THESIS BOOKLET

To the PhD dissertation of

Karen Gabriela Liñán Segura

titled

The Political Economy of Energy Transition in Mexico

Supervisor;
Dr. Palánkai Tibor

Co-supervisor;
Dr. Szent-Iványi Balázs

Doctoral School of International Relations and Political Science
Institute of World Economy

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Abstract

Renewable energy as radical innovation requires not only technological substitutes but also a fundamental transformation at the system level. This means changing social elements such as policies, market rules, regulations for users and producers, and their behavior. Thus, in studying the political economy of energy transition in Mexico, this research adopts a conceptual framework that encompasses the three perspectives (techno-economic, socio-technical and political) through a multi-level perspective approach (MLP). Methodologically, the research proposes a collective case study: the wind energy region *Isthmus of Tehuantepec* in the south of Mexico and the photovoltaic power station named *Villanueva* in the north, represent the four parts of the sociotechnical electricity system from generation and transmission to

distribution and retail. Structural barriers and lock-in within the system can slow down the uptake of renewable energy. At the same time, if system changes are too radical, they can encounter resistance from incumbents, leading to the failure or even slower diffusion of technology. This can be seen in Mexico where energy development and certain policies generate inconsistent responses, from economic, to social, to political. The research findings illustrate how alignment between the expectations of actors at each level (niche, regime, landscape) shape the transition. Strong alignment between these levels will provide momentum at the system level.

Keywords; *evolution of systems, climate change, energy transitions, socio-technical system, system innovation*

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Finally, I would like to dedicate this work to all the Mexican girls out there, for them to never give up, no

matter how hard the situation seems to be; never stop dreaming.

Chapter 1 Introductions

A major challenge for all nations concerning their energy systems is reducing greenhouse gas emissions whilst securing energy resources and boosting economic growth. In the past centuries, growth was pursued without concerns on environmental consequences; countries independently followed their interests and did not understand the pollution effects as a collective action problem presented on a global scale. It is now commonplace to hear about the phenomenon of global interdependence or globalization having its roots in the international political economy literature (Cooper 1972; Keohane and Nye 1977). A key issue in considering the implications of interdependence revolves around the

question of how to achieve coordination and understanding among states. The process of global integration forces significant adjustments in collaboration matters across countries, that is the case of climate change and the current reality of environmental degradation. International efforts, such as the Kyoto Protocol and the Paris Agreement, emerged with the aim to reduce greenhouse gas emissions. The dominant discourse on climate change has led to difficulties in implementing green economy approaches in national policies around the world. In some developing and emerging countries, this leads to trade-offs between the political duty to promote a lower emissions economic model, and the high costs from energy imports, or energy policies that can result in strong political opposition on social welfare.

Countries agreed to reduce greenhouse gas emissions, but the amount of carbon dioxide, methane and nitrogen oxides in the atmosphere keeps rising, heating the Earth at an alarming rate. If one acknowledges that the energy supply sector is the single most significant contributor to greenhouse gas (GHG) emissions impacting the earth's atmosphere (IPCC,2014, p.7), a long-term energy transition will be environmentally beneficial in terms of lowering emissions. For this research, energy transition refers to the global energy sector's shift from fossil-based systems of energy production, consumption and storage; including oil, natural gas and coal, to renewable energy sources; wind, solar, as well as green hydrogen. Energy transition is only possible if it is done in a fair and inclusive way.

Worldwide, the development of renewable energy such as wind and solar has had strong public support, despite its promising technology it can also bring economic and environmental challenges; noise pollution, endangerment of wildlife species, significant capital investments, monopolistic practices, among others. The negative environmental, cultural and political impacts have challenged the adoption of renewable energy, despite its promising technology. This research provides detailed account of the dynamics of energy infrastructure change in Mexico's electricity sector. Several dimensions of the Mexican energy transition are ºhighlighted by the influence and drivers of energy system. All these factors may influence the future of energy transition.

For almost thirty years, social sectors in Latin America have demonstrated resistance to renewable energy technologies through protests and disputes. Particularly in Mexico, where these projects have caused significant social opposition and conflicts in indigenous communities since the early 90's. The epistemics of social opposition in Mexico proposes downstream policy fixes by involving communities in the decision making and benefits of projects. For instance, the literature claims the violation of human and community rights by private energy investors is often associated with the country's renewable energy developments (Castillo-Jara, 2011). Alongside other factors, these can include insufficient consultation and involvement with the local community when developing a project. Until January 2021, out of the 25 wind power plants currently in operation in the southern part of

Mexico[1], only one renewable development conducted a Free, Prior and Informed Consent (FPIC) procedure where indigenous communities could express their views concerning wind energy. Moving towards an increase demand for strategic resources such as lithium and green hydrogen, lessons learned from the past set the context for the country's political agenda on energy transition.

Background and Context of Research

There are many possible pathways energy transitions can take in order to adapt to rising global pressures. Whichever pathway the transition follows, it is inevitable that it will involve major changes not only to technology and infrastructure but also in society, creating a sociotechnical

[1] The southern part of the country makes reference to the *Isthmus of Tehuantepec*, where the majority of wind energy resources are concentrated.

transition[2]. Since early 2000, there have been several ongoing initiatives in Mexico to increase the use of renewable energy technologies and to promote investment. The first wind farm in the country began functioning in 1994 at *La Venta,* an *ejido* located at Juchitán de Zaragoza in the state of Oaxaca. Outcomes generated by these seven windmills were highly applauded by experts around the world. Over the past two decades, neoliberal strategies involving the restructuring of electricity and the regulation of transmission and distribution network had resulted in improved efficiency in terms of energy production. Electricity market liberalization is essential to lower costs and prices for renewable energy sources. This trend attracted a fair amount of attention from international investors around

[2] A sociotechnical transition refers to the evolution and development of a sociotechnical system.

the world and by 2017, Mexico had received the second largest amount of renewable energy investment in Latin America after Brazil (Bloomberg New Energy Finance, 2018). Domestically, former President Enrique Peña Nieto introduced legislation to promote electricity market liberalization. As a result, different instruments were introduced together with the Mexican Emissions Trading System (ETS) and energy auctions for private energy producers. With the change of government in 2018, the national energy strategy was shifted to energy security. On January 2nd, 2020 the national energy system shift was published at the federation's official journal (DOF), the main strategic goal being to decrease import sources and secure domestic energy supply. The official document claimed that energy independence will improve the country's sovereignty (SENER, 2020). The following

year, in February 2021, President Andrés Manuel Lopez Obrador introduced reforms on the Electricity Law that favors energy produced and dispatched by the Federal Electricity Commission (CFE)[3]. This initiative sought to strengthen the Federal Electricity Commission by improving on articles 4, 25, 27 and 28 of the political constitution. However, the second quarter of 2022 the electricity reform was discarded due to the lack of 332 votes required to be approved. The Wholesale Electricity Market (MEM) obtained its victory and with it the possibility to continue operating normally. Energy auctions in which private investors compete for projects and the relevant criteria for obtaining Clean Energy

[3] The reform erase from article 4 the principle of "economic dispatch" in which favoured the most efficient or less expensive source of energy as they could distribute their generated energy to the national grid first. This principle often favoured energy sources coming from private investors such as renewables.

Certificates (CEL) from clean sources. After the latest reform in February 2021, article 16 exempted producers from obtaining the certificates and since 2022 both have been abolished. In terms of political strategy, contradictions can be seen between the former and current governments. While the focus of the previous government was the global environmental target of reducing GHG emissions and favoring market liberalization, the current government has prioritized energy security.

Research questions

Overall, this study addresses the two research questions of "How do global forces (landscape-level) influence the speed and directionality of the energy transition in Mexico?" and "How does social resistance to energy systems emerge?".

Methodology

The overall research is positioned at the intersection of Political Economy, Evolution of Systems and Sustainability Transitions. Data was collected mainly through historical cases means that secondary data was relied on heavily. Sociotechnical transition studies commonly utilize historical case studies in combination with interviews. For instance, Sovacool et al. (2012) used 149 in-depth interviews at 89 institutions to examine the growth of the Solar PV market and social acceptance between 1991 to 2007 in Germany, the United States and Denmark.

For this research, primary data was collected using semi-structured interviews conducted between March 2020 and

August 2020. It is important to mention that methodology and research approach were affected by the global COVID-19 crisis. Although, the pandemic posed serious challenge to the research, particularly to the fieldwork and primary data collection, I was able to adapt to these challenges and conducted a total of 20 semi-structured interviews via telephone, email and Zoom calls. Additionally, the interviews were useful for mapping, analysis and verifying the reliability of the secondary data that was collected throughout the three years of research.

The following table shows the number and order to interviews in relation to each case or level; nine in relation to the *La Venta* case study and ten in relation to *Villanueva.* Participants were divided by the three

complex levels proposed by the multi-level perspective (MLP) for exploring sociotechnical transitions.

Theories and Analytical Framework

This research addresses the gap in the transitions debate by using a systemic perspective approach to generate a better understanding of transition in all its complexity, without breaking it down into isolated components. The approach also allows emerging properties specific to a level (micro-level, meso-level and macro-level) to be identified. Comprehensively, it favours the communication and generalization of the larger phenomena being studied, which is the transition of sociotechnical regime to renewable energy. The original contribution on the field is threefold. First, the present

research does not focus on the emergence of radical innovation, but rather, on the synergies of the transition which involve social resistance, innovation substitution and policy for the co-evolution of existing regimes. Second, it constructs a cause-effect theory for understanding energy transitions in developing countries from a political economy perspective. This is done by exploring three groups of variables, techno-economic, socio-technical and political, to better understand niche dynamics and relations between various levels of decision making. Finally, the entire doctoral thesis aims to elucidate the analytical and methodological challenge that energy transition studies face in Mexico and in developing economies. In this sense, it responds to those who have pointed out that the "Political economy of energy

transitions is a vastly understudied area" (Goldthau & Sovacool, 2012, p. 238).

Findings

The national implementation of renewable energy as radical innovation requires not only private investments and new technological entrants. It requires a fundamental transformation and readiness at the system level. This study demonstrates that alignment of shareholders' expectations between the three levels (niche, regime and landscape) and social resistance and acceptance, influence transition dynamics (barriers and drivers). This means that these phenomena are behind changing social elements such as policies, regulations for users and producers, market rules, social behaviours, etc. That is why in

studying the political economy of energy transition in Mexico, this thesis has adopted a multidisciplinary framework Each stage of the research adopted a conceptual framework that encompasses the three perspectives (techno-economic, socio-technical and political) through a multi-level perspective approach (MLP). Methodologically, the research proposed a collective case study: the wind energy region Isthmus of Tehuantepec in the south of Mexico and the photovoltaic power station named Villanueva in the north,

The findings are summarized in four main points:

1. By conceptualising the notion of energy transition, Chapter 2 identified the most relevant literature and methods. It concluded that a well-designed research on

energy transition must include an underpinning theory (meta-theoretical framework: three perspectives), a theoretical background (science and technology studies) and a methodological approach (multi-level perspective).

2. Chapter 3 demonstrated that structural barriers and lock-ins within the system can slow down the uptake of renewable energy. By using examples from the existing energy system in Mexico, it explained that if system changes are too radical, they can encounter resistance from incumbents, leading to resistance in communities, from economic to social to political.

3. Chapter 4 demonstrated that shaping actors' expectations and building strong alignment of expectations with new entrants would contribute towards

changing old pathways and directions of transitions. New technological entrants provide the niche (micro-level) with the opportunities to collectively shape the prospective socio-technical structures of a system.

4. Chapter 5 concludes that across global scales, different sets of actors can mobilise institutional and organisational conditions towards desired directions with the use of media, strikes and public awareness. Different types of transition dynamics can influence change towards desired directions

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