to generate electricity where it was consumed. Cuesta (2001) has found archival evidence of 16 such electricity factories in Sobrarbe which operated at low power (from 3Kw to 30kw). These factories provided lighting and power services. While the supply of electricity in this manner had evident problems, especially regarding the reliability of the service, 'electricity factories' enabled local residents direct control over the use of electricity production technologies.

These electricity factories disappeared with the arrival of large national utilities for energy production and distribution. They operated at a very small scale and hence, they were almost irrelevant for big utility companies except in cases in which they were absorbed into the network, for example, to support transmission services. The presence of the big utilities in Sobrarbe, such as Iberduero, since the late 1920s meant the incorporation of larger population centres into larger networks. Electricity factories continued to operate in marginal spaces which were not provided by larger companies because they were unprofitable. The gradual deterioration of technologies, migration of population, dwindling local capital and the lack of institutional support meant that local electricity factories gradually disappeared. In some cases, the local electricity network was maintained in precarious condition via the reutilisation of abandoned infrastructure. In some cases, one villager alone had to maintain the installation with limited capacity and considerable risk. Many villages lost the electricity supply and were not electrified until the democratic transition of 1975-1978, when the construction of infrastructure became a priority to stop a perceived rural exodus. With the loss of electricity factories, habitability conditions in remote villages deteriorated. There was also a missed opportunity to develop locally adapted technologies and communal institutions for energy production, in favour of a centralised, large-scale model of electricity generation and distribution.

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[8] Letter sent to Emilio Garcés. Private records. Translated by the author.

Thus, the constitution of a national electricity network in Spain was translated into specific politics of inequality production, both in terms of how spaces were shaped and who could access the process of technology enhancement and development. Innovation territories were not just ascribed to specific political visions and mechanisms of calculation, but also to the structuration of the technological space with implications for the politics of transitions.

4. Conclusion

While the renewable transition is still unfolding, the previous transition towards a unified energy network during the dictatorship in Spain demonstrates that the entrenchment of socio-technical regimes depends on the constitution of innovation territories, and these in turn are an expression of political technologies that influence energy transitions.

The notion of political technology makes explicit the spatial and political aspects of transitions. Focusing on innovation territories highlights the construction of visions as a political process with spatial implications and their dependence on suitable techniques of calculation, which refer both to the control of space and populations. Moreover, the notion of innovation territories emphasises that socio-technological change is tied to the production of inequalities, especially regarding the capacity of certain social groups to actively steer transitions to sustainability.

In Spain, the constitution of specific visions of hydropower territories was made visible in the constitution of the modern electricity system in Spain in which a modernity project was tied to idiosyncratic hydraulic politics that focused on reimagining the figure of the labourer for the progress of the nation. Diverse methods of calculation and territorial control were deployed in the constitution of hydraulic politics, from the design of the dams themselves to the constitution of appropriate regulatory and valuation frameworks that would ensure such politics achieved the envisage purpose. In this process there was a demarcation of spaces of exclusion and inclusion, made visible for example, through the process of expropriation as well as through a process in which particular socio-technical configurations- within a unified, centralised network- were favoured over decentralised models of electricity provision.

Changing political landscapes meant a challenge for carefully constructed technological territories. With the advent of democracy the conditions for the maintenance of the hydraulic regime rapidly deteriorated. While some remnants of this form of hydraulic/hydropower politics persist, projects like Jánovas- and the violence associated to them- are not conceivable today. This leads to a broader question about the extent to which changes in the landscape, the ebb and flow over which regime actors have no influence, may render successful political technologies unviable. On the one hand, while territories may be characterised by strategic projects of socio-technical change, they may also be appropriated through time, history and everyday practices into particular socio-technical landscapes in which the strategic project is reimagined. On the other hand a particular politics of socio-technical change may lead to processes of institutional path-dependency.

The Spanish electric utilities adapted rapidly to the waning influence of the hydraulic paradigm changing the structures of energy generation and investing in thermal and nuclear energy and, more recently, in renewables. The institutional configuration of electric utilities supported the hydraulic paradigm for more than 40 years, and effectively constituted an electric oligopoly in Spain. This was built upon an alliance with the state apparatus that has remained at the heart of electricity policy. While public opinion and environmental concerns changed during the transition to democracy, the state and the electric oligopoly have

maintained the institutional regime of electricity generation and distribution virtually unchanged. Current innovation territories prevent actors outside this alliance to innovate in electricity generation and distribution, hence curtailing alternative pathways for transitions to sustainability.

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