Intersect, Vol 16, No 1 (2022)

Cloudy Days for Solar Energy: A Study of the Spanish Solar Photovoltaic Feed-in Tariff through the Multi-level Perspective and Socio-technical Transition Pathways

Ana Díaz Vidal
University of Edinburgh

Abstract

This article explores the under-researched area of policy failures from a Multi-level Perspective (MLP) theoretical framework. In the process, it builds on MLP as a framework and suggests theoretical additions that may increase its explanatory power: the consideration of politics in regimes by exploring power dynamics and the importance of landscapes in influencing transitions. The article offers a contextualization of energy policy in Spain. It then outlines the theoretical framework combining MLP to the socio-technical transition pathways and adding political economy to the regime level. In the analysis it explores the interactions between niche, regime and landscapes followed by a discussion of the ability of the theory to explain and explore policy failures. The article concludes landscape and regime levels are essential in explaining the Spanish SPV case while highlighting the importance of power relations, especially within the regime level. It finally challenges Multi-level Perspective to further explore the complexity of the relations among its different levels. The article suggests further exploration of policy failures as a source of both theoretical and political insight.

1 Introduction

Feed-in Tariffs (FITs) were introduced in multiple European countries, including Spain in 2007 to encourage the development of Solar Photovoltaic (SPV) facilities to generate renewable energy (Stenzel & Frenzel, 2008). However, while the policy was a success in some places, it has been considered a policy failure in the Spanish context since it has not achieved its initial objectives and it was removed. Though comparative evaluations have been conducted (Haas, 2019), there has not yet been an in-depth exploration of the Spanish FITs from a socio-technical systems perspective (explained in Section 2). I seek then to explore how policy failures occur looking at the interactions between niches, regimes and landscapes while exploring how the Spanish case fits into the Geels et al. (2016) typology of sociotechnical transition pathways. In the process, I seek to add politics into regimes by exploring power dynamics and to reclaim the importance of landscapes in influencing transitions by answering the following research question:

How can a socio-technical approach explain the failure of feed in tariffs for PV solar energy in Spain?

In what follows, I offer a contextualization of energy policy in the Spanish context, together with an overview of the techno-legal framework where the niche, regime and landscapes interact. I then outline the theoretical framework I use in my analysis, combining the multi-level perspective to the socio-technical transition pathways and adding political economy to the regime level. In my analysis I explore the interactions between niche, regime and landscapes followed by a discussion of the ability of the theory to explain and explore policy failures, making some recommendations for enriching the area. I finish by offering concluding remarks.

1.1 Background on Spain and Energy Policy

The Spanish energy system has three key characteristics: first, given its position in a peninsula, Spain is an energy island and has difficulties in energy trade (del Río & Mir-Artigues, 2014). Secondly, consistent government intervention since the beginning of the century led to wholesale electricity prices remaining unchanged in real terms which contributed to broadening tariff deficit, that is, the gap between the cost of electricity production and the price consumers pay (Gürtler, Postpischil, & Quitzow, 2019) that is assumed by the government. Lastly, the Spanish energy market is an oligopoly: the three biggest companies provide energy for over 90% of consumers (Bilbao et al., 2011).

The Spanish experience with SPV installation and energy production is often termed a failure in academic circles (Ciarreta, Gutiérrez-Hita, & Nasirov, 2011; Girard, Gago, Ordoñez, & Muneer, 2016; Sorman, García-Muros, Pizarro-Irizar, & González-Eguino, 2020). Spain is in a privileged geographical location to produce SPV energy due to its latitude in the south of Europe, and its sunlight time (Sanchez-Duran et al., 2019). As such, it is better suited than other European countries that have also incentivized solar energy through policy such as Germany (Sanchez-Duran et al., 2019).

Making use of this potential, Spain emerged as a leader in renewable energy production between 2003 and 2013 (Sorman, Pizarro-Irizar, García-Muros, González-Eguino, & Arto, 2019). However, the boom came with a bust and Spain is now no longer a pioneer in SPV energy generation, falling from the first position to the sixth in 2015 (Gürtler et al., 2019).

1.1.1 Techno-Legal Framework

FITs were first introduced in Spain in 1997 (Gürtler et al., 2019). They work by guaranteeing a floor price for certain energy production methods, in this case, solar energy, without setting a cap on the volume of energy generated eligible for the scheme (del Río & Mir-Artigues, 2014). This signals stability and encourages investors to deploy such long-term projects (Sanchez-Duran et al., 2019).

In June 2007, the Royal Decree 661/2007 provided very generous FITs premiums, priority grid access for solar energy generators and a revision of prices only every four years (Gürtler et al., 2019). While the expectation was to see a gradual and steady increase in installed solar energy capacity, the output grew by 500% in a year (Espejo-Marín & Aparicio-Guerrero, 2020), as shown in

Figure *1*. The increase in capacity was accompanied with an unsustainable increase in project funding expenditure and the Spanish government followed with the Royal Decree 1578/2008 that revised tariff levels and set capacity quotas in order to cool down the market (Gürtler et al., 2019). The Royal Decree 41/2010, further reduced FITs rates and the Royal Decree Law 1/2012 established a moratorium on the installation of new SPV plants (del Río & Mir-Artigues, 2014), virtually removing the incentive structure that had been emerging since 1997.

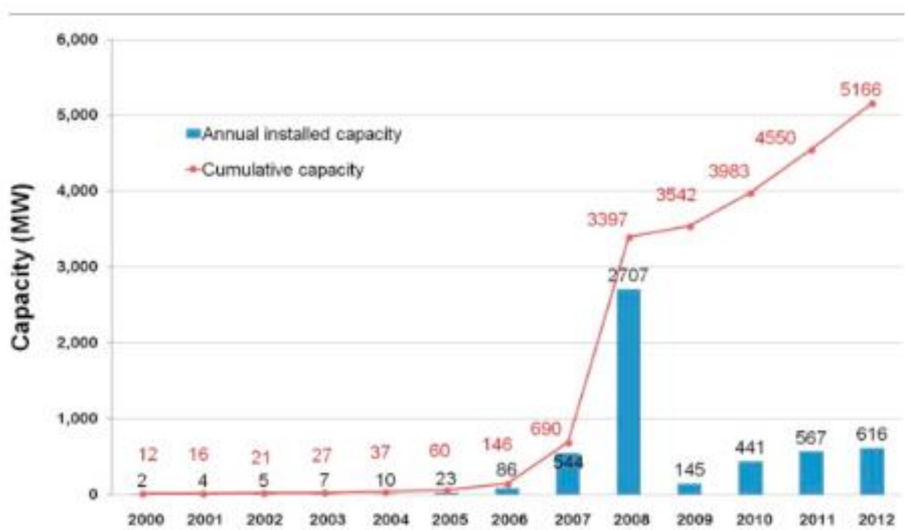

FIGURE 1. SPV installed capacity by year and cumulative (Girard et al., 2016)

2 Theoretical Approach

To answer my research question, I rely on the multi-level perspective (MLP) and on the sociotechnical transition pathway framework. MLP is a middle-range theory that combines economics, sociology, and institutional theory (Köhler et al., 2019) to explain how socio-technical transitions occur. It accommodates for a broader range of societal actors to the narrower technological regime concept (see: Winter & Nelson, 1982). The theory relies on the interaction between three levels: (1) **niches** are the micro-level spaces for radical innovation that develop on the fringe of regimes; (2) **regimes** are composed of actors, institutions (policies and norms) and infrastructures: and (3) **landscapes** consist of mostly slow-changing exogenous factors such as macroeconomic conditions or cultural patterns (Geels, 2002; Geels & Schot, 2007; van Rijnsoever & Leendertse, 2020).

The sociotechnical transitions pathway framework was developed by Geels in 2007 and reformulated in 2016. From Geels and Schot (2007) I use the idea that transitions can look different depending on the **timing and the nature** of multi-level interactions and how those combine. I also explore the landscape **shock typology** developed and focus on specific shocks embodied in the economic crisis, that is, the ones with low frequency, high amplitude, high speed and low scope. The Geels et al. (2016) reformulation of these transition typologies adds the idea of exploring **actors, institutions and technologies** and how they engage at all levels. I will also include considerations of the three in my analysis.

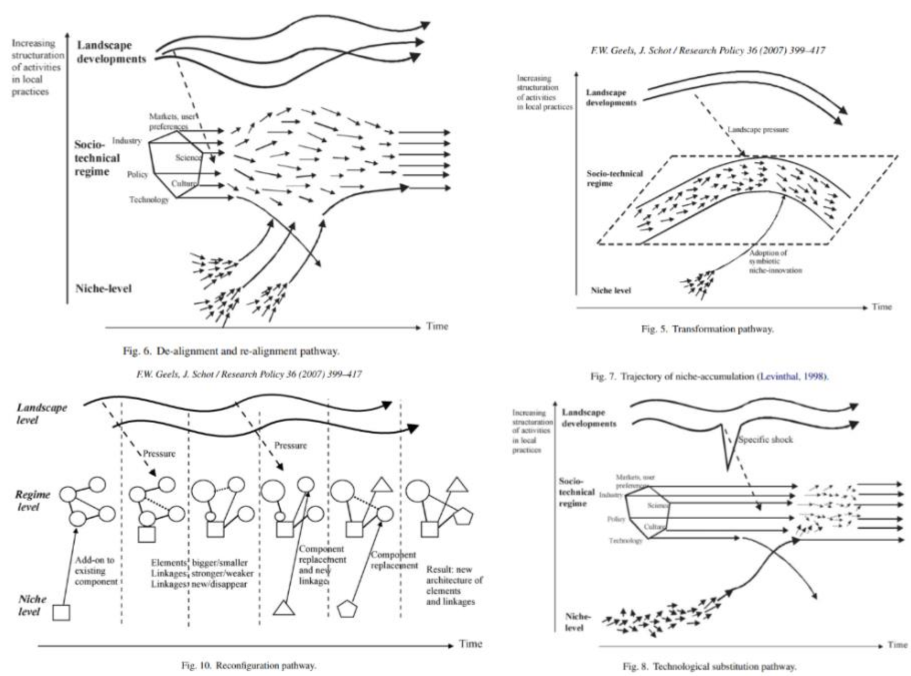

FIGURE 2. The four sociotechnical transition pathways in Geels' (2007) typology

In these two key texts, four pathways are theorized: technological substitution, transformation, reconfiguration, and de-alignment and re-alignment (see Figure 2). The *transformation* pathway happens when there is moderate landscape pressure while niche innovations are underdeveloped to which regime actors respond by modifying the development direction. The *de-alignment and re-alignment* pathway is a consequence of a large sudden change in landscape, which erodes the regime and opens a window for the emergence of competing innovations. The *technological substitution* pathway happens when landscape pressure prompts a developed niche into replacing the existing regime. Finally, in the *reconfiguration* pathway, symbiotic innovations are added into the regime and trigger adjustments that modify it (Geels & Schot, 2007).

The MLP literature is enriched by active debates as to its explanatory power addressed, for example, by Geels (2011). Through this case study I aim to show how MLP can incorporate solutions to two of its main critiques: first, the MLP is criticized for being a bottom-up **niche-centric** model, disregarding the importance of landscape (Berkhout, Smith, & Stirling, 2004). Secondly, politics at the regime level, and the **power relations** embedded in it, are underexplored (Geels, 2014). Therefore, I take a case where I show the landscape has an important role and I add political economy considerations to the regime level.

3 Analysis

Listed below are the key elements of each level I analysed for the Spanish SPV case:

Landscape	Regime	Niche
• Economic crisis • Climate change • Market Liberalism • Economic Structure	• Government officials • Policies (including FITs) • Energy oligopoly companies • Technologies (gas, oil, coal)	• Solar energy technology

TABLE 1. Landscape, regime and niche elements in the Spanish PV case (author's own)

3.1 Landscape – regime: Power is not only about energy

The first two levels that interact to shape transitions are the macro-landscape and the meso-regime. According to Geels and Schot (2007), a landscape change can have **reinforcing** effects or be **disruptive** depending on the nature of the interaction. In this section I analyse landscape changes and how they interact with the regime in the Spanish PV case.

A landscape shock that had a large **disruptive** impact in the Spanish case was the **economic crisis** starting in 2008. The recession in all sectors led to a reduced energy demand that led to a decrease in energy prices (Gürtler et al., 2019), meaning the government contribution to solar energy providers had to increase to reach the price minimum established in the Royal Decree 661/2007. This, combined with the newly emerged discourse of austerity and the need to cut public expenditure in face of the crisis (Jordan, Green-Pedersen, & Turnpenny, 2012) pushed the newly acquired central position of solar energy to a corner again.

Other more stable landscape characteristics also combined to have an impact on the regime transition towards solar energy mainstreaming. The Spanish **economic structure**, for example, **reinforced** the incumbent regime. Spain is dependent on construction and low-cost tourism (Girard et al., 2016) which are energy demanding industries. These high energy needs makes Spain less willing to experiment with niche innovations, thus reinforcing the regime.

Another characteristic influencing the incumbent regime is **market liberalism**, the quasi-hegemonic ideology, which utilizes markets and price-based tools to solve policy issues. In this light, FITs and their **price-based incentives** are considered a valid option and other policies utilizing non-financial incentives are in a less advantageous position. However, the liberal market perspective is unable to determine an accurate subsidy level to balance the market and promote SPV without flooding it (del Río & Mir-Artigues, 2014) and is very **inflexible to shocks**.

On the other hand, introducing **power** into the study of sociotechnical transitions, the market liberalism paradigm has led to an **antagonistic** relationship between two key regime actors. Given that market competition is considered the normal way of engaging, tensions emerged between policymakers and the oligopolistic energy industry (Sorman et al., 2019) when the latter perceived FITs as excessive interferences that generate market distortions. Thus, in this case, the **landscape enables a feud** that can lead to regime instability and that closely links the success of technical innovation to broader power struggles within the regime (Geels, 2012).

A further landscape element, the **climate crisis,** causes widespread civil society concern for sustainability and leads to a further power struggle, this time between actors in the same group: policymakers. The FIT policy was implemented in 2007, the year before Spanish general elections and managed to attract the support of many environmentalist groups for the PSOE (a liberal democratic party that had not engaged with this voter segment before). **Electoral promises** and elections can shift regimes and open doors for niche innovations to reach the mainstream.

3.2 Landscape – niche

The second interaction is that between landscape and niche. Different transition pathways can be followed depending on the **timing of interactions**, that is, whether the landscape pressure happens when the niche is developed or not (Geels & Schot, 2007).

In this case, the **landscape in its most literal sense** can also be considered an essential part of the sociotechnical landscape that, even though it is stable, enables niche innovations to flourish. The vast amount of **cheap land** in rural Spain and the large **solar energy potential** (Espejo-Marín & Aparicio-Guerrero, 2020) give SPV plants in the region a comparative advantage position, producing more energy than in other regions with the same economic investment. Thus, the landscape enables niche emergence.

The other key interaction between landscape and niche is twofold: First, the **climate crisis** pushed niche innovation into the mainstream as a potential solution to the carbon intensity of the traditional energy sources. The landscape enabled new regime policies supporting a still **underdeveloped** niche. Second, the **economic crisis** as a landscape shock hit when the niche-innovation was still not price competitive without the generous FITs. Although the regime space had been opened, as I explain in the next section, the landscape shock from the economic downturn resulted in an austerity approach to regime policies and meant the elimination of subsidies for renewables, and a drastic cut in economic incentives for SPV.

3.3 Regime – niche

The third interaction I analyse is that between regimes and niches. The interaction, again, can be of **competitive** or of **symbiotic nature**, where the niche seeks to replace the regime or is adopted as an add-on to the regime Geels and Schot (2007).

As with the other relations, there is not only one way in which regimes and niches interact: the SPV technology as a niche innovation was **symbiotic** with the government policy direction and with regime culture (especially with the sustainability concerns). The FITs are aligned with other renewable energy support **policies** such as the 2004 renewable energy act (Sorman et al., 2019) in leading Spain towards the adaptations required to increase energy security and sustainability. SPV as a niche innovation was also symbiotic with the incumbent **regime culture**: civil society concerns with sustainability and quality of life led to widespread support for renewable energy policies. The CIS (2001) survey, representative of the Spanish population shows that 80.1% of the 2492 respondents believe developments in solar energy provision will improve life quality.

At the same time and related to the power struggles that the landscape enables within the regime, there is a **competitive** relationship between the incumbent **energy industry** and the incoming **niche technology**. Although the three biggest firms in the Spanish energy market included renewables in their energy portfolio, mainly wind turbines (Stenzel & Frenzel, 2008), they are not willing to change their business model towards renewables in the short term and thus see the incoming solar technology firms as threats. The oligopoly controls 100% of the national distribution network (Bilbao et al., 2011), thus solar energy poses a threat to the centralized energy provision approach that perpetuates their power. Solar panels are a tool for the potential decentralization of the energy network (Adil & Ko, 2016) and, unlike wind farms, can be installed and utilized by individuals that would cease to depend on these large companies.

Año	Panel solar	Inversor solar
2007	3,30	0,130
2008	2,50	0,128
2009	1,68	0,125
2010	1,40	0,117
2011	1,10	0,110
2012	0,75	0,107
2013	0,60	0,090
2014	0,45	0,085
2015	0,42	0,079
2016	0,38	0,070
2017	0,35	0,064
2018	0,34	0,057
2019	0,28	0,055

Fuente: Asociación Nacional de Productores de Energía Fotovoltaica (ANPIER). Anuario Fotovoltaico 2019.

FIGURE 3: Costs of SPV installations by year in Spain (Espejo-Marín and Aparicio-Guerrero, 2020)

A key flaw in the relation between regime and niche was the **lack of dynamism** in planning and the inflexible nature of governmental institutions. The regime policy (FITs) was based on a forecast extrapolating from past trends (Amer, Daim, & Jetter, 2013) and thus, did not account for the quick price change of the incoming niche technology. The technology prices dropped after the Royal Decree 661/2007 (See Figure 3). Tariffs were designed to give developers an internal rate of return of around 7%, however, given the decreasing costs and the inflexibility of the FIT design, actual internal rates of return were closer to 15% (del Río & Mir-Artigues, 2014).

Instead of the most conservative approach of waiting for niche innovations to develop and fit into regime rules, the regime designed rules to fit the niche in what Geels et al. (2016) term a **stretch and transform** approach. Policymakers designed a policy that distorted the markets to provide space for, at the time less profitable, renewable energy sources. Probably driven by the pressure of electoralism, and the favourable geophysical conditions, the regime opened a policy space that allowed SPV emergence without fully understanding or predicting the speed at which this niche innovation would evolve and become more cost efficient.

4 Discussion

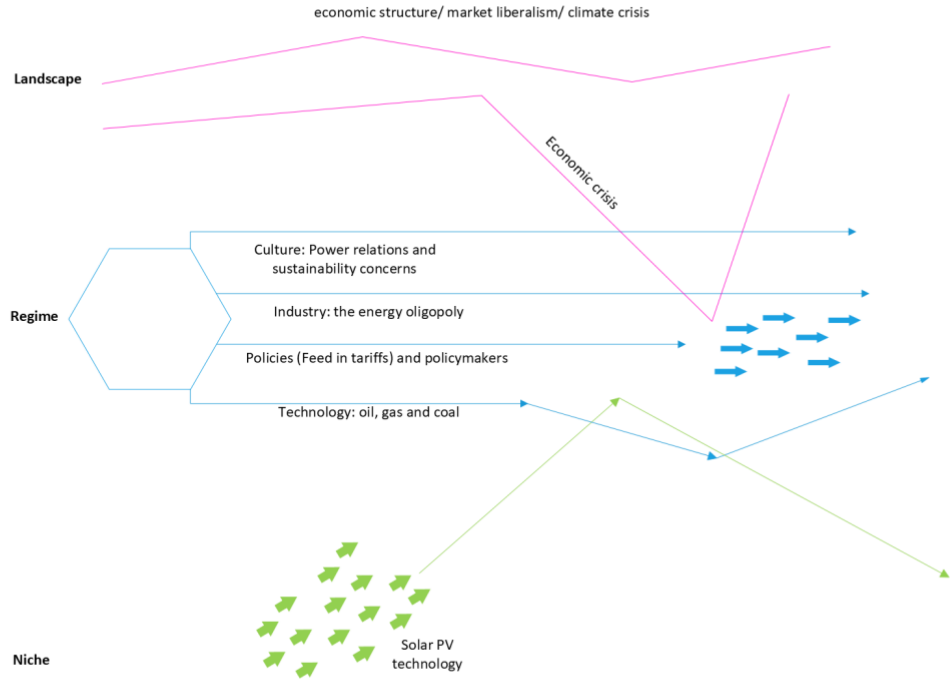

FIGURE 4: The Spanish SPV transition pathway and its failure (author's own)

Geels et al. (2016) already recognise the complexity of energy transition pathways and the fact that change rarely occurs through one of their typified paths: "*Our reconceptualisation also enables a more fluid understanding of shifts between pathways as transitions unfold"* (Geels et al., 2016:900). However, **there are two areas where the typology is not flexible enough**: the exploration of **tensions within levels**, that is within regimes, niches, or landscapes, and the consideration of **pathway failures**. The pathway followed by the Spanish case is best represented by

Figure *4*, where the x axis represents time).

Before the economic crisis and from 1997, there were elements of a *reconfiguration* pathway driving SPV into the regime. With limited institutional change, the niche innovation was slowly added on to the regime through policies up until 2007. It was framed as an add-on and never threatened the incumbent regime technologies or industries due to its small size

Between 2007 and 2008, the pathway that most resembles the Spanish case is *technological substitution*. At the institutional level, a stretch and transform approach was taken, making rules (the FITs) to fit the incoming niche (SPV technology). This enhanced the widespread adoption of the new technology and broke with the slow co-shaping between niche and regime of the *reconfiguration* pathway. At the actor level, outsiders play a key role in opening the doors for niche innovation: civil society movements' increasing concern with climate change, a landscape factor, was essential in pushing for regime change. But there is no actor uniformity: power struggles within the regime between incumbent industry and niche technology generate a pressure that contribute to the failure of the policy.

From 2008, the main feature of the Spanish SPV case is the specific shock posed by the economic crisis, which kick-started a shift to the *de-alignment and realignment* pathway. However, in this case, due to the characteristics of the policy, lacking flexibility regarding prices and a mechanism to limit the scheme to a manageable size, and of the niche innovation, not yet price competitive, the shock acts as a barrier to the transition and reinstates the old order.

As Geels et al. (2016) pose, there is shifts between pathways as transitions unfold. However, their typology does not explain why policies fail. I have identified two key interactions that should be considered in future pathway design and that explain failure: First, there is a **push and pull relation** within the **regime** level between industry and policymakers that makes the regime stability vulnerable. Second, even though some **landscape** aspects favour the emergence of the niche technology, i.e. climate change or the solar energy potential, a landscape shock like the economic crisis, can also bring a transition down.

The effects of large landscape changes after transitions start should be considered and planned for. This recommendation is only reinforced by the second large scale crisis of the century: the Covid-19 pandemic, which suggests landscape shocks will be more frequent than ever and that it is essential to include contingency plans in future energy transitions policymaking.

5 Conclusions

Through this essay, I responded to the research question posed in the introduction: ***How can a socio-technical approach explain the failure of feed in tariffs for PV solar energy in Spain?***

I applied MLP and transition pathways to the case of a policy failure considering the timing and nature of interactions between niches, regimes and landscape and the role of actors, institutions, and technology. Moving away from niche-centric assessments of transitions I show how landscape and regime are essential in explaining the Spanish SPV FITs failure. I have also highlighted the importance of power relations, especially within the regime level.

The relations between the different levels in the MLP are more complex than what Geels' typology posits: Landscape factors can have a disruptive effect on regimes, i.e., the economic crisis, a reinforcing effect i.e., climate change or both at the same time i.e., market liberalism. Similarly, the relations between niche and regime are simultaneously competitive, as is the case of the feud between the incumbent energy industry and the new solar technology, and symbiotic, with niches and policymakers having similar interests.

In discussing how to apply pathways to the Spanish case, I find evidence that supports Geels et al. (2016) in stating that there are shifts between transition pathways over time. However, to understand and explain how policies fail, more attention should be paid to the tensions within regimes and landscapes and how those changes in transition pathways occur.

Deriving from my analysis, two recommendations for developing sustainable energy policies can be extracted: first, power relations must be considered in socio-technical analysis. Second, policymakers should plan for landscape shocks. The lack of dynamism in policy design and the inability to modify incentives is one of the key factors that led to the failure of the Spanish SPV FITs. **Further research** should explore the effects of large landscape shocks not only on successful transitions but also on failures.

References

Adil, A. M., & Ko, Y. (2016). Socio-technical evolution of Decentralized Energy Systems: A critical review and implications for urban planning and policy. *Renewable and Sustainable Energy Reviews, 57*, 1025-1037. doi:https://doi.org/10.1016/j.rser.2015.12.079

Amer, M., Daim, T. U., & Jetter, A. (2013). A review of scenario planning. *Futures, 46*, 23-40.

Berkhout, F., Smith, A., & Stirling, A. (2004). Socio-technological regimes and transition contexts. *System innovation and the transition to sustainability: Theory, evidence and policy, 44*(106), 48-75.

Bilbao, J., Bravo, E., Garcia, O., Varela, C., Rodriguez, M., & Gonzalez, P. (2011). Electric System in Spain: Generation capacity, electricity production and market shares. *International Journal on Technical and Physical Problems of Engineering (IJTPE), 3*(9), 91-96.

Ciarreta, A., Gutiérrez-Hita, C., & Nasirov, S. (2011). Renewable energy sources in the Spanish electricity market: Instruments and effects. *Renewable and Sustainable Energy Reviews, 15*(5), 2510-2519.

CIS. (2001). ESTUDIO CIS nº 2.412 OPINIONES Y ACTITUDES DE LOS ESPAÑOLES HACIA LA BIOTECNOLOGÍA FICHA TÉCNICA. In. Madrid: Centro de Investigaciones Sociológicas.

del Río, P., & Mir-Artigues, P. (2014). Spain's solar PV investment bubble. *International Institute for Sustainable Development. Retrieved March, 14*, 2018.

Espejo-Marín, C., & Aparicio-Guerrero, A. E. (2020). La producción de electricidad con energía solar fotovoltaica en España en el siglo XXI. *Revista de Estudios Andaluces, 39, 66-93.*

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy, 31*(8-9), 1257-1274.

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions*(1), 24-40. doi:10.1016/j.eist.2011.02.002

Geels, F. W. (2012). A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. *Journal of Transport Geography, 24*, 471-482. doi:https://doi.org/10.1016/j.jtrangeo.2012.01.021

Geels, F. W. (2014). Regime resistance against low-carbon transitions: introducing politics and power into the multi-level perspective. *Theory, Culture & Society, 31*(5), 21-40.

Geels, F. W., Kern, F., Fuchs, G., Hinderer, N., Kungl, G., Mylan, J., . . . Wassermann, S. (2016). The enactment of socio-technical transition pathways: A reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990–2014). *Research Policy, 45*(4), 896-913. doi:https://doi.org/10.1016/j.respol.2016.01.015

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy, 36*(3), 399-417.

Girard, A., Gago, E. J., Ordoñez, J., & Muneer, T. (2016). Spain's energy outlook: A review of PV potential and energy export. *Renewable Energy, 86*, 703-715. doi:https://doi.org/10.1016/j.renene.2015.08.074

Gürtler, K., Postpischil, R., & Quitzow, R. (2019). The dismantling of renewable energy policies: The cases of Spain and the Czech Republic. *Energy Policy, 133*, 110881.

Haas, T. (2019). Comparing energy transitions in Germany and Spain using a political economy perspective. *Environmental Innovation and Societal Transitions, 31*, 200-210. doi:10.1016/j.eist.2018.11.004

Jordan, A., Green-Pedersen, C., & Turnpenny, J. (2012). Policy dismantling: an introduction. *Dismantling public policy,* 3-29.

Köhler, J., Geels, F. W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., . . . Boons, F. (2019). An agenda for sustainability transitions research: State of the art and future directions. *Environmental Innovation and Societal Transitions, 31*, 1-32.

Sanchez-Duran, R., Barbancho, J., & Luque, J. (2019). Solar energy production for a decarbonization scenario in spain. *Sustainability, 11*(24), 7112.

Sorman, A. H., García-Muros, X., Pizarro-Irizar, C., & González-Eguino, M. (2020). Lost (and found) in transition: Expert stakeholder insights on low-carbon energy transitions in Spain. *Energy research & social science, 64*, 101414.

Sorman, A. H., Pizarro-Irizar, C., García-Muros, X., González-Eguino, M., & Arto, I. (2019). On a rollercoaster of regulatory change–risks and uncertainties associated with renewable energy transitions. *Narratives of Low-Carbon Transitions*, 121.

Stenzel, T., & Frenzel, A. (2008). Regulating technological change—The strategic reactions of utility companies towards subsidy policies in the German, Spanish and UK electricity markets. *Energy Policy, 36*(7), 2645-2657. doi:https://doi.org/10.1016/j.enpol.2008.03.007

van Rijnsoever, F. J., & Leendertse, J. (2020). A practical tool for analyzing socio-technical transitions. *Environmental Innovation and Societal Transitions, 37*, 225-237.

Winter, S. G., & Nelson, R. R. (1982). An evolutionary theory of economic change. *University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship*.