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The Politics of Sociocultural Impacts in Mexico's Ongoing Energy Transition

By

Nain B. Martinez Segura

A dissertation submitted in partial satisfaction of the
requirement for the degree of
Doctor of Philosophy
in
Environmental Science, Policy, and Management
and the Designated Emphasis
in
Science and Technology Studies
in the
Graduate Division
of the
University of California, Berkeley

Committee in charge:

Professor Matthew D. Potts, Chair
Professor Alastair Iles
Professor Kate O'Neill
Professor Daniel Kammen

Summer 2020

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by

Nain B. Martinez Segura

Abstract

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Doctor of Philosophy in Environmental Science, Policy, and Management

and the Designated Emphasis in

Science and Technology Studies

University of California, Berkeley

Professor Matthew D. Potts, Chair

Grounded in science and technology studies (STS) and political economy, this dissertation elucidates and analyzes the construction of Mexico's controversy regarding the sociocultural impact of renewable energy technologies and their central role in the domestic politics of its ongoing energy transition (ET). Much attention has been devoted to the diffusion of policies and technologies of ETs and measures taken to strengthen their technical and economic viability. However, the opposition to policies and infrastructures of ETs has revealed that the implications of these transformations exceed the substitution of technologies and energy resources, having broad interplay with the social domain. This issue can be illustrated by Mexico's controversy around the sociocultural impacts of renewables. From its local origin in an indigenous territory to its implications for international climate policy, this controversy is evidence of the complex interplay between the social arena and ETs and problematizes their compensations and contradictions.

Research in political economy tends to underestimate the role of the sociotechnical arrangement of technological projects and their contextual meaning in the shaping of the agendas and visions of actors and social groups. In analyzing these issues, scholars frequently focus on later stages where the objective and subjective frame of actors' agendas have already been delineated. I focus on the earlier stages of these issues by investigating critical areas in the construction of Mexico's renewables controversy, specifically: *i*) its epistemological development, *ii*) the formation of the policy intended to address this issue, and *iii*) the subsequent implementation of these policy tools. In doing so, I argue, the design of the ET policy played a crucial role in defining the characteristics that shaped renewable energy projects in Mexico. In turn, the contours of the controversy over sociocultural impacts were shaped by the interaction of these projects with the particular vision of the

territory hold by the indigenous Huave and Zapotec communities and their social organization. I also argue that among the diverse possibilities for addressing this controversy, the government response led to the design of policy tools that have limited scope for altering the interplay between projects' sociotechnical arrangements and local communities. As a result, the design of this political solution has prevented the closure of the controversy, leading to the current political instability.

In Chapter 2, “*Resisting renewables: The energy epistemics of social opposition in Mexico*,” I examine the academic and technical research on social opposition to renewable energy (RE) in Mexico and the normative visions embedded in this body of knowledge. Previous research has examined the authoritative role of knowledge production in the shaping of ETs, yet non-economics social research has received less attention. I argue that social research plays a central role in some components of ETs, and when these areas concern an unequal dispute between different interests and visions, then the production of knowledge, its outcomes, and its use can have vast energy justice implications. In the Mexican case, researchers have addressed the opposition to renewables through different understandings of human interactions with projects and methodological choices, shaping critical aspects of knowledge-making, such as the voices and agendas of the included social groups. In their outcomes, these research practices have offered competing interpretations of the causes of social opposition and the alternatives to solutions, which propose different material and symbolic roles to communities (e.g., downstream policy fixes for addressing social externalities vs. communitarian involvement in the decisions, management, and benefits of projects). Through a subject of controversy characterized by the lack of domestic regulation and experience and limited institutional capacity, social research has exceeded the academic domain, providing critical insights into the activism, the policy formation, and the practices of governmental and private actors.

In Chapter 3, “*The social and material shaping of Mexico’s energy transition*,” I analyze the formation of Mexico’s Law on the Use of Renewable Energies and Financing of the Energy Transition (LAERFTE-2008) and social impact assessment (2014), tracing the translation of this controversy back to the sector’s institutions and the process of policy formation. I argue that although climate mitigation and the social opposition of renewables have promoted destabilizing changes in the political regime of Mexico's energy sector, the existing sociotechnical arrangement of this system has meant that entrenched industrial interests and values, as well as bureaucratic decision-making norms, have persisted in the way that institutions process these agendas and in the design of policies and regulations. Mexico's position in the international politics of climate change and the limitations that the national regulatory framework to the development of renewables played a crucial role in the design of LAERFTE. The solutions that this Law established to the investment and cost-effectiveness of renewables and their intermittency and transmission frame the particular arrangement of the projects took in Mexico - wind, large-scale, private, for

the consumption of large corporations - and their concentration in Tehuantepec. The local effect of these projects and their interaction with the vision and organization of the indigenous Huave and Zapotec communities that inhabit this region defined the emergence of opposition groups with a discourse focused on sociocultural revindication. The centralism and top-down management that have characterized energy institutions and policies and the dispute between the political left and right regarding private participation in this sector framed the institutional translation of this controversy and the design trajectory of the SIAs and associated policy tools.

In Chapter 4, “*The effectiveness of the social impact assessment (SIA) in energy transition management: Stakeholders' insights from renewable energy projects in Mexico*,” I analyze the performance of this policy tool in Mexico’s renewable sector. Social opposition to renewable energy projects has become a significant issue both for the deployment of RE technologies and its social justice implications, yet the policy tools oriented to address this issue have received little research attention, particularly in the Global South. Since its introduction in 2014, the SIA has generated some favorable changes in the sector’s social management. Yet, its effectiveness is constrained by diverse issues related to its institutional and regulatory design, government implementation, practices of companies and consultants, and restricted social involvement. Moreover, the sector’s sociotechnical arrangement (priorities, organization, experience, and policies) strongly influences the performance of SIAs and accounts for the lack of consideration of social aspects in project design and planning. Thus, I argue that without a substantial internalization of the social dimension in the priorities, policy, and planning of RE, the SIA would be limited to a problem-fixing role, which would constrain the effective management of social impacts.

This dissertation builds on and extends STS scholarship on energy transitions in three distinct ways *i*) research in social sciences, showing the justice implications that may stem from research practices *ii*) the formation of policies and regulations, revealing the role played by social and material factors and *iii*) the management of social impacts and relations, demonstrating the crucial role of these areas in the construction of energy futures. By tracing these arenas, my findings show that the practices of knowing, governing, managing, and contesting RE projects have been intimately intertwined: From international climate negotiations to Mexico's adoption of ET policies and the emergence of local opposition groups to the formation of policy tools for addressing social impacts, to the current uncertainty facing Mexico's climate policy. The interplay among research production, political agendas, and regulatory rules have influenced each other at the international, national, and local domains, co-producing Mexico's particular energy transition pathway, regional geographies of energy development, social movements, actors' practices, and societal views. Taken collectively, my findings uncover existing alternatives that can help think about, design, and govern a fair ET system in Mexico, and reveal the political and social risks of driving top-down ETs without a substantive involvement of the communities.

In memory of Leonor Martinez Segura (1966-2020)

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Writing this page has been tough. These days her absence comes to me like the sea.

Chapter 1

Introduction

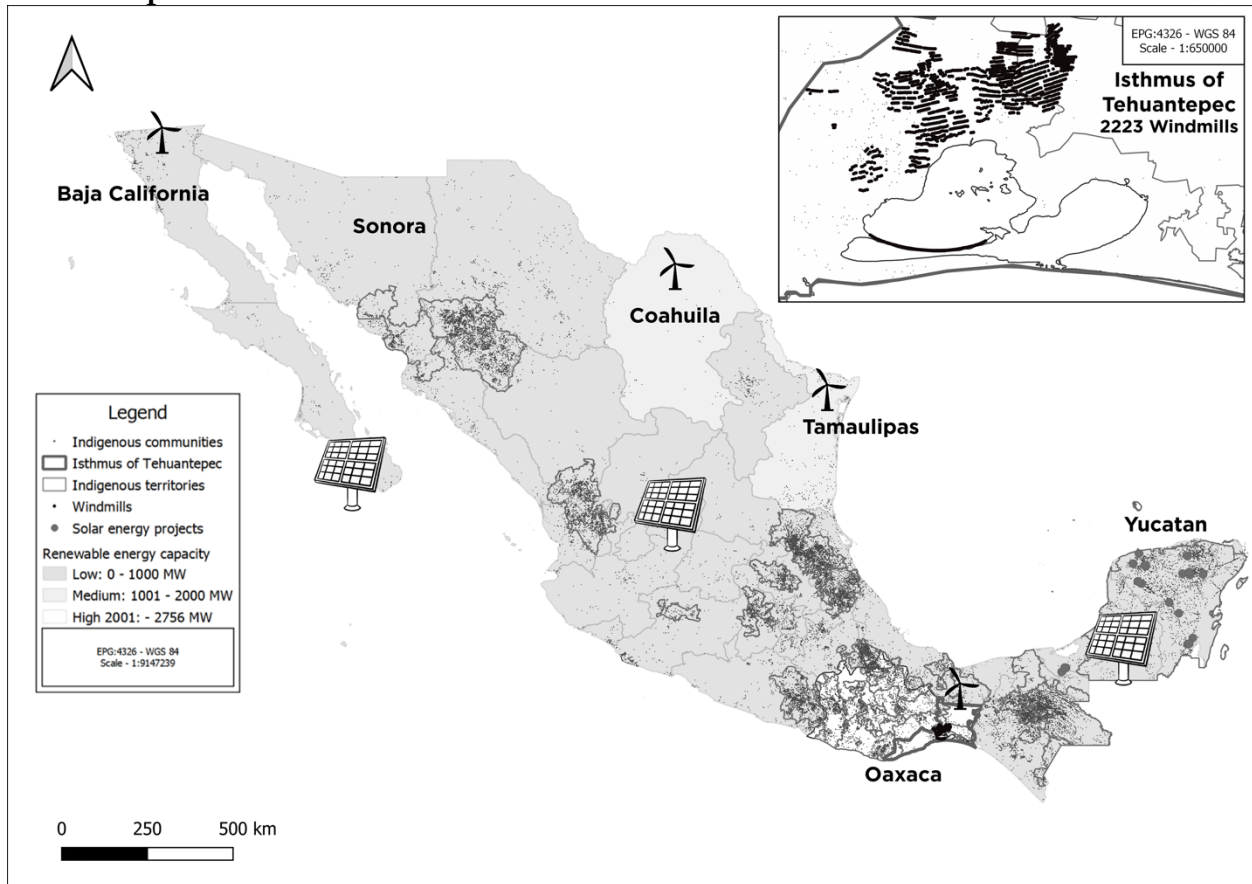
1.1 Overview

Grounded in science and technology studies (STS) and political economy, this dissertation analyzes and elucidates the construction of controversy over the sociocultural impact of renewable energy (RE) projects and its centrality to Mexico's politics of energy transition (ET). Much attention has been devoted to the diffusion of ET policies and technologies and measures taken to strengthen their technical and economic viability. However, the community opposition to ET policies and infrastructures has revealed that the implications of these transformations amount to much more than the substitution of technologies and; in fact, they have a broad interplay in the social domain (Stirling, 2008; Abramsky, 2010; Miller et al., 2015; Moore & Hackett, 2016; Reusswig et al., 2018; Delina & Janetos, 2018). This is particularly true in Mexico, where the controversy over renewables' sociocultural impacts has shaped the trajectory of ET development (Howe, 2014; Rousseau, 2017; Boyer, 2019; Zárate-Toledo et al., 2019; Cruz, 2020). From its local origin in an indigenous territory to its implications for international climate policy, this controversy illustrates the complex interplay between the social arena and ETs and problematizes their compensations and contradictions.

Mexico has built a robust climate and energy transition political framework and is considered by the international community to be a leader in the Global South's climate agenda (Pulver, 2013; Pulver & Sainz-Santamaría, 2018). In 2008, Mexico adopted one of the first energy transition laws among industrialized countries and emerging economies. This regulatory framework was strengthened in 2015 before the Paris Agreement (DOF, 2015; Jano-Ito & Crawford-Brown, 2016). Between 2016 and 2018, Mexico achieved one of the highest global investment levels in renewables, such as wind and solar photovoltaic (PV) projects, and annually broke international records for the lowest generation prices (McCrone et al., 2018). However, since 2009 opposition groups have emerged from among the indigenous Huave and Zapotec communities that inhabit the Isthmus of Tehuantepec in Oaxaca (See, **Figure 1**) (Nahmad et al., 2014; Huesca-Pérez et al., 2016). This development encouraged the formation of active grassroots organizations and saw the sociocultural impact of renewables being included in the agenda of human rights and environmental NGOs, researchers, and international organizations (Juárez-Hernández & León, 2014; Boyer, 2019). The controversy also incentivized the governmental introduction in 2014 of new regulations in the area of RE that call for social impact assessments

(SIAs), indigenous consultation, and shared social benefits (Grunstein-Dickter, 2016; Rousseau, 2017; Huesca-Pérez et al., 2018). As a result, universities have created specific academic programs in the area, and new professions have emerged, such as social impact consultants and social project managers. However, the problem of local resistance to RE technologies persists, as evidenced by the recent opposition of Mayan communities in Yucatan to developing solar PV projects (Loredo, 2018; Zárate-Toledo et al., 2019).

Figure 1. Mexico's wind and solar energy installed capacity and the Isthmus of Tehuantepec in 2020.



Source: Figure created by the author.

Over the past two years, the controversy has escalated into a high-profile issue for Mexico's climate change policy, reshaping its contours and the agendas of the actors and social groups involved. In 2018, for the first time in Mexico's democracy, the political left became the federal government and achieved an unprecedented legislative majority (PBS, 2018). The new administration has maintained a position that is critical of the local impact of renewables. For instance, in presenting the National Energy Transition Plan (2019-2024), Víctor Toledo, head of the Secretary of Environment and Natural Resources, stated:

[Facing] *the harassment of some powers to prevent the country from achieving energy sovereignty, the defense of oil as a strategic resource becomes a provisional but necessary condition for the construction of national sustainability, which requires energy transition ... We need technological designs, not the gigantic blades that rotate to catch the air of indigenous territories, but at houses, neighborhoods, and buildings* (translated from Contreras, 2019, June 7).

In March 2020, standing in front of a wind farm in Baja California, Andrés Manuel López Obrador, Mexico's president, said:

This is one of the most beautiful places in Mexico, but the rulers' lack of sensitivity is expressed here too. They authorized those fans to produce wind power; you can see how they affect the landscape. They can say that this generated electric power, but not too much. Moreover, these are private business because it is necessary to subsidize them. This is one of the frauds of the neoliberal period (translated from Animal Político's Newsroom, 2020, March 28).

In 2019, the federal administration canceled the Mexico-Germany Energy Alliance Summit, which had focused on promoting technological transfer and investment in ET (Proceso, 2019). The administration also suspended electricity auctions, the primary mechanism for promoting investment in renewables' deployment (Rodríguez, 2019). Moreover, in 2020, the administration has implemented different regulatory and economic strategies to limit the access of RE projects to the transmission infrastructure and to favor the market participation of the state-owned electricity company and the use of oil and coal for electric power generation (Reuter, 2020; Solís, 2020). The government's actions and discourse have resulted in a suspension of investment plans in renewables, arousing critics from some of the NGOs and activists that used to focus on the social effects of RE initiatives (Alire- García, 2020). The current political context raises uncertainty about Mexico's compliance with its nationally determined contributions (NDCs) and its future in international climate politics (Climate Action Tracker; 2019; Climate Transparency, 2019).

In this context, my research brings work in STS on energy into conversation with political economy studies on energy transitions. Research in political economy tends to underestimate the role and importance of the socio-technical arrangement of ETs (i.e., the combination of political aims, ownership schemes, financial models, planning procedures, technological choices, development scales, and infrastructure needs) and its contextual meaning in the shaping of the agendas and vision of actors and social groups that support or oppose this larger project of transformation. When analyzing these issues, scholars frequently focus on the later stages, when the objective and subjective frame of actors' agendas have already been delineated, with some relevant exceptions (e.g., Bernstein, 2013; Dimitrov, 2016). Nonetheless, STS

scholarship demonstrates that the social and technical features of energy systems are critical in their impact on local geographies and the social order and that these impacts are interpreted and processed by the institutions, actors and social groups with which they interact (Ottinger, 2013; Miller & Richter, 2014; Phadke, 2018; Levenda, 2019). Thus, it becomes essential to analyze the mutually shaping influence of the socio-technical arrangement of ETs on the agendas of social groups and how social views and agency shape the features of ETs.

I undertake this inquiry through Jasanoff's formulation of co-production, which establishes that the production of knowledge and political and economic order are intertwined at multiple stages. Their joint evolution creates technoscientific projects and legal regimes that shape regional landscapes, social norms, and institutional practices. Simultaneously, these changes shape social identities, discourses, representations, and relations. This formulation proposes that the practices of knowing, building, and governing and the social and material are making each other (Jasanoff, 2014; Iles et al., 2016; Miller & Wyborn, 2018). My analytical approach also builds on insights from STS research on socio-technical systems for addressing the specificities of energy transitions. This research demonstrates that large-scale technological systems (e.g., electric power systems and automobile-based transportation requires) require the interconnection of extensive networks of activities, technologies, and infrastructure. However, the organization and functioning of these networks also demand specialized institutions, regulatory and cognitive rules, and the involvement of diverse actors and social groups (e.g., companies, workers, researchers, consumers) (Hughes, 1987; Geels, 2004; Miller et al., 2015). These systems' material and social organizations have coevolved over time, establishing independent and path-dependent relationships that stabilize their functions and introduce chance in these systems, such as energy transitions (Unruh, 2000; Laird & Stefes, 2009; Geels, 2019).

Grounded in STS, this dissertation analyzes and elucidates critical areas in the construction of controversy in Mexico over the sociocultural impact of renewables, specifically: *i*) the domestic epistemological development regarding the impacts of RE projects and the causes of social opposition; *ii*) the formation of policy tools that aim to address social impacts of RE projects and their social relations; and *iii*) the performance of such policy tools. In doing so, I argue that the contingent design of the ET policy played a crucial role in defining the characteristics that shaped renewable energy projects in Mexico. The contours of the controversy over the sociocultural impacts were shaped by the interaction of these projects with the particular vision of territory held by the indigenous Huave and Zapotec communities and their social organization and collective natural resources management. I also argue that among the diverse possibilities for addressing this controversy, the government response led to the choice of policy tools that have limited scope for altering the interplay between projects' socio-technical arrangements and local communities. As a result, the design

of this political solution has prevented the closure of the controversy, leading to the current political instability.

I undertook this study based on a mixed-method approach focused on qualitative data gathered, similar to previous STS research on energy (e.g., Laird & Stefes, 2009; Phadke, 2011; Barandiarán, 2018; Moore, 2018). Although I explain these methods in granular detail in each chapter, this dissertation is based on participant observation and thematic and discourse analysis of interviews and primary and secondary documentary sources. The observant participation took place in Mexico City (2017–2018), where I acted as a full-time research advisor for the initiative "Communities and Renewable Energies," engaging in several policy-related work meetings and public forums. Between 2018-2019, I conducted semi-structured interviews with actors and social groups that have been key in different sites and processes around Mexico's controversy. The interviews included policymakers, NGOs, local opposition groups, local inhabitants, energy companies, private actors, international organizations, consultants, university-based scholars, and experts. These interviews took place in Mexico City, Merida, and San José Tipceh (both locations in Yucatan), and Ensenada (Baja California), and included actors with direct involvement in other geographies, such as Oaxaca, Sonora, and Chihuahua. I gathered primary and secondary documentary sources, including peer-review publications, the regulatory framework, peer-review publications, grey literature, media sources, and publications produced by NGOs, international organizations, and private actors.

This dissertation provides critical insights into the evolution of Mexico's controversy on renewable and its technical and political approach by tracing and deconstructing its epistemological development, political formation, and implementation. My findings collectively deliver crucial insights to aid our understanding of the centrality that sociocultural impacts have acquired in the politics of making energy transitions in Mexico and the uncertainty that this necessary transformation is currently facing. As the director of an NGO pointed out in a research interview: *"After the government's actions against renewable projects, it is revealing that together companies were not the communities affected by the obstruction of the projects and the cancellation of investment plans. This shows the risks of building an energy transition without considering and without benefiting local communities. We need to think of other ways."* It is, in fact, the central project of my dissertation to explore alternative ways of thinking about, designing, and governing a fair energy transition in Mexico. Based on this case study, I aim to reveal the sociopolitical risks of driving top-down ETs without the local communities' substantive involvement.

1.2 STS literature on energy transitions

The rise of ongoing energy transitions (ETs) as a matter of concern for STS scholarship has coincided with the path followed by the development of climate mitigation policies. Since the formulation of theories referred to as Social Construction of Technology (SCOT) and Large Technological Systems (Bijker et al., 1987), the relationship between energy and society has become a central inquiry for STS research (Sismondo, 2010). This scholarship has demonstrated that collective visions, institutions, and social groups play a critical role in the development and functioning of the technologies and systems that frame the modern production and consumption of energy (e.g., electric power systems and automobile-based transportation) (Hughes, 1987; Geels, 2004; Jasanoff & Kim, 2009; Sovacool & Brossmann, 2013). Crucially, these technologies and systems have shaped human activities, behaviors, and meanings (Nye, 1998; Jones, 2014). Grounded in these insights, an ever-increasing amount of STS research on ETs has been conducted since the 2010s. In the United States (US), the Clean Power Plan, the 2009 American Recovery and Reinvestment Act of the Obama Administration and the state-level renewable portfolios promoted significant investment in technologies and projects that focused on the mitigation of greenhouse gasses (GHGs) in the energy sector (Morris et al., 2012; Rodrik, 2014). Besides, US diplomacy played a critical role in the adoption of mitigation goals by emerging economies and the achievement of the Paris Agreement (Dimitrov, 2016; Chasek et al., 2017). Advances in the climate change agenda during this period sparked a surge of STS research on the technologies, policies, and infrastructures that frame ongoing energy transitions (Miller et al., 2013). Nevertheless, the construction of the policy tools to manage social effects and relations have received less attention. Moreover, the development pathways of energy transitions in the Global South remain broadly under-researched.

Government and private funding for research in renewable energies have focused on studies that explore how the efficiency of these technologies and the development of utility applications could be improved. In comparison, research related to public health and environmental issues associated with these technologies and technological innovation lines deemed less relevant by companies (e.g., microscales and distributive systems) have received less funding. Consequently, several areas of these research agendas remain "undone science," or areas where scientific research has not been done despite high public relevance or community interest. (Phadke, 2013; Mulvaney, 2013). The resulting disparities in what is known about renewable energies constrain the available epistemic resources for addressing social issues and environmental claims and the development of applications that have social aims (Aitken, 2009; Tironi & Barandiarán, 2014). This bias in knowledge production and technological development has followed such tendencies as the increasing size and scale of wind turbines and blades since the 1990s and the magnitude of their interference with the local landscape (in 2010, the average wind turbine had grown to a height of 80m while blades expanded to 42m) (Ottinger, 2013).

Moreover, current solar energy installations rely on toxic materials (cadmium-based semiconductors) and generate similar waste flows as in the electronics industry (Mulvaney, 2019).

Historically, energy institutions and policies in the United States have been aimed at and organized around provision, reliability, and low cost. Similarly, ET policies and the sector's planning and design of projects have been oriented around these goals (Laird, 2013; Miller et al., 2013). For instance, the targets and timelines set by the state-level renewable portfolio standard programs in the US promoted the deployment of large-scale wind and solar PV facilities that would aim to reach an electric power generation level similar to that of current fossil fuel technologies (Phadke, 2013; Mulvaney, 2019). The planning of these projects tends to be based on the potential of renewable energy, the cost of land, and infrastructure needs. Typically, there is no consideration of the social aspects of these enterprises (Moore, 2018). Thus, these policies' goals and the planning and design of the projects frame the magnitude of their effects on local geographies and shape the relationship of the resident social groups with their environment (Walker & Cass, 2007; Phadke, 2018). Moreover, as evidenced by Arizona's residential solar model, policies affect the social domain not only through direct and physical interaction. Arizona's policy also resulted in the uneven distribution of the benefits and drawbacks of solar, with disproportionate benefits going to high-income households (who can afford these technologies). At the same time, low-income ratepayers felt the impact of contributing to utility subsidies and the fixed costs of maintaining the grid (Miller et al., 2015).

Jasanoff & Kim (2013) demonstrated that sociotechnical imaginaries regarding nuclear energy in South Korea, the US, and Germany are embedded in their domestic institutional views on managing the risk and benefits of nuclear energy and its inclusion (or not) into ETs. Similarly, local shared views on the benefits of technological innovation have framed the energy transitions in Portland, Oregon and Phoenix, Arizona, and influenced these cities' divergent route characterized by the development of smart grids and distributed generation (Levenda et al., 2019). Moreover, the design of integrated assessment models (IAMs), which have become a central tool in evaluating and decision-making of climate mitigation policies and projects, reflect some extent the researchers' and modelers' understanding of the social organization and its interplay with the environment. This understanding influences the theories, methods, and assumptions they use to make these models (Ellenbeck & Lilliestam, 2019). IAMs tend to attribute different weights to the areas of the social and environmental relationship, and the sociopolitical aims for climate mitigation (e.g., profitability or sociopolitical viability). This produces variations in their outcomes and insights that cover the knowledge needs of different international, national, and local actors (Geels et al., 2016).

STS research on energy transitions has demonstrated that although technologies can mitigate the effects of GHGs, their design, materials, and physical

configuration can similarly lead to adverse outcomes in respect of other relevant environmental and social goals. For example, it could cause some social groups to gain control over others (Ottinger, 2013; Mulvaney, 2013). Policies, planning procedures, and assessment practices significantly influence the features of infrastructures and their local interplay with social environments (Moore, 2018; Phadke, 2018). Moreover, the design of these policies and procedures can work for or against relevant political goals, such as social equity and poverty reduction (Miller et al., 2015). However, ETs are not determined by their internal logic. As in other human manufacturing areas, the technical and social characteristics of energy transitions are also influenced and mediated by the agendas and vision of actors and social groups (Sovacool & Brossmann, 2013; Levenda et al., 2019). By doing this, STS scholarship has provided critical insights into the broad social and environmental effects and political implications of ETs.

However, through my research for this thesis, I identified gaps in the existing STS research on energy transitions. Previous researchers have examined different arenas of knowledge production, such as technological innovation and the engendering of infrastructures and the effects of policies and planning processes on development trajectories (Miller et al., 2015; Mulvaney, 2019). Researchers have also deconstructed several components of the socio-technical arrangement of ETs, such as and the economic, environmental, and technical assessment of projects (Tironi & Barandiarán, 2014; Ellenbeck & Lilliestam, 2019). However, the following areas have received far less attention: *i*) research in non-economic social sciences, *ii*) the formation of policies and regulations, and *iii*) the management of social impacts and relations. My dissertation aims to extend STS discussions into these areas, showing their critical role in ET building.

Although the Global South has taken the lead in investment in and the deployment of energy transitions (WB, 2017; McCrone et al., 2018), existing STS research has primarily focused on the US and Europe, with some notable exceptions (e.g., Tironi & Barandiarán, 2014; Moore, 2018). My research analyzes the contextual valence and relation among research practices, political domains, and management areas in Mexico's controversy, which are central areas of concern by STS scholarship. Moreover, in countries like South Africa, Brazil, China, and Mexico, to mention a few, researchers have indicated how little research has been conducted on their domestic institutional and sociopolitical conditions as they relate to the challenges of ET (Tang et al., 2008; Lombard & Ferreira, 2014; Rousseau, 2017; Gorayeb et al. 2018; Huesca-Pérez et al., 2018; Khan, 2020). Such conditions limit research that could provide relevant insights for these geographies, and they also make these issues less visible to research agendas and academic debates, framing an issue of knowledge justice (Egert & Allen, 2019). My study of the Mexican case aims to help address this shortcoming. Importantly, through the characteristics that Mexico shares with other geographies in the Global South (e.g., limited institutional budgets, social inequality, communal land use, land tenure insecurity) (Tang et al., 2008; Gorayeb et al. 2018;

Khan, 2020), this research provides critical insights about the nuances of fair energy transitions in these social milieux.

1.3 Adding STS to political economy analysis of social opposition

1.3.1 Sites and types of social opposition

As the urgency grows to tackle the climate emergency, energy transition policies and infrastructures have faced opposition in different geographies. This opposition has encouraged research that focuses on the sites of opposition (international governance, domestic policies, and the implementation of projects and infrastructures) (O'Neill, 2017) and types of opposition (governmental/institutional, political, and social) (Wüstenhagen et al., 2007; Devine-Wright et al., 2017). Such research serves to clarify the specific factors that drive agendas that are either favorable or adverse to ETs. However, these research approaches provide a limited account of the relationship between the characteristics of ETs and the sociopolitical sphere and the linkages and feedbacks among the sites where ETs are built: international, national, and local (Neville & Weinthal, 2016; O'Neill, 2016). In an effort to remedy this limitation, I examine the opposition to energy transitions in terms of STS.

Between the 1990s and 2000s, the opposition of emerging economies to assuming mitigation commitments and the non-ratification of the Kyoto Protocol by the US, among other political issues, constrained an international climate regime's formation. This issue prompted research from fields such as political science and international relations on nations' positions in the climate arena (Bernstein, 2002; Hallding et al., 2013). Structural factors, such as the level of economic dependence on fossil fuel industries, the intensity of emissions, financial and technological capacities, and regional climate risks, generate a differentiated distribution among nations of the costs, capabilities, and benefits of climate mitigation (Keohane & Victor, 2011; Lachapelle & Patterson, 2013; Lewis, 2014; Harrison, 2015). This pattern helps determine or influence a country's position on the climate regime. Other political factors, such as national membership of international organizations (OECD, IEA, or OPEC), participation in the global economy, and the salience of the climate agenda in public opinion, also affect the domestic position of a country (Hochstetler, 2012; Bernauer, 2013). Moreover, interest groups (e.g., environmental NGOs, energy companies, and consumers) and their relative weight in domestic politics play an important role in determining social groups' views and institutional climate agenda (Laird & Stefes, 2009; Cheon & Urpelainen, 2013; Hoffman, 2015). For example, oil companies were critical of the different political trajectories of the climate agenda espoused by the US and European Union in the last decade of the 1900s (Levy & Egan, 2003; Meckling, 2011).

During the 2010s, the more widespread adoption of mitigation policies at the national level and the Paris Agreement's bottom-up design sparked research that examines domestic politics's role in the adoption and design of ET policies. The structure of the energy markets (e.g., the characteristics of producers and consumers), the relative cost-effectiveness of technological choices and their potential economic benefits, and the role of transnational climate networks, among other factors, delineate the actors and interests that frame the ambition of energy transition policies and the political viability of technological choices (Hughes & Lipsy, 2013; Lachapelle et al., 2017; Roger et al., 2017). The national political system (e.g., the strength of the link between the electoral system and the regions or groups affected by or benefiting from the ET; the degree of plurality of the political party system; and the role of the environmental agenda in political ideologies) influence the formation of coalitions that are either in favor of or against ETs, the degree of polarization that exists between such parties, and the ways these agendas are politically processed (Knox-Hayes, 2012; Lipsy, 2012). Moreover, the organization of the state and its institutions (e.g., the level of decentralization of energy governance, and the role of governments in the economic sphere) can also influence the regulatory form and orientation of ET (e.g., market mechanisms, regulations, and subsidies (Harrison, & McIntosh-Sundstrom, 2007; Rodrik, 2014; Hoffman, 2015)).

The deployment of ET infrastructures has also encouraged research that examines the factors that sparked local opposition to RE projects. Although RE projects contribute to climate change mitigation, they can generate local environmental effects that negatively affect local communities (e.g., health risks, esthetic and sound disturbances, pollution). They can also cause landscape fragmentation and affect local wildlife, causing social groups such as NGOs to raise ecological concerns (Tsoutsos et al., 2005; Wang & Wang, 2015). In fact, RE projects can have positive and negative social impacts that are differentially allocated among actors and social groups (e.g., job creation, compensation for landowners, and impacts on property values and local economic activities) (Lewis, 2014; Huesca-Pérez et al., 2016; Rand & Hoen, 2017).

The characteristics of planning and deployment procedures can also lead to local opposition. The assessment of projects often has limited community involvement mechanisms, preventing the inclusion of local knowledge and experience, and identifying society's concerns. In some contexts, assessment and approval procedures lack participation mechanisms, while in others the design of these mechanisms can exclude any deliberation on local priorities or take place on asymmetric information conditions, or their outputs have little influence on final decisions (Stirling, 2008; Gorayeb et al., 2018). Such factors affect a community's right to fair consultation, diminishes social trust, and the future relationship between communities and projects (Vammen-Larsen et al., 2018). Moreover, the historical relationship between local communities and geographies and the resulting cultural meaning of landscapes and biological elements can influence the social responses to projects (Cowell et al.,

2011; Bauwens & Devine-Wright, 2018). For instance, Devine-Wright (2011) found that variations in the attachment to geographic place between two communities in Northern Ireland led to differences in their social acceptance of a tidal energy project.

1.3.2 Co-producing energy transitions and social oppositions

Existing research on political economy has provided critical insights into the factors that generate sociopolitical opposition at different sites – such as government agencies, corporate offices, local communities, and international institutions – where ETs have been built. However, these approaches provide a limited account of the linkages and feedback loops among the sites and the changing nature of the political dynamics (Clapp & Swanston, 2009; Dubash, 2016; Neville & Weinthal, 2016; O'Neill, 2016). In terms of my Mexican case, these include the influence of international climate politics on the emergence of social opposition to renewables in Tehuantepec, the role of community groups in the introduction of social impact assessment in Mexico, and the ways that the performance of this new policy tool have stimulated controversy in Tehuantepec. These linkages among sites are, in fact, the analytical core of this dissertation, which is not merely about the identification of the factors that lead to the opposition, but rather the dynamic interplay between the socio-technical arrangement of projects and the objective and subjective frame of the agendas of social groups.

Therefore, informed by the research on sociopolitical opposition, I have built an analytical approach based on STS, specifically on Jasanoff's co-production formulation. This formulation proposes that the practices of knowing, building, and governing scientific and technological projects and the social and material order are intertwined at multiple stages, influencing each other in a process that, over time, reconfigure these domains (Jasanoff, 2004; Iles et al., 2016; Miller & Wyborn, 2018). My analytical approach also built on insights from STS research on socio-technical systems to undertake the specificities of ETs. Research on socio-technical systems has demonstrated that the dissemination and use of technologies such as the automobile or electric energy, in addition to technological innovation and the production of specialized knowledge, requires the intervention of social visions, institutions, regulations and social groups (Hughes, 1987; Geels, 2004). This technical and social organization creates over time extensive networks of technology, infrastructure, and activities, which shape geographies, regulations, behaviors, political visions, and even identities, producing independent and path-dependent relationships that stabilize the organization of these systems, such as the "carbon lock-in" (Unruh, 2000; Geels, 2019).

Grounded in the lenses of co-production and socio-technical systems, this dissertation approach to the sites and types of sociopolitical opposition to ETs is as follows. As a result of specific historical developments, national energy systems vary widely in their technical and social features (e.g., technologies, infrastructures,

economic interests, institutions, knowledge practices, and regulatory frameworks). In turn, these differences frame the technical factors and the political dynamics that influence the adoption and scope of ET policies (Bernauer, 2013; Hughes & Lipsy; 2013; Barandiarán, 2018). The resulting policies and regulations are vastly diverse in their forms (market mechanisms, regulations, and subsidies), objectives (supply or demand side), and technological choices (e.g., energy efficiency, shale gas, and renewables) (Lachapelle & Matthew, 2013). Their particular design shapes the further socio-technical development of ETs, such as encouraging industrial-scale wind farms or targeting development to regions with high sunlight levels and low levels of habitation (Walker & Cass, 2007; Miller et al., 2013). The resulting social and material effects interact with a particular constellation of social actors such as consumers, local communities, researchers, and environmentalist, who may generate local and national controversies (e.g., impacts on local landscapes and biodiversity, job reduction in fossil fuel industries, or economic impacts on consumers) (Phadke, 2011; Moore, 2018; Phadke, 2018). This interaction causes feedback loops that can reshape the sector's policies, infrastructure features, and social interplay (Batel & Devine-Wright, 2015; Meckling, 2019).

Therefore, this co-productive approach differs from technological determinism or the idea that technological innovation is natural, uncontrollable, and inevitably progressive, resulting in a driving force of history that shapes material and cultural social order (Wyatt, 2008). Technological determinism has influenced frameworks such as "Not in My Back Yard," which addresses social opposition to new technologies and development projects as a matter of perceptions and "social acceptance" (e.g., Michaud et al., 2008; Lai et al., 2019; Proudlove et al., 2020) or academic narratives that view the social dimension as a "barrier" to the deployment of energy projects (e.g., Pasqualetti, 2011; de Rubens & Noel, 2019). Similarly, technological determinism has influenced research approaches that explain opposition to energy transition policies as poor public awareness, information deficit, or selfishness (Phadke, 2011; Hoffman, 2015). These approaches are built on assumptions that opponents are misinformed or ignorant about the benefits of ET policies and infrastructures (Devine-Wright, 2009; Aitken, 2010; Batel & Devine-Wright, 2015). This inhibits developing a better understanding of the human agency's role and the importance of social processes in shaping these large transformation projects.

Co-production also differs from social determinism or the idea that knowledge and technologies are purely the product of social groups' meaning-makings and interaction. Social determinism suggests that human reality is socially constructed rather than an extension of nature (Sismondo, 2008). Rooted in social constructivism, the first wave of STS scholarship demonstrated that the needs and interests of social groups defined, among other meanings and technical possibilities, the solutions to the issues they faced in innovation processes and shaping the pathway of technological development (Bijker, 2010; Cordoves-Sánchez & Vallejos-Romero, 2019). This scholarship provides fewer insights about the factors outside this

microsocial dynamic by primarily focusing on how actors construct issues, solutions, and alternatives in their social interpretations. For instance, researchers pay much less attention to the power relations that affect the social groups that are intervening (or are left out) on design paths (Winner, 1993). Innovation paths are also contextually and historically located. Aspects such as energy resources endowment, the existing technical capacities for using these resources, and their physical properties can frame the specific issues that arise in design processes and can mediate the decisions of actors (Essletzbichler; 2012; MacKinnon & Cumbers, 2019).

Co-production proposes that knowledge, institutions, and technological systems are making each other simultaneously, with changes in one looping back into the other (Jasanoff, 2004). For instance, the development of electric power systems created the conditions for the massive adoption of electro-domestics (e.g., refrigerators, washing machines, and air conditioners) that shaped the way people live and behave within the family unit; while at the same time fostering the demand for fossil fuels and GHG emissions (Nye, 1998; Pearson & Foxon, 2012). In turn, scientific research demonstrated the links between anthropogenic GHG emissions and climate change and informs mitigation policies and innovation paths that deliver technological fixes such as biofuels, windmills, and electric cars (Ottinger, 2013; Beck & Forsyth, 2015; Cloke & Brown, 2017; Levenda et al., 2019). Therefore, the facts and artefacts that humans use to manipulate the world and govern social relations cause feedback effects that reorganize institutions, regulations, and geographies; while these changes simultaneously shape social discourses, activities, relations, and identities; thereby, influencing knowledge practices and needs (Iles et al., 2016; Miller & Wyborn, 2018). Thus, co-production proposes that social and natural domains are interactive and mutually constitutive rather than independent or determined (Jasanoff, 2004).

Therefore, in comparison with existing research approaches to analyzing social opposition to ETs, my co-production approach provides the analytical lens to trace the normative, material, organizational, and subjective aspects that have interacted and intervened throughout Mexico's controversy. In this case, the introduction of renewable energy technologies has led to the formation of new social movements and agendas in opposition, social science research fields, regulations, and practices for managing social effects. However, the pathway that has followed these technologies' development has also been socially, materially, and epistemologically framed by the characteristics of Mexico's energy sector, technologies, and territories. Thus, what has been incorporated into or omitted from these arenas of social innovation establishes a dynamic between stability and change in the socio-technical system, continually shaping the path that the controversy has followed and the roles that actors and social groups play, as well as their interplay with existing infrastructures and with one another.

In Chapter 2, “*Resisting renewables: The energy epistemics of social opposition in Mexico*,” I examine the academic and technical research on social opposition to RE in Mexico, and the normative vision embedded in this body of knowledge. Previous research has examined the authoritative role of knowledge production in the shaping of energy transitions (Mulvaney, 2013; Geels, 2016; Ottinger et al., 2017), yet non-economic social research has received less attention due to its typically limited influence (Sovacool et al., 2015; Stern, 2017). However, in Chapter 2, I argue that social research plays a central role in some components of energy transitions. When these areas concern an unequal dispute between different interests and visions, then the production of knowledge, its outcomes, and its use can have vast implications for achieving energy justice. My findings suggest that researchers have addressed social opposition through different understandings of human interaction with infrastructures and methodological choices. In this way, they have shaped critical aspects of knowledge-making, such as the voices and agendas of the social groups involved. The outcomes of these research practices have offered competing interpretations of the causes of social opposition and alternative solutions, which propose different material and symbolic roles for communities – from downstream policy fixes to the upstream community involvement projects.

My findings suggest that the production of research in this field has exceeded the academic debate to influence the political domain. This influence took place in a context characterized by the low domestic experience of projects’ social effects, the lack of regulation in this area, and limited institutional capacity to meet governmental knowledge needs. By doing so, the production and consumption of these epistemic resources have broad energy justice implications. First, academic and technical social research’s authoritative role can acquire a particular social valence in some geographies and political contexts. Second, far from being neutral, research practices in this field produce explanations and diagnoses that embody a particular normative vision. These normative ideas can have vastly different effects on communities. Third, related to the previous two points, social research on social opposition has an intrinsic social justice dimension due to the characteristics of both the study phenomenon and social research practices. Fourth, sociopolitical actors can influence knowledge justice (or injustice) through their production and use.

In Chapter 3, “*The social and material shaping of Mexico’s energy transition*,” I introduce the concept of “technology governance artefacts.” This concept comprises the institutional agendas, policies, and regulations that establish objectives, rules, and practices for governing technological systems and their social interactions. The notion of technology governance artefacts is founded on the STS observation that when technologies reach a stage of technical and social organization that allows their widespread dissemination and utilization, their political regimes have coevolved alongside these socio-technical systems (Hughes, 1987; Geels, 2004). The ways that institutions process emerging political agendas and design their policies and regulations are shaped by the socio-technical systems over time, resulting in a new

balance in these systems. To provide these observations with empirical weight, I analyze Mexico's Law for the Use of Renewable Energies and Financing the Energy Transition (LAERFTE 2008) and social impact assessment (2014), tracing the translation of this controversy back to the energy institutions and the process of policy formation.

I argue that although climate change mitigation and the social opposition to renewables have promoted disruptive changes in the political regime of Mexico's energy sector, the existing arrangement of the energy system has meant that entrenched industrial interests and values, as well as bureaucratic decision-making norms, have persisted in the way that institutions process the agendas of climate mitigation and social opposition and in the design of policies and regulations. My findings suggest that Mexico's position in the international politics of climate change and the limitations imposed by the national regulatory framework for the development of renewables played a crucial role in the design of LAERFTE. The solutions that this law established for investment in renewables, their cost-effectiveness and intermittency, and the access of these technologies to transmission infrastructure frame the particular arrangement that the projects followed in Mexico (i.e., large-scale wind farms in private ownership, generating power for the consumption of large corporations) and their geographic concentration in Tehuantepec. The local impact of these projects and their interaction with the vision and organization of the indigenous Huave and Zapotec communities that inhabit this region defined the emergence of opposition groups, with a discourse focused on sociocultural claims. The centralism and top-down management that have characterized energy institutions and policies in Mexico, and the dispute between the political left and right regarding private participation in this sector, has framed the institutional translation of this controversy and the design trajectory of the social impact assessments (SIAs) and associated policy tools.

Similar to Mexico, the Global South in the last decade has taken the lead in the deployment of renewables (WB, 2017; McCrone et al., 2018), and these projects have generated much social opposition, mainly among local communities (Hanna et al., 2014; Wlokas et al., 2017; Gorayeb et al., 2018; Huesca-Pérez et al., 2018; Khan, 2020). In response, governments, international banks, and companies have adopted and implemented regulations and policy tools, such as SIAs, that aim to address the causes of social opposition (Hanna et al., 2014; Rousseau, 2017; Vammen-Larsen et al., 2018; Hanna et al., 2019; Vanclay, 2020). Although these policy tools have practical implications for how social aspects are included in the decision-making process and planning of RE projects (Aledo-Tur & Domínguez-Gómez, 2017), their performance remains under-researched (Hanna et al., 2019). I address this question in Chapter 4, "*The effectiveness of the social impact assessment (SIA) in energy transition management: Stakeholders' insights from renewable energy projects in Mexico.*" In this chapter, I argue that without internalizing social aims in the

priorities, policy, and planning of RE, the SIA's role would be limited to problem fixing, which would constrain the effective management of social impacts.

My findings evidence that shortcomings in the regulatory framework in critical areas, such as synergistic, cumulative, and subjective impacts, and the low level of professionalism of consultants and companies, constrain the comprehensiveness of SIAs. The scarce institutional resources in this field of expertise, and the lack of specified review procedures that cover the wide variety of a project's features (e.g., the technology or technologies involved, the scale, and the local environment), have a negative impact on the government's evaluation of the SIA. The low level of development of companies' social management skills constrains the implementation of social management plans, and the regulatory framework does not provide a mechanism for the governmental and social monitoring of these activities.

My research suggests several areas where the design and practice of SIAs can be improved, delivering insights for this aim. Nevertheless, the findings also reveal that broader aspects of energy's regulatory and political framework influence the limited performance of SIAs and social management practices. To illustrate, in Mexican RE policy and institutions, social management remains secondary to its investment and deployment targets. This explains the limited resources that the Secretary of Energy has allocated for the institutional agency in charge of social aspects, and the lack of attention that social management plans receive from companies. Moreover, electricity auctions were designed to promote competition among companies for medium- and long-term contracts. Such competition is based mainly on lower generation costs, and this encourages the planning of large-scale projects. Such large-scale projects tend to be located in regions where land cost is low, and the financial model emphasizes investment returns over the long term. In this way, the electricity auctions shape the magnitude of a project's local impact and the communities' vulnerability with which they interact. Companies are also left with a lower financial margin to implement comprehensive measures for the prevention, mitigation, and compensation of local effects.

By tracing and deconstructing these arenas, my collective findings show that the practices of knowing, governing, managing, and contesting renewable energy projects have been intimately intertwined: From international climate negotiations to Mexico's adoption of energy transition (ET) policies and the emergence of local opposition groups to the formation of policy tools for addressing social impacts, to the current uncertainty facing Mexico's climate policy. The interplay among research production, political agendas, and regulatory rules have influenced each other at the international, national, and local domains, co-producing Mexico's particular energy transition pathway, regional geographies of energy development, social movements, actors' practices, and societal views.

Chapter 2

Resisting renewables: The energy epistemics of social opposition in Mexico¹

Abstract

Previous studies have examined the research practices and their normative roles in various areas of energy transitions (ETs). However, non-economic social research is not usually perceived as influential in ETs, thus receiving less attention. I argue that social research plays a central role in some components of ETs, and when these areas concern an unequal dispute between different interests and visions, then the production of knowledge, its outcomes, and its use can have vast energy justice implications. This issue is illustrated by the controversy over the social effects of renewable energy projects in Mexico. These projects have caused significant social opposition and even conflicts in indigenous communities, which have generated growing social research. Researchers have addressed this issue through different understandings of human interactions with projects and methodological choices, shaping critical aspects of knowledge-making, such as the voices and agendas of the included social groups. In their outcomes, these research practices have offered competitive interpretations of the causes of social opposition and the alternatives to solutions, which propose different material and symbolic roles to communities (e.g., downstream policy fixes for addressing social externalities vs. communitarian involvement in the decisions, management, and benefits of projects). Through a subject of controversy characterized by the lack of domestic regulation and experience and limited institutional capacity, social research has exceeded the academic domain, providing critical insights into the activism, the policy formation, and the practices of governmental and private actors. This research extends energy epistemics to social research practices, providing critical insights about their effects on how societies build energy futures and their interplay with local environments.

¹ This chapter has been published: Martinez, N. (2020). Resisting renewables: The energy epistemics of social opposition in Mexico. *Energy Research & Social Science*, 70, 101632. I have obtained permission from the Graduate Division to use this article in my dissertation

2.1 Introduction

Energy epistemics refers to the central role of knowledge in designing, building, and governing energy technologies and infrastructure (Miller et al., 2013). Much attention is devoted to “hard” or material elements (i.e., transmission lines and wind turbines), as well as to the institutions and rules that govern their planning and construction; meanwhile, knowledge practices are often overlooked as highly technical, objective and neutral information. However, the social context and the characteristics of knowledge practices shape the results of knowledge, which can be incredibly influential in how actors understand and interpret the opportunities and risks of technologies, projects, and regulations, framing the decisions and actions that shape energy systems with durable social and environmental consequences (Miller et al., 2013; Pfister & Schweighofer, 2018). For instance, assessments of the social impact of energy projects can incorporate different research approaches, methodologies, and levels of actor involvement (e.g., objectivist and technocratic vs. participatory and constructivist). Their particular arrangements frame whether and how the knowledge and experience of communities are incorporated into projects’ decision-making, thus having vast consequences for local environments (Miller & Richter, 2014; Aledo-Tur & Domínguez-Gómez, 2017).

Previous research in science and technology studies (STS) has examined the production and influence of energy epistemics in different aspects of ongoing energy transitions (ETs), such as technologies and infrastructure (Mulvaney, 2013; Ottinger, 2013), planning and policies (Stirling, 2008; Miller & Richter, 2014), and the economic, environmental, and technical assessment of projects (Tironi & Barandiarán, 2014; Geels, 2016). This field has provided critical insight about the normative role of knowledge practices in the building of ETs, illuminating their broad political effects and implications for energy justice (Stirling, 2008; Miller et al., 2013; Pfister & Schweighofer, 2018). Non-economic social research (social research) is not usually perceived as influential in ETs; thus, the research practices in this domain receive less attention (Sovacool et al., 2015; Cooper, 2017; Stern, 2017). Social research provides information input for some crucial aspects of ETs, such as the international negotiation of the climate regime, the formation of domestic policies, and the understanding of sociopolitical opposition to policies and projects (Stern, 2017). Moreover, a significant degree of integration of social science is required to understand how social behavior, organization, and dynamics in which energy systems are enmeshed, as well as how their transformations influence social life (Abramsky, 2010; Miller & Richter, 2014). Much remains to be done to integrate social science inputs into the management and design of energy systems, and, as the publications in this journal show, the research and interest in this area have consequently flourished in recent years. Therefore, similar to other areas of knowledge, social research practices also require critical scrutiny.

This study provides insights into the interplay between the making of social science and the social domain by examining research on social opposition to the projects of ETs. The research in this field undertakes one of the phenomena that expresses the interactions, trade-offs, and contradictions between society and energy. Researchers use theories and concepts regarding human interaction in these projects and methods that incorporate information or have direct interactions with actors and social groups, building into their results interpretations about who society is, how to interact with projects, and why to oppose them (e.g., the classification of social groups and their relations and the definition of projects' social benefits and impacts) (Aitken, 2010; Miller & Richter, 2014; Aledo-Tur & Domínguez-Gómez, 2017). On the other hand, in the last decade, the efforts of the international community in terms of climate mitigation, among other factors, have promoted a large formation of policies of ETs in the Global South (Rennkamp et al., 2016). The projects of ETs have simultaneously caused social opposition in these regions, intensifying concerns about the sustainability and social justice implications of ETs (Abramsky, 2010; Ottinger et al., 2017; Reusswig et al., 2018). Consequently, research in this field usually occurs in contexts in which actors and social groups from various dispute different views and agendas with regard to projects and local territories (e.g., Phadke, 2013; Moore & Hackett, 2017). Therefore, this field can illustrate both the features of social research practices and the interactions between society and energy systems while also providing a strategic issue-area to interrogate broad social justice implications.

To address this area, this article opens the “black box” of academic and technical research on social opposition to renewable energy (RE) in Mexico, examining its research practices and the normative visions embedded in its results. Mexico has built a robust ET political framework and is considered by the international community to be a leader in the Global South's climate agenda (Pulver, 2013; Pulver & Sainz-Santamaría, 2018). However, the implementation of RE projects has sparked significant social opposition and even conflicts in indigenous communities, generating political controversy regarding the social impacts of this industry (Howe, 2014; Huesca-Pérez et al., 2016). In response, Mexico's government introduced several policy tools in 2014 for the social management of these projects: environmental impact assessments, indigenous consultations, social benefits, and strategic environmental assessments (Grunstein-Dickter, 2016; Rousseau, 2017; Huesca-Pérez et al., 2018). However, the projects are still being met with social opposition, leading the extension of the controversy in the area (Zárate-Toledo et al., 2019; El Financiero, 2019). Compared to the cases in many countries, researchers in Mexico have studied the opposition to RE in depth, and their insights have been fundamental to the way in which sociopolitical actors understand and approach this problem.

After providing a brief background, I trace the interplay of researchers and sociopolitical actors in some of the geographies and critical moments of this controversy. Thereafter, I examine the features of leading research practices

(positivist, pluralist, constructivist, and structuralist) and the narratives that they provide on social opposition. Next, I analyze the normative visions embedded in the narratives of these energy epistemics. Finally, I conclude by discussing the implications for energy epistemics and the social justice of research practices in the area.

2.2 Energy epistemics and energy transitions

Energy epistemics refers to the central role of knowledge in designing, building, and operating energy technologies. The governance, infrastructure, and technologies of energy systems result from how actors and social groups understand and interpret their associated goals, risks, and benefits (Miller et al., 2013). For instance, actors produce and consume knowledge about developing clean energy technologies, identifying RE, making investment decisions, assessing RE projects' risks and benefits, designing ET policies and regulations, and, importantly, contesting policies and projects. Thus, knowledge practices have a practical and normative role that interacts with the actors' everyday activities and decisions and the material and institutional arrangement of energy systems (Miller et al., 2013; Pfister & Schweighofer, 2018). This interaction further shapes the sociotechnical pathways of ETs, and the outcomes that emerge can vary significantly in terms of climate mitigation, energy security and costs, and local social and environmental (Delina & Janetos, 2018).

The pathway of the development of ETs requires extensive flows of technical and academic knowledge, which often receive little public scrutiny (Stirling, 2008). However, as with other areas of human manufacturing, the agendas and visions of social actors can frame and mediate research production, its outcomes, and its subsequent use, thereby influencing the development of technologies and infrastructures, policies, and planning processes (Miller et al., 2013; Pfister & Schweighofer, 2018). To illustrate, funding for research on RE has focused on technical aspects with economic applications, while research related to the public health issues and the environmental impacts of RE has been incomplete or remains "undone science" (Phadke, 2013). Similarly, the formulation of policies for ETs and the planning of these projects have been informed by technical and economic aspects, but decision-makers have neglect insights into regional sociocultural complexities and their broad social effects (Mulvaney, 2013; Ottinger, 2013; Miller & Richter, 2014).

Energy epistemics plays a relevant role in the material and political organization of ETs. For instance, the market of the research on RE has led to a significant increase in the scale of technologies and projects shaping local geographies as well as community identities and relations with landscapes (Phadke, 2013; Moore & Hackett, 2016). Moreover, integrated assessment models (IAMs) tend to prioritize certain sociopolitical objectives that play a normative role over the policies and

projects of the ETs they evaluate (e.g., profitability or sociopolitical viability) (Geels, 2016). These normative views reflect how researchers understand the functioning of society and, accordingly, the theories, methods, and assumptions that they use in the making of these models (Ellenbeck & Lilliestam, 2019). The influence of energy epistemics in the sociotechnical arrangement of ETs have social and environmental effects (Walker & Cass, 2007; Stirling, 2008; Miller et al., 2015).

Energy epistemics has intrinsic implications for the justice of energy futures. Energy justice (or injustice) refers to the ability of all affected and interested social actors and groups to participate in an informed and effective manner in the decision-making processes on the production and consumption of energy. Energy justice also addresses the effects that the outputs of these decisions generate in terms of the distribution of benefits, risks, and power among different social groups (Ottinger, 2013; Phadke, 2013; Sovacool, 2013). Energy epistemics provides the knowledge insights that inform the development of technologies and infrastructures of ETs and the assessment of the benefits of policies and projects, thus framing the conditions under which actors and social groups think, deliberate, and implement critical aspects of ETs (Tironi & Barandiarán, 2014; Howe, 2014; Ottinger & Barandiarán, 2017). Consequently, what is known, how it is known, and what knowledge account in the construction of ETs all have vast social justice consequences, particularly in the areas and geographies in which actors and social groups contest different visions and agendas under unequal conditions (Stirling, 2008; Mulvaney, 2013; Egert & Allen, 2019).

The production and consumption of research can lead to epistemics inequities for disadvantaged social groups and geographies. Actors with higher economic and political capacity tend to exert a more significant influence on the framing, priorities, and funding of research agendas (Phadke, 2013; Egert & Allen, 2019). The extension of energy epistemics presents intermittency and imbalance in, for example, the area of knowledge (e.g., technical and economical vs. social and environmental), research practices (quantitative and universalist vs. qualitative and contextual), geographies (Global North vs. Global South), and social groups (consumer needs vs. minorities and marginalized social groups) (Fischer, 2000). Researchers often have institutional and professional incentives to prioritize some forms of knowledge production and dissemination (e.g., specialized and high-impact journals), which characteristically leads to unequal access and use by disadvantaged actors and geographies (e.g., language and cost) (Phadke, 2013; Tironi & Barandiarán, 2014). Moreover, the variety of disciplines and approaches through which it is possible to understand energy systems provide different and contrary evidence and arguments that actors and groups can use to support their positions (Martin & Richards, 1995; Sarewitz, 2004; Aledo-Tur & Domínguez-Gómez, 2017).

The research in STS has examined and provided critical insights on the energy epistemics in different areas of ETs, such as technological development, policy, and

planning, economic assessments, territorial and environmental evaluations of projects (e.g., Ottinger, 2013; Miller & Richter, 2014; Tironi & Barandiarán, 2014; Geels, 2016). However, social research is usually perceived as little influential in ETs (Sovacool et al., 2015; Cooper, 2017; Stern, 2017), thus the research practices in this domain has receive less attention. Currently, social research deliver relevant insights in some aspects of the ETs (e.g., international climate negotiation and the understanding of sociopolitical opposition to ETs), and greater integration of its inputs is required to inform about the societal changes that the transformation of energy systems requires, as well as the extensive effects of the changes in these systems in the different actors and social groups (Abramsky, 2010; Stern, 2017). Therefore, it is required a critical understanding of social research practices.

To address this issue, this study examines the research on social opposition to RE in Mexico. Like previous research (e.g., Martin & Richards, 1995; Geels, 2016; Aledo-Tur & Domínguez-Gómez, 2017; Ellenbeck & Lilliestam, 2019), this study identifies and characterizes the main research approaches within this body of knowledge. The positivist epistemics have addressed social opposition as the result of inadequate management of social and environmental externalities of companies. The pluralistic epistemics have understood social opposition as a political problem derived from the differentiated distribution of benefits and adverse impacts among actors and social groups. Constructivist epistemics have examined social opposition as a phenomenon framed by conflicting worldviews and practices of actors regarding projects and their social effects. The structuralist epistemics have understood social opposition as the result of the struggles of communities to maintain traditional livelihoods. These epistemics have gone beyond the academic domain to provide insights related to the activities of activism, policymaking, and the practices of social management.

2.3 Background: Social opposition to renewables in Mexico

After the mid-2000s, the negotiation on the Framework Convention on Climate Change (UNFCCC) began to move towards an agreement at 15th Conference of the Parties (COP 15), where emerging economies would assume mitigation commitments. In this context, Mexico's government wanted to increase national mitigation capacities, particularly in the energy sector, which offered greater investment possibilities (Pulver, 2013; Pulver & Sainz-Santamaría, 2018; Huesca-Pérez et al., 2018). However, the regulation of the electricity sector established some limits on this agenda. Mexico's government nationalized the electric industry in 1960, and since 1975, State-owned companies, such as the Federal Electricity Commission (CFE) and the Light and Power of the Center, have performed all the activities of the sector. In the 1990s, Mexico's governments began a process of liberalization in the sector which, for instance, increased the flexibility of private participation in the sector's self-supply projects and the schemes intended to supply State-owned companies (1992)

(Jano-Ito & Crawford-Brown, 2016). In the 1990s and 2000s, the CFE, with the financing and technical collaboration of international organizations such as the Inter-American Development Bank (IADB), the World Bank (WB) and United States Agency for International Development (USAID), developed some wind farms to evaluate this technology. However, the regulation mandated the CFE to invest in projects and technologies with the lowest generation costs, limiting its capacity to develop wind and solar photovoltaic projects due to the lower cost-effectiveness of these technologies at this time (Juárez-Hernández & León, 2014; Grunstein-Dickter, 2016).

Before the COP 16, which Mexico would host, Mexico's government promoted the Law for the Use of Renewable Energies and the Financing of Energy Transition (LAERFTE) (2008). The LAERFTE allowed the use of RE technologies for private low and medium-scale producers. Importantly, it provided various incentives to this industry, for example, the use of national transmission infrastructure through a low maintenance fee and net metering. These incentives, together with the higher costs of the tariff that CFE offered to the industrial and services sector, provided technical and economic feasibility to projects focused on these sectors (Hamister, 2012; Grunstein-Dickter, 2016). As a result, between 2008 and 2015, RE companies proposed the development of 25 large-scale wind farms to supply large corporate consumers of electricity (e.g., Coca-Cola and Wal-Mart) in the Isthmus of Tehuantepec, with some of the worldwide' highest wind energy potential (Howe, 2015; Rousseau, 2017).

The wind farm projects prompted the opposition of the Zapoteca and Huave indigenous communities that inhabit Tehuantepec. Various opposition groups, such as the Assembly of Peoples of the Isthmus in Defense of Land and Territory (APIITDIT), argued that the private governmental plan of developing this industry in the region without local involvement violated the right of self-determination of the indigenous communities and that the concentration of large-scale projects was causing a rapid transformation of the territory, which affected their traditional way of life and represented a risk to the future of their cultures (Nahmad et al., 2014; Huesca-Pérez et al., 2016). Between 2010 and 2012, Mareña Renovables, a project that sought to develop the largest wind farm in Latin America with 132 turbines and 396 MW, led local groups to implement civil resistance strategies to stop their construction such as demonstrations and to block access to the region (Howe, 2014; Nahmad, 2014). Thus, the activism of local groups and NGOs of human and environmental rights in the region encouraged a political controversy around the social impacts of the RE industry.

In response, the federal government in 2014 introduced various political tools for the social management of projects that sought to address the causes of opposition. In the new regulatory framework, companies had to conduct and approve the Social Impact Assessment as well as an indigenous consultation prior to the building of

projects and proving benefits to communities. The Secretariat of Environment and Natural Resources (SEMARNAT) would also develop strategic environmental assessments of regions with high potential for this industry so that they could evaluate their environmental and social viability (Grunstein-Dickter, 2016; Zárate-Toledo et al., 2016; Rousseau, 2017). This regulatory framework had the objective of regulating greater private participation in the sector, which historically had been managed through state-owned companies. Subsequently, in the framework of the Paris Agreement at COP 21, Mexico's congress passed the Energy Transition Law (ETL) (2015), which replaced LAERFTE. To reach 35% generation of non-conventional clean energy technologies in the electric power mix by 2024, the ETL established obligations for large electricity consumers in the area. It also created market mechanisms such as electricity auctions and clean energy certificates (DOF, 2015).

Between 2016-2018, renewable companies have promoted the development of 56 large-scale wind and solar photovoltaic projects (**Table 1**). However, around 67% of these projects have caused social opposition (El Financiero, 2019). This includes not only the wind projects in Tehuantepec but also the projects and technologies in other regions, such as the solar photovoltaic projects in Yucatán (Zárate-Toledo & Fraga, 2016; El Financiero, 2019). Consequently, sociopolitical actors have intensified their efforts and extended the controversy from the social impacts of this industry to the performance of the policy tools for social management. Local opposition groups and NGOs have pointed out that the policy tools have only been beneficial for the industrial and governmental actors without addressing the substantive claims of communities (Zárate-Toledo et al., 2019). These groups have argued, for instance, that instead of creating mechanisms for the communitarian involvement and the planning and designing of projects according to local characteristics, these tools produce information that companies use to manage and mitigate social opposition (FUNDAR, 2016; Dunlap, 2018; UNAM, DPL, FUNDAR, 2018). In this context, researchers and experts have produced extensive research on the social effects of the projects and the causes of the opposition, which has delivered insights regarding the activities of activism, policymaking, and actors' practices on social management. Therefore, in this study we analyze the epistemological dimension of this controversy.

2.4 Methodology

I undertook this study from the perspective of the field of STS; thereby, I based its methodology on previous studies in the field (e.g., Moore & Hackett, 2016; Barandiarán, 2018). In 2017-2018, I conducted participant observation for 11 months in Mexico City (2017–2018). I acted as a full-time research advisor for the “Communities and Renewable Energies,”² engaging in several policy-related work

² This project is a partnership between the Mexico's Climate Initiative, Civic Collaboration Center, and the Latin American Faculty of Social.

meetings and public forums in the area. Although social research usually has little influence in energy policy, from this experience I found that social researchers and experts participated together with sociopolitical actors in the debate in the area, that their outputs were a matter of discussion in these spaces, and that even some sociopolitical actors collaborated and produced research in the area. Thus, this experience informed this study and motivated my interest in analyzing these research practices and explore how their products can influence the political arena.

I examine the production of the research on social opposition and its interaction with sociopolitical actors at some critical moments and geographies of the controversy in the area (section 5) based on a) the discourse analysis of 28 in-depth, semi-structured interviews with key actors and institutions in both research production and consumption in the field, as well as the sociopolitical actors involved in this controversy, and b) documentary evidence. I personally conducted the interviews in Mexico City (2018), which included participating actors who resided and intervened in other geographic areas, such as Baja California, Oaxaca, Yucatan, and Chihuahua. The interviews included university-based scholars and experts in the area from a variety of institutions, disciplines, and approaches, as well as some representatives from governmental institutions, NGOs, the private sector, activists, and international organizations. Following the conventions of the Protection of Human Subjects, I only mention institutions and organizations that, due to their size, enable me to maintain the confidentiality of the participants.

Next, I conducted an analysis of the research practices and their outputs based on a thematic analysis of 79 scholarly publications addressing the subject in Mexico, published between 2005–2018 (see **Annex 1: Publications**). Researchers' outputs and dissemination channels to the political sphere broadly exceed the form and scope of these publications; however, these publications constitute valuable documentary evidence and provide information on the knowledge practices and their delivered perspectives (Shankar et al., 2017). I conducted the literature search via academic catalogs, national university libraries, and direct consultation with domestic researchers and experts. The literature took the form of academic articles, books, book chapters, the technical publications of institutional and political actors, and postgraduate theses, published in Spanish (37) and English (42). First, I classified publications based on their dominant research approach (positivist, pluralist, constructivist, and structuralist), a step similar to previous research examining social research approaches and outputs (Martin & Richards, 1995; Geels, 2016; Aledo-Tur & Domínguez-Gómez, 2017; Ellenbeck & Lilliestam, 2019). Second, I identified main objects in each study, the variables or aspects it analyzed, its main argument, and the authors' disciplinary approach, methodologies, and research scales. Third, I examined the positions of each publication regarding critical aspects of this controversy, as well as the policy of social management.

2.5 Research practices and their interplay with the politics of social opposition

The activism of local groups and NGOs

The struggle of the communities against the development of wind farms in Tehuantepec was a social phenomenon that attracted various researchers to the region, framing the products of their research. Through their involvement at the local level and their knowledge outcomes, these researchers have documented the adverse social effects of these projects and delivered critical insights for the activism of local groups and NGOs.

Scholars in anthropology, geography, and sociology conducted initial research on social opposition in Tehuantepec (**Table 1**). The lack of local involvement in the decisions of this industry had affected the trust of communities in external actors. Therefore, researchers had to develop a relationship with communities. One of these researchers, for instance, said: *“Many people have approached the communities under the pretext of doing research, but in reality, they are consultants of the companies or researchers who do not return their results to the communities.”* Further, this researcher indicated that *“People distinguish between those who have a real interest in improving the conditions of the communities and among those who only seek to extract knowledge.”* These researchers produced several pioneering academic publications that exposed the violation of human rights in this industry, and the adverse social effects of projects on, for example, the loss of local access to their natural resources, increased social inequality, land speculation, and land grabbing (e.g., Oceransky, 2010; Howe, 2014; Nahmad et al., 2014).

Researchers working in Tehuantepec usually present their results to communities and in local forums, such as in the “Meeting of Peoples in Resistance for the Defense of Our Territory,” which is organized annually by APIITDTT. Moreover, researchers have collaborated directly with local groups, for instance, in the planning of a communitarian co-owned project in Ixtepec (Oceransky, 2010; Hoffmann, 2012). A researcher pointed out that *“One of the main issues for the community project was the cost of technical studies, and creating, together with the communities, a management model that strengthened their traditional collective land use.”* The researcher also suggested that *“The project showed that, unlike what the companies argued, there is no technical or economic impediment for the direct involvement of communities in the benefits and management of projects.”* Although regulatory barriers prevented the development of this project, the proposal has shaped the local imagination, and opposition groups have included in their claims the development of community-owned projects (Hoffmann, 2012; PROCESO, 2019).

Table 1. Main actors in the politics and research of social opposition to renewables

Main groups	Example	Main agenda	Involvement in knowledge production
Governmental Institutions	Secretariat of Energy (SENER) and SEMARNAT	Implementation and administration of ET and climate policies and projects' social management tools	Research promotion and funding related to institutional agendas and needs
Grassroots Community Organizations (GCO)	APIITDTT, Assembly of Defenders of the Mayan Territory, Múuch' Xíinbal, and Articulación Yucatán	Communitarian defense against adverse social and environmental effects of large-scale RE projects	Collaboration with scholars at the local level, promoting interchange between traditional and academic knowledge; citizen research production
Renewable energy companies	Iberdrola, Acciona Energy, Vega Solar, Grupo México, Enel Green Power, and Alten Energías Renovables	Project design, implementation, and operation, and project social impact management	Research funding and promotion oriented to better private social practices and projects' social risk assessment
Environmental and human rights NGOs	FUNDAR, CEMDA, ProDESC, Civic Collaboration Center, and OXFAM	Communitarian defense, collaboration with GCOs	Inhouse research and research funding and collaboration aiming to documenting projects' local impacts and improve social regulations in the private sector
International organizations	IADB, USAID, WB, and German Development Cooperation	Promotion of ET agenda, technical support to Mexico's government area	Inhouse research and research funding oriented to ET policy and projects' social management policy
Climate NGOs	Mario Molina Center, World Wildlife Fund, and Mexico's Climate Initiative	Promotion of the ET agenda and technical capacities building in the area	Inhouse research and research funding and collaboration oriented to promote an ET policy and projects' social management policy
Private organizations and thinktanks	Private Sector's Committee for Sustainable Development Studies, Mexican Institute for Competitiveness, Mexican Wind Energy Association, and Mexican Solar Energy Association	Promotion of favorable regulatory conditions for the sector's competitiveness and private investment	Inhouse research, and research financing and collaboration aiming for better private social practices and legal certainty for private investment
Universities and research institutions	Mexico's College, Latin American Faculty of Social Sciences, Center for Economic Research and Teaching, Mexico's National Autonomous University, and Center for Research and Higher Studies in Social Anthropology	Experts and decisionmakers training in the energy sector, and research production in the area	Academic programs, research lines, scholars, and research production on diverse aspects of social opposition and projects' social management

Note: the list of actors is not exhaustive. Source: Author.

On the other hand, different NGOs of human and environmental rights such as the Mexican Center for Environmental Law (CEMDA), the Project on Economic Social and Cultural Rights (ProDESC), and The Project on Organization,

Development, Education and Research (PODER) have accompanied the activism of local groups in Tehuantepec and have incorporated in their agendas the equitable development of this industry (**Table 1**). The research produced in Tehuantepec and even some other researchers have directly delivered information inputs to NGOs, for example, to document conflicts and negative impacts of projects, justify legal procedures against projects, and even for the publication of several reports on the subject (e.g., PODER & PRODESC, 2011; FUNDAR, 2016; UNAM, DPL, FUNDAR, 2018). An activist pointed out that:

There was a widespread perception that for being renewable energy the projects were sustainable and we had to place the issue in the public discussion. . .the reports have helped us to show the impacts of the projects not only in human rights forums but even to provide information about the issue for international banking or companies seeking to enter the country.

Policymaking and the practice of social management

The activism in Tehuantepec generated political incentives for the federal government to address social opposition. The lack of institutional capacities to cover its informational needs in the area created the context for including policymaking insights from researchers and experts. The policy tools of social management that resulted from this process have generated new knowledge needs in governmental and private actors. In response, various academic institutions have created lines of research and professionalization programs in the area that have influenced how institutions, companies, and consultancies approach the practice of social management.

In 2012, the conflict around Mareña Renovables resulted in halts in construction, causing economic losses and uncertainty within the companies in the sector. In response, the companies lobbied for the new federal government of Enrique Peña Nieto (2012-2018) to address the issue. A key decision-maker in this administration said, *“In the ceremony in which Pedro Joaquín Coldwell took protest [the head of SENER], representatives of several embassies such as Japan, Netherlands and others spoke with him about the urgency of resolving the conflict in Mareña.”* As a result, SENER included the issue in its agenda.

In SENER, the anchor government institution of energy policy, the decision-maker who was responsible for managing the problem had previously developed an approach as a university-based scholar in the field of energy sustainability, framing the institutional approach. For the first time in its history, SENER hired a small group of experts in the social sciences to develop its management strategy in the area. A governmental official said, *“The information that circulated came mainly from the companies and did not explain the conflicts, people were very annoying. . . we had to identify the main factors that had led to a problem of this magnitude.”* Another official

pointed out, *“There was pressure from both companies and communities to resolve the issue, and we were a very small team. . . it was essential for us to take back the existing documentation and incorporate inputs from NGOs and experts.”*

During 2012–2013, SENER held several meetings with some key factors such as the environmental and human rights NGOs, companies, and some scholars and experts in the area. A researcher said, *“We met in their offices [SENER] and began to sketch from scratch the social management policy.”* She went on to say that *“the companies arrived in Mexico, and they forgot their social responsibility practices. The companies were doing very poor work in the area; they did not assess their social risks and did not consult the communities.”* In this process, some publications also provided guidance. Since 2010, federal institutions such as the Secretary of the Interior and the National Council of Science and Technology, as well as international organizations such as the IADB funded various studies aimed to analyze conflicts in Tehuantepec and provide recommendations for sector policy (MICI & BID, 2012; SEGOB, 2013; Nahmad, 2014).

The institutional diagnosis showed that the regulatory framework lacked the mechanisms which would ensure that companies evaluated the social contexts where they proposed their projects, while also informing and including communities in the planning. Moreover, companies were not identifying and managing their social impacts, and projects had generated little economic benefits in Tehuantepec. As a decision-maker indicated, *“After the building stage, projects were generating minimal local jobs and did not consume almost nothing, they bought even paint in Spain.”* As a result, SENER designed the policy tools of social management included in the Hydrocarbons Law and the Electricity Industry Law (2014): Social Impact Assessment, Indigenous Consultation, benefits to communities, and Strategic Environmental Assessment (Huesca-Pérez et al., 2018; Zárata-Toledo et al., 2019).

On the other hand, these policy tools were the first of their kind in the country. Therefore, governmental and private actors who lacked experience in the area have required new knowledge and skills for their implementation. SENER included insights from researchers, experts, and publications for the design of the methodologies for the implementation of the policy tools, and the administrative procedures for their supervision. A governmental decision-maker in the area indicated:

There are many areas in which we require research, for example, on the effects that EvIS [SIA] are having on local project management. . . since 2014, more than nine thousand EvIS have been carried out, which I believe is a database that could be used to systematize specific development guides, impacts, recommendations and evaluation criteria for the different types of projects and technologies. . . we have four people in the area, eight if you include the staff on loan, we cannot

do these studies, and we depend on the reports of organizations or publications.

Similar to government institutions, private actors lacked the epistemic capabilities to implement new social management activities. For example, consultancies have required personnel who can lead the SIAs of projects, and companies have needed new capacities for the implementation of their social management plans. In response to this demand, various academic institutions have created lines of research and courses, diplomas, specialties, and master's degrees focused on the professionalization of social management, in which governmental officers, consultants, and business managers usually are the primary users (**Table 1**). Through these programs, the teaching of researchers and the study material they present to participants influence how consultants and business managers understand and practice social management. A consultant who graduated from one of these programs, for example, said:

If you review the first EvIS [SIAs] they were very poor jobs, nobody knew how to delimitate the projects' areas of social influence or how to characterize the social impacts. . .the consultancies had no idea of how to do fieldwork with the communities, forget about informed consent or the protection of personal data; in some cases, consultants initiate the problem with the community.

2.6 Opening the “black-box” of the energy epistemics

Research approaches and the production of epistemics

The acquisition of academic and technical knowledge of social opposition to RE in Mexico requires vastly different research practices and characteristics of production. Researchers have conducted their studies based on positivist (35%), structuralist (35%), pluralist (18%), and constructivist (11%) approaches (see Methodology). Although university-based scholars have been the main producers of this knowledge, some sociopolitical actors have also participated in relevant ways. For instance, international organizations, governmental institutions, and private organizations (e.g., think tanks) have published eight studies with a positivist approach (e.g., MICI& BID, 2012; SEGOB, 2013; B&HRRC, 2017; USAID, 2017; SENER & BID, 2018), which has been particularly relevant the involvement of IABD. Human rights and environmental NGOs (e.g., FUNDAR and PODER) have published three studies with a structuralist approach (e.g., PODER & PRODESC, 2011; FUNDAR, 2016; UNAM, DPL & FUNDAR, 2018). Researchers have focused their research in Tehuantepec (75%), either through case studies or as part of national or regional analyses.

Table 2. Academic Worldviews and Practices.

Aspect	Positivist	Pluralist	Constructivist	Structuralist
Philosophical view on reality	Independent, objective, measurable	Independent but lived differently	Relative, subjective, contextual	Independent but framed by historical and cultural forces
Ontology	Projects' social externalities or impacts	Projects' social effects	Social meanings of projects' impacts	Social struggles or contradictions
Disciplines	Public policy, law, environmental management	Political sciences, public policy	Sociology, anthropology, history, cultural studies	Geography, anthropology, history
Aspects variables	or Policies, regulations, policy tools, institutions, practices	Actors, benefits, affectations, interests, agendas,	Ideologies, values, knowledge, meanings, experiences	Natural resource control and access, power relations, social struggles, resistance, movements
Methodologies	Policy regulatory analyses, interviews	and Policy analyses, process tracing, interviews	Ethnography, interviews, discourse analysis, participant observation	Ethnography, interviews, participant observation
Scale/approach	National-level, top-down	Regional, multilevel	Local-level, bottom-up	Project-level, bottom-up
Actors consulted in the research process	National stakeholders: government institutions, NGOs, industrials, international organizations	National and local stakeholders: government institutions, NGOs, industrials, international organizations	landowners, communities	Communitarian groups with different cultural and social identities; and local representatives from governmental institutions, industrials, and NGOs

Source: Author based on a thematic analysis of scholarly publications.

The four research approaches embed different philosophical views on the nature of social reality and its determinants, which frame their particular ontological objects (**Table 2**). This aspect is critical to the making of epistemics, because even if these approaches apparently address the same social phenomenon—namely, social opposition—their academic worldviews lead to a particular interpretation and definition of their research problem, framing their further research practices and knowledge outcomes.

Researchers in each approach also demonstrate distinctive knowledge practices. In Mexico, researchers using a given approach tend to cluster in a few disciplines (interestingly, there is no research in the field from an economic discipline) and thus characteristically focus on specific aspects of social opposition topics while also using disciplinary research methodologies to acquire, interpret, and validate social knowledge (**Table 2**). Their disciplinary practices, therefore, frame the problem

dimensions that they target and the process of knowledge generation that they apply. Academic worldviews on social reality—notably, positivist—are markedly more influential in some disciplinary paradigms than others.

These approaches also frame the way researchers in their practices tend to interact with some social actors and groups and geographies (**Table 2**). For instance, researchers using the positivist and pluralist approaches usually seek to understand general issues that lead to social opposition instead of more circumstantial factors, focusing on the national or regional levels. Their methodologies usually incorporate the opinions of national political actors who have a strong influence over the politics of the sector, gaining insight into the main political interests and discussions of these actors.

By comparison, researchers from the constructivist and structuralist approaches seek to understand projects' social meanings or struggles, focusing on specific, location-based projects or communities. In their methodologies, these researchers therefore interact with local actors who are actually participating in a conflict, which allows them to acquire knowledge about why and how communities oppose projects. Therefore, research practices include partial evidence from social reality; for instance, the national actors in most cases do not interact directly and daily with projects and their local effects. Instead, the methodological emphasis on local actors can leave out external actors, whose decisions can have broad local implications.

The energy epistemics on social opposition to renewables

The knowledge practices that feature in the different research approaches have shaped distinctive energy epistemics on social opposition. These epistemics have delivered narratives of the issue based on and resulting in vastly different understandings of the causes and implications of this social phenomenon. The following subsections address the narratives related to these energy epistemics based on representative references, arguments, and findings.

Positivist epistemics

Positivist epistemics address social opposition as an issue generated by the social and environmental impacts or externalities of projects. Consequently, these epistemics have examined the deficiencies in the institutional and regulatory framework of renewables and the development of projects that prevent the identification and management of social and environmental impacts. This research has produced insights about the governance of the sector and the private actors' practices.

Mexico's energy sector has historically developed without an agenda on social management, and as a result, its governance was not designed to guarantee adequate

management of projects' impacts. For instance, policy and regulation related to renewables have not incorporated the national regulation for indigenous people's rights and environmental protection, causing deficiencies in both areas (Hamister, 2012; Grunstein-Dickter, 2016). Moreover, the sector's institutions lack the capacities for following up the local development of projects and their impacts, for instance, insufficient personnel, budget, and local offices (USAID, 2017).

Investors and companies have not adapted their practices to manage social risk. Investors do not have procedures to assess companies' social practices, such as fair negotiations for land rights acquisition, which can reduce investment risks associated with social conflicts (B&HRRC, 2017). Companies base the design and planning of projects on their technical and financial viability and have not developed the procedures to estimate social risk (Jano-Ito & Crawford-Brown, 2017). Moreover, companies have not adapted their social responsibility policies to Mexico's institutional environment and sociopolitical characteristics (MICI & BID, 2012; B&HRRC, 2017).

Diverse issues in the design and practice of the policy tools for social management affect their efficiency. For instance, in the preparation of impact assessments, consultants implement inadequate methodologies for social participation, reducing the quality of outputs and social management strategies (USAID, 2017). In consultation process, companies do not provide enough information to communities, reducing the engagement and trust of the latter in the process, which can also initiate negative perceptions of projects. The procedures for defining shared social benefits usually have a philanthropic orientation (e.g., funding to local celebration) rather than identifying investment options that maximize positive impacts and improve social acceptance (e.g., educative infrastructure) (MICI & BID, 2012; BID, 2015).

Positivist epistemics offer a representation of the problem in which government and private actors, through their resources, policies, and practices, are central to the organization of social life and its interplay with projects. Although this research provides a critical perspective on the policies and practices of government and private actors, it offers less information on the causes, conditions, and incentives that promote or allow these issues. Moreover, by focusing on these actors, this epistemology provides little information as to how the identified problems affect communities and social groups. Furthermore, the visions and agendas that local actors have on projects and territories are absent in this narrative. However, positivist epistemics usually take problem-solving approaches, which allow them to produce specific inputs for the regulatory and political frameworks, simplifying the potential transmission and use by governmental decision-makers and private actors.

Pluralist epistemics

Pluralist epistemics address social opposition as a political issue. These epistemics have examined the effects of the policy and projects of ETs in the distribution of benefits and impacts among different actors. This research has identified the different actors involved in these controversies, providing information about their interests and agendas.

The financial model of REPs demands rapid development and stable operations, particularly at the initial stage, due to the high initial investment in technology. Local oppositions thus pose significant risks to companies (Nahmad et al., 2014). To manage social risks, companies implement diverse strategies, including lobbying with governmental institutions to increase their legal certainty, creating agreements among companies to prevent competition for areas or interference in negotiations, managing projects' critical economic information to prevent speculation, and more recently, implementing social management practices (Juárez-Hernández & León, 2014; Friede, 2016).

In Tehuantepec, the land property and tenure frames local actors' interests and involvement. Private landowners usually negotiate individually with companies, while in areas with a communitarian land regime, landowners require the authorization of the collective authorities, generating tensions and even disputes inside the community which are related to the potential negative environmental and social effects of projects (e.g., human health risks and soil pollution). Greater transparency and access of all stakeholders to the benefits and risks of projects can improve the decisions of landowners as they negotiate compensation (Juárez-Hernández & León, 2014; Nahmad et al., 2014). On the other hand, the majority of the community members who are not involved in projects or are without land rights are affected by negative social impacts (e.g., increase in costs of land or local products, greater community inequality, and landscape transformation), but they are not incorporated in the assessments and consultations of projects and do not receive direct benefits, causing the incentives for their opposition. Therefore, the comprehensive identification, mitigation, and compensation of social impacts require the involvement of excluded social groups in the policy tools of social management (Nahmad et al., 2014; Friede, 2016).

The position and involvement of governmental institutions depend on their agendas in the sector. As it is responsible for national climate policy, SEMARNAT has supported the diffusion of RE, but its private ownership and the intermittency of RE is an institutional risk to the CFE, which controls the electric power market and the national transmission infrastructure, generating conflicting policies between the CFE and the policy of ET (Juárez-Hernández & León, 2014). Moreover, SENER promotes investment in projects and has targets in ET, and simultaneously it is responsible for the approval of social impact assessments, creating conflicting agendas inside the institution (Rousseau, 2017).

Pluralist epistemics offer representations of the problem framed by the economic and political agendas of companies, different social groups, and institutions. This research delivers critical insights about the development of this industry and its inequitable allocation of benefits and negative impacts among different actors and social groups, which potentially can be used for the redesign of the policy tools in the area. However, by focusing on the material and tangible aspects, these epistemics provide less information on the visions and meanings that also motivate and support the involvement of the different actors and groups.

Constructivist epistemics

Constructivist epistemics address social opposition as an issue framed by different actors' worldviews. These epistemics insist that actors interpret the material and symbolic effects of RE based on their subjectivities, including their ideologies, values, knowledge, and experiences; thus, social opposition is not only a response to its tangible effects but also reflects a dispute about its social meanings. These epistemics have examined various social identities and their interpretative frameworks, providing an understanding about the social meanings of the projects' sociotechnical arrangements and their environmental and social effects.

The RE projects embody the interests and subjectivities of the actors that intervene in their design. Policymakers and companies design the policy of ET and projects with the objective of increasing their cost-effectiveness and profitability, benefitting the energy companies that own the projects, large private consumers with the reduction of electricity costs, and the government through the advancement in its climate mitigation agenda. However, Zapotec and Huave indigenous communities perceive them as extracting local RE resources for consumption by distant industries while the communities themselves are affected by the transformation of their territory and are subject to the same electricity tariff and irregular access (Howe et al., 2015). Rather than being against RE projects, local groups oppose the concentration of projects in Tehuantepec and their particular characteristics, such as their ownership, scale, and energy use. The local oppositions propose pathways for the development of projects in which communities take an active role. This would include their involvement in the planning and designing of projects, projects with communitarian co-ownership, and projects intended to supply local energy needs (Howe, 2014).

The projects and their social and environmental effects are interpreted by actors based on ideologies, knowledge, and experiences. For instance, influenced by the green growth discourse and by technical knowledge and management, governmental actors and developers perceive Mareña to be socially and environmentally beneficial due to its effects on climate mitigation, local economic investment, and job creation (Howe et al., 2015). By comparison, framed by

indigeneity, the new-Zapatismo discourses, and traditional knowledge and experiences, Zapotec and Huave indigenous communities perceive the project as a danger to maintaining traditional territories and to the future of their culture due to potential impacts on environmental resources that are crucial for local subsistence (i.e., the lagoon and shrimp) and on communitarian equity and cohesion (Simon, 2013). However, the design of assessments and decision-making processes lack the mechanisms for including the knowledge and experience of communities and addressing their social and environmental claims (Howe, 2014; Howe et al., 2015).

Constructivist epistemics offer a representation of the problem framed by the cosmopolitan views of developers and government officials and the visions and experiences of local communities. This research provides understanding about the subjective, emotional, and ethical meanings that frame the agendas and actions of the different actors and groups, particularly of the usually excluded local communities and opposition groups. By doing so, these epistemics uncover hidden social debates and political and technical alternatives for the building of ET.

Structuralist epistemics

Structuralist epistemics address social oppositions as issues generated by the social and environmental impacts or externalities of projects. Legitimized by dominant epistemologies, policies, and institutions, foreign energy corporations are expanding their control over communitarian lands and national energy resources, threatening the survival of indigenous communities and leading to resistance from them. This research has examined the conditions that allow the industrial development of renewables, providing critical insights about the deployment of projects, their effects on disadvantaged groups, and the emergence of social movements.

Dominant academic discourses portray RE as a solution for climate change, without addressing other critical factors such as consumption patterns and unlimited economic growth. The technological development of RE replicated the organization of fossil fuel technologies (large-scale and private), favoring energy corporations' control and interests (Sellwood & Valdivia, 2018). Thus, dominant epistemologies and techniques internalize the logic and interests of energy corporations, providing an environmental justification for the capitalist expansion over RES and the appropriation of communitarian lands and natural resources by energy corporations (Oceransky, 2010; Dunlap, 2018).

Since the 1990s, Mexico's governments have implemented neoliberal policies that created structural conditions to legitimize and legalize the transfer of land and energy resources to private corporations. The elimination of legal protection of common land property allows for the division and acquisition of these lands, facilitating the transfer of land rights to private actors (Oceransky, 2010). The reduction of programs and subsidies to support agricultural activities has weakened rural economies, creating a favorable condition for the private access to

communitarian lands (Sellwood & Valdivia, 2018). Moreover, the privatization of the energy sector has provided a pathway to transfer energy resources from the State to private corporations, without generating channels for community involvement (FUNDAR, 2016).

In Tehuantepec, companies collaborate with governmental actors and local elites to negotiate land rights, generating structural disadvantages for communities during land negotiations. Companies carried out project assessments without communitarian involvement, since this sector also did not have access to the studies' outputs. Governmental actors that were sympathetic to projects conducted indigenous consultation (Oceransky, 2010; PODER & PRODESC, 2011). Communities lacked project information on social and environmental impacts, constraining their capacity to influence these processes. Moreover, companies use shared social benefits as a strategy to capture local elites, divide communities, and weaken opposition groups (Dunlap, 2018).

As a result, indigenous groups, peasants, and fisherman in Tehuantepec have created resistance organizations like APIIDTT. These organizations demand the right of self-determination over traditional territories, projects owned by communities, projects' cancelation, collective compensations, and natural resources protection (Oceransky, 2010; PODER & PRODESC, 2011). Due to the governmental and local elites' complicity with companies, local groups must implement civil resistance strategies to contest the dispossession of communitarian lands and their social and environmental contradictions (Dunlap, 2018).

Structuralist epistemology offers a representation of the problem from the local level and from the perspectives of disadvantaged social groups. This research provides a historical perspective on the agendas of economic and political actors that have framed the development trajectory of epistemics, technologies, and policies of RE, problematizing how they favor the private control of energy resources and community lands. Moreover, this research provides detailed information about the communities and their historical struggle to maintain their traditional way of life against the interests of external actors. By doing so, these epistemics frame the social opposition within the broader debates of social justice related to the economic and political model and historical discrimination towards indigenous communities.

2.7 Normative visions of energy epistemics

Energy epistemics deliver different narratives about social opposition to projects, in which practical translation can have very different implications for the justice (or injustice) of communities. These epistemics provide frameworks for understanding, diagnoses, and technical discussions that portray in less or greater detail the views and agendas of the various actors and social groups involved in the controversy. Moreover, their narratives offer vastly different material and symbolic roles to the

institutions, companies, communities, and opposition groups. Therefore, the energy epistemics embed normative visions related to broader questions of the sociopolitical building of Mexico's ET and its interaction with communities.

Table 3. Normative and practical visions.

Aspect	Positivist	Pluralist	Constructivist	Structuralist
Solution to social opposition	Efficient identification, mitigation, and management of projects' negative impacts and the amplification of positive ones	A better political arrangement with the economic, political and social actors affected by this industry	Projects designed based on the local sociocultural characteristics, resulting in diverse sociotechnical arrangements that internalize the management of social impacts and relations	Reparation of the damages caused to communities and a reorientation of the ET to communitarian development and public service
Governance	Institutions and policymakers are outside the problem, occupying a central role in the sector's governance	The sector's governance results from the interplay of actors, and governmental institutions are critical for mediating these relations and forming interaction rules	The sector's governance is polycentric; consequently, regulations and projects should be the result of deliberative, multi-actor, and contextual processes	The sector's governance should be based on communities' institutions, decision-making process, and traditional natural resources' uses
Sociotechnical pathways	Large-scale private projects require better implementation and impact management	Large-scale private RE projects require policies and instruments to identify and compensate affected actors	Projects' technology, scale, ownership, and energy use must be designed based on the context. Private large-scale projects can coexist with communitarian, state, or mixed-ownership projects	Projects' profits and energy' use must benefit the communities that own RE through communitarian or social ownership projects

Source: Author based on a thematic analysis of scholarly publications.

The narratives of the energy epistemics embed positions on the governance of ET and the characteristics of the projects (**Table 3**). For instance, although the positivist and pluralist epistemics can be critical with some aspects of the policy of ET and the management of projects, their narratives do not provide alternative development paths in the area. Therefore, their narratives take for granted the current sociotechnical arrangement of projects as the only possibility for the domestic ET. By contrast, the constructivist and structuralist epistemics often show alternative ways to govern and build projects; for instance, communities taking a central role in the planning and design of projects, projects with communitarian/social ownership, and the use of electricity to cover local needs.

Therefore, these epistemics provide competing normative views on critical aspects of the politics of ETs, such as which actors should govern, design, and own projects and use their electricity. The particular set of answers offered by their narratives involve vastly different material and symbolic roles for the governmental, industrial, and communitarian actors (e.g., a bottom-up ET in which communities have an active role in the management and benefits of projects vs. a governmental/private top-down ET and projects oriented to a private economic benefit).

Framed by the previous point, the epistemics deliver competitive explanations about the causes of social opposition (**Table 3**), proposing very different paths on how to address the issue and the question of who should be involved in the task (e.g., improving policy and practices, better political arrangement, bottom-up and pluralistic design, or transforming the economic/private orientation of the sector by a social aim). The practical translation of these narratives have different consequences in the area. For instance: 1) whether or not the sociotechnical organization of projects is questioned as part of the causes of social opposition, raising the question of the appropriateness of reorganization or reform; and 2) whether or not the construction of a political solution in the area includes the vision, knowledge, and experience of communities and the claims of opposing communities.

Energy epistemics also offer specific technical discourses for the policy tools for social management (**Table 4**). Positivist narratives remark on the lack of accuracy and reliability of outputs, suggesting further technification and standardization. The pluralistic approach suggests that the outputs of policy tools should aim to provide technical information and procedures for mutual understanding and negotiation of the actors, producing a sense of fairness among them. The constructivist approach criticizes the narrow scope of the policy tools that limit the communities' substantial influence on project definitions, and it advocates opening these tools to communities. The structuralist approach indicates that policy tools are intrinsically biased to favor the interests of companies due to the asymmetries in resources and control between private actors and communities, suggesting that their purpose is to legitimize and legalize projects and mitigate social resistance.

Therefore, in their technical discourses, the energy epistemics embed normative views about the nature of the policy tools and their sociopolitical outputs. These different visions show that: 1) the policy tools have different political possibilities, and some of which may substantively include the experiences of communities and the views of opposition groups, while others may strengthen government and private control in the sector, extending the causes for civil resistance; 2) the function and political results of these policy tools are framed by those who participate in their design, implementation, and use of their outcomes; and consequently, 3) rather than further technification, the capacity of the policy tools to address to some extent the causes of social opposition depends on the substantive involvement of communities.

Table 4. Projects' social management policy.

Aspect	Positivist	Pluralist	Constructivist	Structuralist
Indigenous Consultations	Issues in communication between companies and communities and deficiencies in procedures affect the engagement and trust of local actors	Some local actors and groups are not included, reducing the procedure's effectiveness in addressing local concerns	Consultation agendas do not include communities' substantive issues, and their implementation does not consider local forms and procedures to exercise participation	The consultations are used to legitimize the project because the asymmetries between companies and community in terms of the control of the procedure and resources prevent local actors from exerting any real influence
Social Impact Assessments	Insufficient institutional capacity, consultant inexperience, and methodological issues constrain their quality	Assessments' outputs are not accessible to the public, constraining the possibility of the social actors to gain information as to project implications	Assessments do not include local views, knowledge, and experiences, so their outputs do not address the priorities and social effects that concern the communities	Companies use their results to obtain information from opposition groups and design strategies for marketing and social control
Projects' Shared Social Benefits	Regulation does not provide a procedure for estimating the benefits, and the type of investments have little impact on the development of communities	Issues in the scope and focus of investments prevent the compensation of some affected local groups	These do not contribute to the visions of local development because the communities do not participate in the definition of what is an acceptable benefit or in defining the manner in which these should be transmitted and managed	Used to obtain the collaboration of social and political leaders and generate divisions within the communities to weaken social resistance movements

Source: Author based on a thematic analysis of scholarly publications.

2.8 Conclusion and discussion

The accumulated research on the social opposition to RE in Mexico shows the complexity of this social phenomenon. The causes that lead to the opposition involves factors diverse in nature, such as institutional and political design, private and governmental practices, the sociotechnical arrangement of projects, visions and agendas of different actors and social groups, and the control and access to RE. Moreover, between 2008–2018, many of these factors have changed (e.g., the legal framework and the cost-effectiveness of RE technologies) and have manifested differently in diverse territories and sociocultural contexts (e.g., the wind farms in Tehuantepec and the Huave and Zapotec communities; the solar projects in Yucatán and the Mayan communities).

Researchers have addressed the nature of social reality and its relationship with energy systems through different interpretative frameworks (e.g., positivist, pluralist, constructivist and structuralist), which have framed critical aspects of this research, such as the object of study (e.g., social externalities, social effects, social meanings, and social struggles), the variables and factors of analysis, methodologies and even the interplay with some geographies and social groups (e.g., institutions, companies, NGOs, and opposition groups). These research practices integrate facts and evidence about some dimensions that make up this social phenomenon, which are interpreted and organized by researchers according to their interpretative frameworks for the making of academic knowledge. The resulting epistemics embed and reproduce to some extent the visions and knowledge of the researchers and the social groups involved in their production, delivering very different interpretations of the causes of social opposition and their possible solutions.

However, in Mexico, these epistemics have provided insights in the sociopolitical arena, for instance, to the activism of opposition groups and NGOs, the formation of social management policies, and private practice in the area. This influence took place in a context characterized by: **1)** a recent development of the domestic policy of ET and the RE industry; **2)** the emergence of opposition to projects for their social effects as new arenas of controversy in the sector; and **3)** the absence of a regulatory framework and institutional experience in the area. Like previous studies in other research arenas (Martin & Richards, 1995; Fischer, 2000; Sarewitz, 2004; Geels, 2016), this research shows that when an issue-area of the social domain is the matter of a new political controversy, social research can provide relevant information for actors and social groups for their political definitions and initial policy developments.

The plurality of research practices is an indispensable element for academic debate. However, research on social opposition in Mexico reveals that this field has some specificities that require broader considerations than academic conventions. For example, these research practices do the following: **1)** address a politically disputed area with relevant effects for different actors and social groups; **2)** require the incorporation of information about or the direct interaction with social groups; **3)** occur in political contexts and locations with broad social inequities; **4)** portray and represent these groups, their perspectives, and interests with their results; and **5)** can provide orientations to these groups through the interaction of researchers and their knowledge outputs. Due to these aspects, research practices in the field exceed the arena of academic domain and can have significant political effects for different actors and groups, and their production, outcomes, and use therefore require a broader discussion of social justice (Mulvaney, 2013; Ottinger, 2013; Phadke, 2013; Ottinger et al., 2017; Egert & Allen, 2019).

First, the authoritative role of academic and technical social research can acquire a particular social valence in some geographies and political contexts. On the

one hand, this case study suggests that when energy institutions lack experience in an area and the capacity to generate information that justifies and guides their decisions and actions, academic-based research and sociopolitical actors (e.g., international organizations and NGOs) can meet the institutional knowledge needs and influence their approach. On the other hand, the critical research that occurs in local contexts where there is a dispute among different groups with unequal economic and political conditions can provide evidence that strengthens the claims and activities of the disadvantaged groups. Therefore, future research is needed about the valence of social research in different geographies and its political interplay, for instance, about the role of international organizations in the funding and production of studies in the Global South and its effects on the diffusion of policies related to diverse factors of ETs.

Second, far from neutrality, research practices in this field produce explanations and diagnoses that embody normative visions, which can have vastly different effects for communities. In Mexico, positivist epistemics have proposed the downstream implementation of government/private policies and practices to evaluate, measure, mitigate, and compensate the social externalities of the projects. This vision is uncritical regarding the political architecture of the sector (top-down decisions and planning without local involvement) and the characteristics of the projects (private, large-scale, and economically oriented), obscuring the relationship between these elements and the material and symbolic causes of the local opposition. Its political translation can deepen and extend government/private control of the sector to the management of community, exacerbating the conditions of inequality for local actors. On the other hand, pluralist, constructivist, and structuralist epistemics have extended the narrow debate on social impacts to question different aspects of the social and technical arrangement of projects (e.g., policy and planning, scales, productive orientation, and ownership and management models). With differences in their scope, these epistemics propose different forms of upstream involvement of communities in aspects such as decision-making, planning, and project benefits, internalizing through these processes the management of impacts and social relations.

Third, related to the previous two points, social research on social opposition has an intrinsic social justice dimension due to the characteristics of both the study phenomenon and social research practices. In Mexico, the research on social opposition includes primary and secondary information about the actors involved in this controversy. However, the economic and political inequities between actors and groups can also emerge in their ability to include inputs in these research practices. These actors have differences in their capacities, for instance, to disseminate their positions and make them accessible to researchers; the production of data that is “valid” or “relevant” for academic conventions; and even the direct promotion of research through funding. Therefore, the fair production of academic knowledge in this field requires broader considerations on how groups are included and

represented when disadvantaged in the dispute, such as the communities and local opposition groups.

Fourth, sociopolitical actors can influence knowledge justice (or injustice) through their production and use of epistemics (Fischer, 2000; Stirling, 2008; Aitken, 2010; Ottinger et al., 2017; Egert & Allen, 2019). Unlike academic-based research, in which production and publication processes tend to require extensive time periods, some sociopolitical actors have the financial and technical capacities to produce studies on emerging aspects of the political agenda. Therefore, these actors may play a crucial role in the availability of research with different approaches and traditions at critical moments of political definition. Moreover, sociopolitical actors, particularly institutions that act and make decisions of a public nature, have a responsibility in the use of different epistemics that illustrate the complexity of social reality. In their activities, these actors must complement the use of research epistemics with the direct dialogue and involvement of communities and their traditional knowledge, which are usually excluded from Mexico's institutional processes.

Chapter 3

The social and material shaping of Mexico's energy transition

Abstract

Previous research has examined political incentives in the adoption and design of energy transition policies. Although energy transitions affect domestic energy sectors, the role of governance in these sectors has received less attention. I argue that these sectors' material and social arrangements play a crucial role in the design of the governance of energy transitions. This issue is examined through the energy transition law adopted by Mexico in 2008 and the Social Impact Assessment design introduced to this sector in 2014. Although the international climate agenda promoted adoption of the energy transition policy in Mexico, its design was influenced by the pre-existing organization of its energy sector (e.g., the regulatory framework, electrical infrastructure, institutional practices), which framed aspects of the subsequent development of projects, such as their scale, use, and location. Local communities opposed these projects, making sociocultural demands. The absence of a regulatory and institutional framework in this area played a critical role in escalating this problem to a national controversy. To address this problem, the sector's institutions sought to form a policy for social impacts and relations. In this design process, the Mexican government had different possibilities regarding the institutional arrangement, areas of intervention, scope, and regulatory form. The sector's practices, centralization, political disputes, and interest groups were critical in the policy design process, shaping the regulatory form, scope, and functions of the resulting policy tool.

3.1 Introduction

The governance of energy transitions (ETs) is critical for their domestic development trajectory and their environmental and social outputs. Different agendas intervene in the political design of ETs, from groups that promote climate mitigation to actors who oppose for different reasons, such as industries that see an economic risk and local communities that perceive adverse impacts) (Lipsy, 2012; Bernauer, 2013; Roger et al., 2017). These design processes occur in long-standing energy sectors that have been built around infrastructures, regulatory and cognitive rules, institutions, and even political visions and cultural relationships that may have come to be entrenched and difficult to displace (Nye, 1998; Jones, 2014; Hoffman, 2015). However, the influence of these aspects on the governance of ETs has received little attention.

I undertake this inquiry grounded in the field of science and technology studies (STS). An essential STS contribution is revealing that the modern production and consumption of energy cannot be understood as a narrow technological innovation and development (Bijker, 2010). The electric power system and transportation based on fossil fuels are large-scale technological systems integrated by interconnected networks of technologies (e.g., tires, engines, spark plugs), infrastructures (gas stations, pipelines, roads), and activities (extraction, transport, processing, distribution, and consumption). The development of these systems has required the intervention of different social groups such as researchers, entrepreneurs, institutions, and workers (Hughes, 1983, 1987, 2004). For instance, the gasoline-powered automobiles and hydroelectric dams in early development stages generated compelling views about their social possibilities in the US. These views were critical in driving the institutional support that aided their development and adoption and faced technical failures, financial constraints, and social controversies (Sovacool & Brossman, 2013). The development of these systems has also incentivized the specialization of research fields, economic chains, institutions, and workers, which has in turn shaped social behaviors, identities, needs and regional economies (Nye, 1998; Laird, 2013; Jones, 2014; Jones & Reinecke, 2017). This can be illustrated by the powerful cultural meanings that coal mining and the oil industry have acquired in some regions of the US and their linkages with the domestic politics of ETs (Hoffman, 2015; Princen et al., 2015).

Therefore, technological innovation is critical for advancing energy transitions, yet political views, institutions, and regulations also play a fundamental role in adopting these technologies and their social organization. The institutions that govern energy systems have created over time, path-dependent relationships around many components of these systems (Laird & Stefes, 2009; Geels, 2019). For instance, traffic jams create political incentives that lead to growing public investment in more highways and roads, creating physical barriers to cyclists and walkers; simultaneously, governmental urban plans promote cities' spread-out development,

making automobile use more necessary. Unruh (2000) states that these path-dependent relationships between institutions and energy systems can lead to legal and political constraints in adopting ETs technologies. Moreover, the policies and planning procedures of ETs are fundamental in promoting further pathways of sociotechnical development (technological choices, scales, uses) and their effects over local geographies and social environments (Stirling, 2008; Miller et al., 2015).

Although STS scholarship has demonstrated that political regimes play a critical role in constructing energy futures, less attention has centered on the *making* of policies and regulations governing ETs. One consequence is that the influence of current sociotechnical systems based on fossil fuels in the design of ETs remained under-theorized. Another practical consequence is that in the current context – in which domestic energy systems and their political regimes are in flux (Miller et al., 2013) – STS research on pathways in which new institutions and rules might take in response to emerging ecological and social challenges has been limited. This arena is critical to understanding how the values, practices, and interests shaped within fossil fuel-based energy systems are integrated (or not) into the construction of energy futures. Although other disciplines such as political science undertake this area of inquiry, STS scholarship has much to say about the governance of ETs and their broad political and philosophical implications.

To address these gaps, I introduce the concept of ‘technology governance artefacts’, comprising the institutional agendas, policies, and regulations that establish objectives, strategies, rules, practices, and activities for governing technological systems and their social interactions. This concept is founded on the STS observation that when technologies reach a stage of technical and social organization that allows for their widespread dissemination and utilization, their political regimes have co-evolved alongside these material systems (Hughes, 1987; Geels, 2004; Miller et al., 2015; Geels, 2019). The ways that institutions process emerging political agendas and design their policies and regulations are socially, materially, and epistemologically framed by the sociotechnical systems over time. Simultaneously, what is incorporated into or omitted from institutions’ design work establishes a balance between stability and change in these systems, shaping the pathway that energy developments follow and the roles that industry, community, government, and NGO actors play, as well as their interplay with existing infrastructures and with one another.

In the current international context, in which societies are building energy futures and ETs are politically unstable and unsatisfactory for social and environmental outcomes (Ottinger et al., 2017; Meckling, 2019), the concept of technological governance artefacts provides a theoretical and methodological approach to open the “black boxes” of energy regulation and policy, and examine their social and material shaping. To provide these observations with empirical weight, I analyze Mexico’s Law on the Use of Renewable Energies and Financing of the Energy

Transition (LAERFTE, 2008) and the introduction of social impact assessment (2014). The LAERFTE was one of the first energy transition laws among industrialized nations and emerging economies. This law encouraged energy companies to propose the development of 21 wind farms in the Isthmus of Tehuantepec (Nahmad et al., 2014). Indigenous Zapotec and Huave communities, along with opposition groups, argued that the projects would negatively affect their traditional way of life, causing controversy over renewables' social effects (Howe, 2014). The energy sector lacked legal instruments to address the emerging controversy, which led to a policy formation process that resulted in social impact assessment procedures (Huesca-Pérez et al., 2018; Rousseau, 2017).

Based on the concept of 'technology governance artefacts,' I examine the design of LAERFTE – the way that the law's features frame both the development of energy projects which have caused controversy regarding their social effects. I then trace the translation of this controversy back to the sector's institutions and the process of policy formation that resulted in social impact assessment. I find that although climate mitigation and the social effects of renewable energy projects have promoted destabilizing changes in the energy political regime, the existing sociotechnical arrangement of this sector has meant that the entrenched industrial interests and values, as well as bureaucratic decision-making norms, have persisted in the way that institutions process these agendas and in the design of policies and regulations.

3.2 Theoretical framework: Technological governance artefacts

Economic and technical objectives, such as energy provision, reliability, and low costs, historically have oriented energy institutions and policies. As a result, the sector's decision-making, policies, and planning build heavily on technical and economic rationality (Phadke, 2013; Mulvaney, 2013; Miller & Richter, 2014). One consequence is that the policies and planning of energy transitions tend to overlook their broad implications on geographies, local communities, and even their strategic role in other political arenas, such as poverty reduction and social inequality (Walker & Cass, 2007; Miller et al., 2015; Moore, 2018).

The technification of national energy policies usually includes strong commitments to technological solutions; consequently, even if the sector incorporated participatory mechanisms for local decisions, public deliberation regarding the risk and benefits of technological choices in comparison to other alternatives would likely be constrained (Stirling, 2008). Moreover, the agendas and visions of social groups influence these policies and regulations. For instance, nuclear energy policies in South Korea, the US, and Germany are framed by domestic institutional views on managing technological risks and benefits and the role of the state (Jasanoff & Kim, 2013). In the US, opposition to rare earth mining projects required for green energy

technologies is managed through corporate social responsibility policies, without public scrutiny of their definition and scope (Phadke, 2018).

The institutions, policies, and regulations that govern energy systems exercise a critical influence on the emerging pathways of technology and infrastructure development (Miller et al., 2015; Geels, 2019). Yet how the institutions that have coevolved in these systems process the new political agendas related to ETs and how policies and regulations are made has received little attention. The 'technological governance artefact' idea aims to fill this theoretical and practical gap. Although other social science disciplines such as political science have addressed this domain, STS scholarship has much to say about the design of future energy systems' political regimes and their broad political implications.

Technological governance artefacts build on the concepts and methodologies of the Social Construction of Technology (SCOT) framework, which proposes that technological design is socially shaped rather than having its internal logic. In particular, early in their development period, technological devices can hold different meanings and interpretations for different social groups (or interpretative flexibility), causing conflicts among these groups about the desirable qualities and features of the technology. Multiple forms of the technology can initially co-exist, reflecting design solutions that these actor groups propose and enact (or design flexibility: Hughes, 1987). A particular interpretation can prevail at some stage, leading to the technology assuming a single stable configuration (called "closure"). Consequently, SCOT analyzes technology design pathways through the competing interpretations of relevant social groups without presuming that technologies enjoy an independent existence outside the network of actors who intervened in their making (Hughes, 2004).

The methodological approach of technological governance artefacts takes these concepts from SCOT: *i*) the principle of symmetry, which states that there is not an independent function of technology outside the human domain for examining the configuration of artefacts based on the arguments and claims of social groups, and *ii*) the unit of analysis (individual artefacts) for delivering thick social description of how social groups construct issues, solutions, and alternative design pathways (Bijker, 2009). However, there are several significant ontological and methodological differences. First, whereas SCOT focuses on demonstrating the social construction of a specific technology, a technological governance artefact approach elucidates how the interplay among the technical, material, and social arrangements involved in technological systems shape the *governance* of technologies via artefacts such as regulations, policies, or market instruments. Second, SCOT traces the technological design and controversies that emerge from these processes, providing little information about the interested groups that are not involved and the broad social effects that result from the features of artefacts (Winner, 1993). Consequently, the TGA extends the concept of interpretative flexibility to examine the political

controversies that incentivize an institutional response and the controversies associated with the design and implementation of design outputs, delivering critical insights about power relations among social groups and broad political implications. Finally, the TGA approach does not assume that the resulting artefact attains 'closure' or enduring stability: because institutions are continuing to grapple with social, economic, or political developments, they may adjust the artefact in ongoing feedback loops.

The scope and analytical capacity of the technological governance artefact must be distinguished from other STS approaches that deal with the politics of technology. For instance, the concept of sociotechnical imaginaries has addressed the co-construction of society and science & technology and the normative and organizational role played by technology in social life (Jasanoff & Kim, 2009). In recent years, fruitful research based on sociotechnical imaginaries has illuminated how political communities develop visions that frame the institutional approach to the benefits and risks of technoscientific projects and trends followed by their development (e.g., Jasanoff & Kim, 2013; Levenda et al., 2019). The ontology of sociotechnical imaginaries concerns technological cultures that powerfully influence the making of policies and regulations. However, its temporal and social granularity is limited for tracing the micro-social interactions and the institutional dynamics involved in the design of policies and regulations.

In comparison to sociotechnical imaginaries, technological governance artefacts have a more specific ontological object: how institutions that have coevolved with sociotechnical systems process new political agendas and design their rules. TGA builds on the concept of co-production, which states that the practices of knowing, building, and governing scientific and technological projects and the social and material order are intertwined at multiple stages, influencing each other in a process that, over time, reconfigure these domains (Jasanoff, 2014; Iles et al., 2016; Cloke et al., 2017). Yet, TGA undertakes the co-productive process in mature technological systems, providing the conceptual and methodological tools for addressing the social dynamic and short-term temporal scales involved in making its components. Thus, TGA's analytical capacity requires two conditions: 1) a political regime of technological systems with sedimented structures, practices, and social relations and 2) an interdependent relationship between this regime and the sociotechnical system that it governs. Consequently, technological governance artefacts cannot explain cultural trends, other political arenas, or even all political regimes of technology. However, if these conditions are met, technological governance artefacts can help open the "*black boxes*" of institutional agendas, policies, and regulations to examine their social and material making and discuss their broad political and philosophical implications. By doing so, technological governance artefacts build on and extend STS research to the design of the political regimes that govern sociotechnical systems.

3.3 Methodology

I based this study on mixed methods to analyze primary data and secondary information, similar to previous research in STS (e.g., Moore, 2016; Barandiarán, 2018). First, I conducted 11 months of participant observation as a full-time research advisor based in Mexico for the “Communities and Renewable Energies” project,³ which has informed this research and framed its subsequent methodology. This project aims to create bridges of understanding among diverse actors involved in domestic politics of energy transition and propose recommendations for improving the sector's social management policy. During this collaboration, I conducted an analysis of the sector's administration and the positions of critical actors. I participated in 45 policy-related work meetings and five public forums. My participant observation allowed me to know in depth: 1) Mexico's energy transition policy and its social management policy; 2) points of disagreement and tension between different actors, and 3) actor positions on the subject. This enabled me to identify the social, economic, institutional, and political actors that played a significant role in building social opposition to renewable projects and the design and implementation of LAERTE and SIA.

I also conducted 36 semi-structured interviews with key actors and social groups involved in social opposition to projects and policymaking of LAERTE and SIA, including social leaders, human rights and environmental NGOs, renewable energy companies, institutional decisionmakers, and policymakers, politicians, scholars, and international organizations. I carried out these interviews in Mexico between 2018-2019. Interviews lasted between 45 minutes and 3.5 hours. Afterward, I did thematic analysis of the interviews focused on identifying critical information related to the LAERTE and SIA – for instance, stages in their design, actors involved, and controversies among actors. Subsequently, I used discourse analysis of these interviews to identify the actors' position, their arguments, motivations, and interaction with other actors and groups.

I also incorporated an analysis of primary documentary information and existing academic literature. The documentary analysis included critical documents, such as the LAERTE, the Electric Industry Law, administrative provisions of the SIA, domestic energy transition policy, and sector's planning documents. Finally, I reviewed academic research on Mexico's opposition to renewable energy projects and SIA published in English and Spanish and gray literature on these issues by domestic NGOs and government institutions, and international organizations.

³ This project is a partnership among Mexico Climate Initiative, Civic Collaboration Center, and Latin American Faculty of Social Sciences.

3.4 The technological governance artefact and its material and social effects

The Law on the Use of Renewable Energies and Financing of the Energy Transition

In this section, I look at how a technological governance artefact was initially created to promote private investment in renewable energy: the LAERFTE- 2008. I analyze how its initial design exerted significant effects on the emergence of a new renewable energy sector in Mexico, physical projects in one Mexican region, and the resulting social controversy.

The international politics of climate change and Mexico's position in this arena generated domestic political incentives for the Mexican government to seek rapid deployment of non-conventional renewable energy technologies (Pulver, 2013; Jano-Ito & Crawford-Brown, 2016). Different political, legal, and technical components of its existing energy sector (e.g., political visions and disputes for its future, regulatory limitations for public and private investment in renewable energy technologies, the relative cost-effectiveness of these technologies, and electricity tariffs) framed the design of the LAERFTE (Grunstein-Dickter, 2016; Jano-Ito & Crawford-Brown, 2016). The resulting technological governance artefact exerted tremendous influence on the particular sociotechnical development of renewable energy projects and their interaction with local communities.

After the mid-2000s, negotiations in the Framework Convention for Climate Change (UNFCCC) started moving towards an agreement at the Conference of Parties in 2009 (COP 15), where emerging economies would assume mitigation commitments. This discussion included a variety of forms for the agreement, from the bottom-up approach that finally framed the Paris Agreement in 2015 to a legally-binding/top-down agreement with some sort of economic mechanism (Aldy & Robert, 2010; Bodansky, 2012) At that time, emerging economies such as China, India, and Brazil were opposed to acquiring mitigation commitments because of their potential economic consequences. However, Mexico, another relevant emerging economy, took a favorable position on this issue (Roberts; 2011; Hochstetler, 2012; Pulver, 2013).

Mexico's leading position in the climate regime was influenced by its particular economic and political relations. Since 1994, this country has been an OECD member and has oriented its international policy to strengthen political and economic relations with the United States, Canada, and the European Union (EU). Therefore, Mexico's governments have sought to position the country as a responsible actor in the climate arena since the beginning of UNFCCC negotiations, and a switch in its position could cause reputational damage (Torres, 2019). Simultaneously, a potentially legally binding agreement could negatively affect Mexico's economy,

dependent on exports to North America and the EU (Torres, 2004; Lopez, 2018). In this context, Mexico's federal Calderon government (2006-2012) wanted to strengthen domestic capacities to implement a mitigation policy, particularly in the energy sector, which offered greater cost-effectiveness and investment possibilities than other strategies (Torres, 2013).

However, the existing regulatory framework governing the energy sector restricted both public and private investment in non-conventional renewable energy. Since 1936, Mexico's energy sector had developed around a vision of energy sovereignty, interpreted as national ownership of energy resources, state-owned companies carrying out all developments, the provision of energy as a public service, and the use of revenues for national development. Therefore, the Constitution only allowed private participation in the electricity sector for "self-supply" projects. Since 1990, governments had made some changes in the regulation to flexible private investment in the sector, yet the political left and most citizens opposed to its liberalization prevented constitutional reform (FUNDAR, 2016; Jano-Ito & Crawford-Brown, 2016). The regulation also regarded the provision of electricity as a public service, mandating the Federal Electricity Commission (CFE) to invest in projects and technologies with lower generation costs. Due to the domestic abundance of hydrocarbons and the then-high cost-effectiveness offered by wind and solar PV energy, these technologies did not offer generation prices competitive with hydrocarbon-based technologies, legally constraining the CFE's investment in these technologies (Juárez-Hernández & León, 2014; Grunstein-Dickter, 2016).

The Calderon administration set a target of increasing the participation of non-conventional renewable energy technologies from less than 0.5 to 8% by 2012, expecting to achieve significant progress before hosting COP-16 in 2010. Consequently, in 2008, Mexico's Congress approved LAERFTE intending to promote investment in these technologies. Little consultation took place with civil society groups, local communities, or the Mexican public (DOF, 2008; Hamister, 2012). To avoid violating the Constitution, this law was built on the concept of "self-supply," allowing associations between renewable energy companies and consumers to develop projects. The law created three crucial structural features that exerted substantial power on how the sector developed. First, it created a legal mechanism for private companies to offer electricity directly to consumers. Second, it opened a niche in the electricity market for the diffusion of these technologies. In the national electricity market, tariffs for the industrial and commercial sector subsidized domestic users; thus, renewable technologies could offer competitive prices for these sectors. Third, it provided some incentives that gave technical viability to the sector, such as low tariffs for the use of the national transmission infrastructure by these projects in areas with surplus transmission capacity.

Consequently, renewable energy companies such as Iberdrola, Acciona Energy, Grupo México, and Enel Green Power planned 21 wind farms to supply electricity to

large commercial consumers (i.e., Coca-Cola, Walmart, and Heineken) in the Isthmus of Tehuantepec in Oaxaca. Several technical and economic factors encouraged the concentration of these projects in this area. Tehuantepec is one of the areas worldwide with the most significant potential for the wind industry. Unlike other Mexican regions with high potential for wind energy such as Baja California and Tamaulipas in the north of the country, Tehuantepec had a better-developed transmission infrastructure and was closer to large electricity consumption centers as Mexico City (Juárez-Hernández & León, 2014; Grunstein-Dickter, 2016). Moreover, Oaxaca is considered nationally one of the states with the lowest level of "development"; thereby, the state government perceived the wind industry as a valuable opportunity to promote private investment (Howe, 2014).

The rules and strategies contained in LAERTE, in interaction with the interests of industrial actors and some technical factors, shaped the particular sociotechnical form that projects took: privately-owned large-scale wind farms for supplying large private-sector consumers, located at Tehuantepec. This arrangement addressed the international and domestic energy transition agenda and overcame some of the economic and technical issues that had constrained the development of renewable energy technologies. However, the policymakers and industrial actors involved in the top-down design process of LAERTE and projects left out two critical pieces: the social effects of these projects and their interplay with local communities (Hamister, 2012; Grunstein-Dickter, 2016; Rousseau; 2017).

The interpretative flexibility of projects and the emergence of social opposition

The wind farms in Tehuantepec had broad interpretive flexibility for different relevant social actors. For instance, the federal government considered these projects to be the means for achieving the ambitious national target of increasing renewable energy. Renewable energy companies believed that these projects' characteristics were a way to make wind energy competitive with hydrocarbon-based technologies. Large private consumers saw them as an opportunity to strengthen their image of social responsibility while reducing their electricity costs (SEGOB, 2013; Juárez-Hernández & León, 2014; BID, 2015). In contrast, the indigenous Zapotec and Huave communities that have inhabited the region interpreted – in the decision-making, number, scale, ownership, consumption, and effects of these projects – a new attempt to colonize their territory and a risk to their cultural identity (Oceransky, 2010; Simon, 2013; Howe, 2014; Sellwood & Valdivia, 2018). This led to the emergence of local opposition groups. The activism of local groups sparked the interest of some NGOs and scholars who saw in these projects the violation of indigenous communities' human rights, and of the political left which saw an example of risks associated with privatizing the energy sector (PODER & PRODESC, 2011; FUNDAR, 2016). The conflicting interpretations among these relevant social groups and the

critical role of local oppositions gave form to the political controversy about these projects' social effects.

The Zapotec and Huave Indigenous communities have been historically opposed to any external initiative that challenges their territorial control, from the expansion of the Aztec Empire to the Spanish colonization to the subsequent development projects of the Mexican State and private initiatives. Distinct from other indigenous regions, communities in Tehuantepec have been able to preserve their cultural identity and traditional social organization, for instance, their collective land ownership and natural resource management practices (Lucio, 2018). As a result of their particular history, these communities have developed strong capacities for social organization and political mobilization. Moreover, they have given a particular meaning to Tehuantepec, from which they interpret their control over the territory as a fundamental condition for preserving their autonomy and cultural identity (Simon, 2013).

The advent of wind farms in Tehuantepec in 2009 quickly led to the emergence of local opposition groups. They argued that their land and wind would be used to generate profits for foreign energy companies and electricity for supplying large and distant transnational companies. At the same time, communities would pay the same electricity tariff and, even in some cases, have irregular access to the service. Moreover, they contended that the plan of developing the wind industry in Tehuantepec violated the right of self-determination of indigenous communities over their territory (Oceransky, 2010; Nahmad et al., 2014; Dunlap, 2018; Suárez & González, 2018). The sociocultural meaning that communities give to the region framed how local groups perceived these projects' sociotechnical aspects: this was a new attempt at colonizing their lands and extracting natural resources (Howe, 2015; Boyer, 2019).

The subjective and relative meaning that local groups gave to wind farms and their effects focused their discourse on the social arena, among different possibilities. These projects had various potentially controversial aspects. For instance, environmental NGOs were concerned about the massive installation of wind turbines affecting bird populations in Tehuantepec, a critical migration corridor for these species (Henestroza, 2009; Zárate-Toledo & Fraga, 2016; Huesca-Pérez et al., 2018). The political left made the critique that these projects would displace the Federal Electricity Commission (CFE) from the most profitable segment of the electricity market, which would not only affect the finances of the state-owned company but also the subsidies for domestic consumers (Juárez-Hernández & León, 2014; Sellwood & Valdivia, 2014). Yet, local opposition groups largely emphasized the effect that these projects would have on their communities and culture. For instance, the Mareña Renovables project sought to install wind turbines on the "Santa Teres" sandbar. Opposition groups argued that the turbines' noise and light would impact traditional fishing, centering the debate about the environmental effects on the life of the

community, among other ecological interpretations (Howe et al., 2015; Lucio, 2018; Boyer, 2019).

The director of a human rights NGO who participated as an observant of this issue pointed out:

The community wanted to know how the project would affect shrimp fishing, but the environmental impact assessment had focused on species with environmental protection, and neither the company nor the government could give them information about it.

Consequently, local groups in Tehuantepec built a discourse to oppose projects based on their negative social and cultural impacts (Simon, 2013). For instance, they argued that the projects would displace communities from their access to land and natural resources and introduce external actors to the region. The projects would also cause inequality between landowners who would receive an economic benefit from projects and most of the community that would suffer local damage (Howe, 2014).

Local opposition groups provided political visibility to the issue through their organizational capacity and legitimacy as representatives of indigenous communities that have lived in the region for centuries. The issue piqued the interest of human rights and environmental NGOs such as the Economic, Social and Cultural Rights Project (ProDESC), Project on Organization, Development, Education and Research (PODER) and Gobixha Integral Human Rights Defense Committee (DH Code), among others, and academics, who collaborated with local groups in their oppositional activities and played a critical role in documenting the adverse impacts of wind farms (PODER & PRODESC, 2011; FUNDAR, 2016; UNAM, DPL, FUNDAR, 2018). The local opposition also attracted the interest of the political left, for which national sovereignty over the energy sector has been a constitutive element of its ideology and political program. This political current interpreted wind farms as a government strategy to advance the privatization of the energy sector; consequently, Tehuantepec's conflicts illustrated the risks of private participation in the sector (Ruiz-Mendoza & Sheinbaum-Pardo, 2010; Martinez, 2019). Thus, local opposition groups involved national social and political actors in their agenda, escalating the issue to a high-profile political controversy with widespread political ramifications.

The project of Mareña Renovables intended to develop the largest wind farm in Latin America (132 turbines/396 MW), representing nationally one of the more substantial investments in infrastructure and was the flagship of the domestic energy transition policy. From the surrounding communities, Ejido Alvaro Obregon, San Dionisio del Mar, and San Mateo del Mar emerged some groups that actively opposed Mareña (Nahmad et al., 2014). The opposition groups, in collaboration with some NGOs, presented legal complaints to prevent its construction. Yet, Mareña had complied with the regulation, had its Environmental Impact Assessment (EIA) report

approved, and had leases with landowners, who agreed on the economic compensation. Consequently, legal procedures favored the company.

In response, between 2011-2012, opposition groups implemented civil resistance measures, including demonstrations, road blockages, and occupation of the project's facilities, and even formed a community police force to prevent access to the region by company personnel and government representatives. The conflict in Mareña stopped its construction, causing a governance crisis in the region. On the one hand, the project complied with current regulations, but continuing its construction could result in a violent confrontation with the communities (Sellwood & Valdivia, 2014; Avila-Calero, 2017; Ramirez, 2019; Cruz, 2020). On the other hand, the energy regulation and the EIA did not address the elements in dispute; namely, these instruments did not address the opposition groups' claims regarding sociocultural impacts (Rousseau; 2017; Huesca-Pérez et al., 2018). Although the projects were legally, economically, and technically "viable," the local opposition questioned their social viability. Therefore, the discourse and actions of local communities created a political problem for the governance of Mexico's energy transition.

3.5 The material and social shaping of governance artefact

In this section, I look at how the social controversy and industry behavior, in turn, fed back into the TGA, shaping its further design and development through adding social impact assessment as a new regulatory element. SIA thus instigated further cycles/loops of technological change, industry development, and social controversy.

The institutional translation of the political controversy

The strategies of economic and social actors focused the energy decisionmakers' attention on the emerging controversy in Tehuantepec. Through concrete experiences, they transmitted the importance of the issue to those decisionmakers and the different stakes at play. In this interplay, decisionmakers' previous experiences played a vital role in their interpretation and approach to the issue. Moreover, the translation from social and economic actors into the institutional arena took place in a particular context in which broad energy politics generated the political conditions for potential regulatory changes. Therefore, various aspects of the entrenched social and political organization of the energy sector (i.e., power relations, political agendas, and previous management experiences) framed how the controversy was institutionally processed and the available options that decisionmakers perceived, framing the further design of the new technological governance artefact: the SIA introduced in 2014.

In December 2012, while opposition in Tehuantepec was high, the new federal administration of Enrique Peña Nieto (2012-2018) entered the situation. The conflict

in Mareña had caused significant economic losses to the company and introduced uncertainty for other industrial actors with projects in the region (Grunstein-Dickter, 2016). Consequently, these industrial actors mobilized to obtain a favorable solution from the new government. A key decisionmaker in this administration said: *“In the ceremony in which Pedro Joaquín Coldwell took protest [the head of SENER], representatives of several embassies such as Japan, Netherlands and others spoke with him about the urgency of resolving the conflict in Mareña.”* In welcoming the new head of the Ministry of Energy (SENER), the corporate representatives pressured him to act to diminish resistance to renewable projects.

Within SENER, resolving the conflict was delegated to the Undersecretary of Electricity (SSE). The new head of the SSE, Lurdes Melgar, was formerly a scholar, researching energy and sustainability, and had collaborated with environmental NGOs networks. Her experience thus framed the approach that the ministry took to address the issue. In early 2013, SSE held meetings in Mexico City with NGOs, companies, and academics, seeking to understand the problem. Later, Lurdes Melgar visited Tehuantepec, intending to listen to opposition groups and local actors' perspectives. Some opposition groups members threw rocks at the car in which she was traveling, preventing her access to the region. Through her intense experience, the opposition groups transmitted the political and social risks of a governmental response that did not address their claims back to distant Mexico City. The event was a turning point in the SSE, which, for the first time in SENER's institutional history, hired a team of social science experts to manage the opposition in Tehuantepec and design government strategy in the area.

Simultaneously, the continuing discussion of constitutional reform affecting the energy sector would frame the TGA's developing path. In mid-2013, the administration (from the Institutional Revolutionary Party, PRI) made a political alliance with leading national political forces to promote a reform agenda called "The Pact for Mexico." This agenda aimed at "carrying out the legal and institutional changes to modernize the country and boost its development." The most ambitious and controversial element in the reform agenda was constitutional reform that would finally fully open the energy sector to private investment. Initially, the federal government intended to focus this reform on the hydrocarbons sector (oil, natural, and shale gas), the crown jewel of Mexico's energy sector. Yet, during negotiations with the National Action Party (PAN), which would grant the necessary votes for the reform, PAN conditioned its support to include the electricity sector (Mondragón, 2014; Alpizar–Castro & Rodríguez–Monroy, 2016). The constitutional reform was approved in 2013, which required the updating of the entire sector's regulation due to the magnitude of the change in the sector. As a result, the SSE was included in the process of negotiation and formulation of these laws.

The SSE became the transmission channel for opposition to renewable energy projects to design the new regulatory framework. Through its offices in Mexico City and its staff in Tehuantepec, the SSE had become the focus of political pressure from both companies and opposition groups. At the same time, this team found that SENER lacked institutional mechanisms or legal instruments to address the problem. Therefore, they thought that the new regulatory framework's design was an opportunity to develop the required political tools in the area, namely creating a social impact assessment (SIA) process. However, the proposed inclusion of SIA in the regulatory framework generated opposition from other SENER parts, which they thought would complicate the sector's management.

The first critical step in developing a SIA framework was to generate government decisionmakers' support that would allow its making. The SSE sought to convince the Secretary of SENER, Pedro Joaquín Coldwell, based on three arguments: First, the regulation of the sector did not comply with the right of indigenous communities to be consulted in development projects, which Mexico had promised to uphold through Convention 169 of the International Labor Organization. Second, the reform sought to attract more private investment in the sector, generating a significant number of social conflicts that needed to be resolved. Third, the sector's regulation lacked legal instruments to address the conflicts in Tehuantepec and future controversies about the social effects of the sector, thus creating substantial political risk for SENER.

Pedro Joaquín Coldwell supported the position of SSE. He was a senator in the previous administration, which framed his position on the subject. On the one hand, he had participated in constitutional reform in which human rights in international treaties ratified by Mexico acquired legal character over national laws; thereby, he understood that failure to comply with Convention 169 could cause future judicial problems. On the other hand, the previous federal administration attempted a similar energy reform in 2008, which was prevented by the opposition of the leftist parties and extensive social mobilizations. The conflicts in Tehuantepec had become a political flag of the left; thereby, the administration considered it an area of political vulnerability for both the approval of laws and their subsequent implementation. Influenced by these experiences, the Secretary decided it would be worth pursuing SIA despite the expected economic actors' opposition.

The diagnosis and policy prescription

The policymakers' initial step was to prescribe a solution to address the controversy, but its causes had broad interpretative flexibility for the different social groups involved. Based on their diverging views, communitarian, social, economic, and governmental actors envision vastly different solutions: (1) social ownership and use of energy; (2) substantive involvement of communities in the decision and benefits of projects; and (3) better corporate social responsibility practices. These potential

solutions varied in the scope and type of the technological governance artefact that they would generate (from a redesign of energy regulation to private management practices), as well as in the level of involvement and control that the various actors would have (**Table 5**) (Martinez, 2020). However, these actors had different capacities to influence the institutional vision taking form within SENER. The resulting institutional prescription delineated the particular functions that the future technological governance artefact would perform and the outputs that it would deliver, laying the foundations for its further design pathway.

Local opposition groups were critical of both the projects' sociotechnical arrangement and their process of implementation; therefore, they believed that the solution was canceling all projects, and rethinking the projects and the sector's policy based on Indigenous and local perspectives (Hoffmann, 2012; Howe, 2014; Nahmad, 2014; PROCESO, 2019). Human rights and environmental NGOs thought that the problem lay in the top-down planning and decision-making. Consequently, these groups proposed "prior, free, and informed" consultation and the substantive participation of communities in the projects, for example, through co-ownership schemes (PODER & PRODESC, 2011; FUNDAR, 2016; UNAM, DPL, FUNDAR, 2018). By contrast, industrial actors argued that the problem source was the bad social responsibility practices of some companies and the lack of legal certainty in this new sector; thus, they proposed that strengthening corporate social responsibility policies could address the issue (BID, 2015; B&HRRC, 2017).

As a government representative, the SSE sought to mediate between different groups' positions and find a political solution that would simultaneously meet opposition group demands, allow the development of this industry, and meet the national renewables target. Through meetings with the actors involved in the controversy and some experts and its research on the subject, the SSE decided that three central aspects had caused resistance to projects⁴. First, the companies had not investigated their projects' social characteristics, both to assess their social feasibility and to design a social management strategy. Consequently, in several cases, companies lacked the most basic information about their projects' social context. As a decisionmaker indicated:

An international expert negotiated Mareña's land leases. This guy required an English-Spanish translator and another for Spanish-Zapoteco. This was already unbelievable, but in one of the meetings, the community spoke Huave, an entirely different language from Zapotec. This prevented the most basic communication among the negotiator, the translators, and the community. The community perceived this as an insult damaging from there on all the process. They even didn't know the community's language.

⁴ Based on interviews with the involved decisionmakers, researchers, and NGOs.

Second, projects had not carried out a participatory process; in many cases, communities did not know about projects until these were in actual construction, which also prevented companies from incorporating local perspectives about the projects and addressing their concerns about potential impacts. Third, projects generated minimal direct and indirect local benefits. The payment for the land lease was deficient compared to international standards, and the positive effect of the projects on the local economy was minimal. Moreover, projects imported almost all their requirements, not only their technological components but also basic supplies such as paint or tools. Jobs for locals were restricted to the building stage, while foreign personnel or those from Mexico City had a few permanent positions (SEGOB, 2013). As a decisionmaker indicated, *“After the building stage, projects were generating minimal local jobs and did not consume almost nothing, they bought even paint in Spain.”*

As a result, decisionmakers in SSE believed that the solution required evaluating the social effects of projects and determining their social viability. This should be carried out in a participatory process that allows the growth of mutual understanding between companies and communities. The process should assure the improvement of local benefits. Those decisionmakers believed that these functions could be delivered by a political tool similar to environmental impact assessments (EIA)⁵. In Mexico, the use of EIA has permitted management of the environmental controversies around projects and has delivered prevention and mitigation strategies and some local compensations. Internationally, regulators are increasingly adopting social impact assessment procedures to manage the social dimensions of many types of developments (Hanna et al., 2014; Rousseau, 2017; Huesca-Pérez et al., 2018; Vammen-Larsen et al., 2018; Vanclay, 2020; Hanna et al., 2019; Khan, 2020). This expanding institutional experience and knowledge inspired SSE decisionmakers to choose to translate the SIA concept into their domestic context. They envisioned a new technological governance artefact integrated into LAERFTE, which itself was still a reasonably new TGA. This artefact would allow the government to mediate between industry interests and opposition demands; systematize the processing of these controversies; and generate routines for measurement, management, and compensation of social effects. Thus, the new TGA produced ongoing engagement processes and project design pathways that configured how economic and social actors behaved.

The design pathway for Social Impact Assessment

The institutional prescription narrowed the possibilities of a political solution, as decisionmakers settled on the SIA tool. However, even within this alternative, design paths could lead to very different results, from regulation with government controls and social participation mechanisms to private self-regulation by companies. In this design process, diverse social groups interpreted their interests and preferences

⁵ Based on four interviews with decisionmakers involved in this process.

based on broader considerations about their role and agendas in the sector, their relationship with other actors, and the sector's legal and institutional characteristics – generating the issues that emerged during the trajectory of design and their solutions. These actors' interactions defined the features of the new TGA: institutional design, legal form, scope, type of outputs, and the involvement of different actors. A key policymaker reflected: *"We knew that an assessment of social aspects was necessary, but we did not know who would implement it, manage it, or even its name."*

The policymakers in SENER initially considered that reforming EIA policy could deliver the functions that they were expecting. Although the existing EIA framework includes a chapter on social aspects with a minimal scope in Mexico, it could be improved for a comprehensive social evaluation. The Secretariat of Environment and Natural Resources (SEMARNAT) had developed institutional capacities for EIA management, for example, personnel trained for its evaluation, and state and regional offices that allowed it to implement public consultations and monitor environmental management plans. However, decisionmakers in SEMARNAT perceived different institutional risks. The EIA framework was applied to development projects in general, so expanding its social evaluation component could encourage controversy in other sectors such as mining and tourism. This alternative also required modifying environmental regulation, which after several conflicts among companies and environmental groups and legal changes since its introduction in the late-1980s, had reached some level of regulatory stability. Although this design pathway could build on a robust institutional experience and capacity, SEMARNAT's political considerations undermined its viability.

Consequently, SENER policymakers focused on designing a policy tool that would fit within the regulation and institutions of the energy sector. In the following months, SENER carried out a convincing and negotiating process with the economic and social actors. SENER held more than 30 meetings and workshops to expose the benefits of social management in the sector to the hydrocarbons and electricity companies. For instance, in one of the workshops, Canadian companies explained how conflicts with indigenous communities in the 1970s and 1980s had halted energy projects and how managing their impacts had settled this issue. The discourse of SENER to the private actors based mainly on two arguments: First, opening the sector would bring great business opportunities for companies, but the long-term political viability of this new scheme required relationship management with local communities. Second, a policy tool would provide an institutional mechanism to manage disputes and grant them legal certainty, preventing their projects from ending in irresolvable conflicts as with Mareña.

Table 5. Design pathway of the Social Impact Assessment

Event/Decision	Pathway took by actors	Other available alternatives	Groups involved	Groups excluded	Influence of the energy sector	
					Technical factors	Social factors
How to address the new area of controversy about the social effects of projects?	Technical evaluation and management of projects' social impacts, and the improvement of social participation and local economic benefits	Cancellation of projects and designing a new policy with the involvement of communities; Prior, free and informed consultation of the communities and their substantive involvement projects decisions; Improve corporate social responsibility policies	SENER consulting companies, NGOs and scholars	Local opposition groups	Lack of institutional mechanism and policy tools for addressing the arena of controversy	Centralization and top-down decision of the sector; institutional experience; power relations and level of political influence among groups
In which institutional arena should be addressed the evaluation of projects' social impacts?	Design a new policy tool for the energy sector	Change existing EIA and build under the institutional experience of SEMARNAT	SENER and SEMARNAT	Local opposition groups, companies, and NGOs	Low political feasibility to change environmental regulation	Different institutional priorities and political risks between SENER and SEMARNAT
Is there political feasibility in the sector to work toward a new regulation in the area?	A new regulation is feasible due to the low opposition of the most relevant companies	The involvement of social actors in the discussion process and define the political feasibility also based on them.	SENER and companies	Local opposition groups and NGOs	Different business opportunities and experience in the area among companies	Centralization and top-down decision of the sector; power relations and level of political influence among groups
What should be its legal form and scope?	Legally binding but with low institutional and social controls	The regulation with governmental supervision	SENER, renewable energy companies, other government	Local opposition groups	Political risk that the new regulatory framework does not	Different institutional agendas in the sector; power relations

		and social involvement ; private self-regulation; without any outcome or solution.	al institutions		address the issue	and level of political influence among groups
What institutional capacities would require its design?	A design that requires minimum development of institutional capacities	Built institutional capacities that allow governmental supervision of projects at the local level	SENER and SGCP	Local opposition groups and NGOs	Budget restrictions	Different institutional agendas in the sector

Source: Author.

The different positions of energy companies on the subject gave political viability to this design pathway. The renewable energy companies had ongoing projects or project plans in Tehuantepec; therefore, they considered that this tool would hamper their projects and legitimize opposition groups' agenda. In contrast, the oil and gas companies, which had greater economic relevance and political influence nationally, had a neutral and even, in some cases, favorable position. These companies, mostly American, historically had faced public pressure within their home countries regarding their environmental and social impacts; consequently, they had built internal competencies for social management and conducted social feasibility studies. In these companies, which would enter Mexico after the reform, managers thought they should avoid controversies with the communities, in particular, because of the country's proximity to the US and the close relationships between NGOs in both countries.

SENER's approach to convincing the less influential social actors was less active, underlining both their lack of involvement in the negotiation and tension areas that would shape the policy tool. This institution did not carry out any dialogue with local opposition groups due to their position that projects should be canceled, and future projects should have some communitarian co-ownership scheme. Consequently, their position was unacceptable for renewable energy companies and questioned the government's strategy to address the issue. The national NGOs close to local groups in Tehuantepec argued that the communities had to be consulted, and the policy solution should contain the substantive involvement of communities in decisions, project management, and benefits. Therefore, they considered that SENER's proposal did not address the central issues and stayed away from this policy formation process. Other environmental NGOs that believed that the proposal could generate a relative improvement in the area refused to participate in the design process due to the lack of involvement of directly interested social groups and NGOs, damaging their strategic relationship with these social actors.

As a result of these conditions, the subsequent negotiation was carried out mainly between SSE and the renewable energy companies. Based on its institutional experience with EIA, the ministry proposed that this policy tool should take the form of regulation in which SENER would establish the methodologies and administrative procedures for the studies; evaluate studies' outputs and dictate the social viability of the projects before their construction; carry out consultations in cases that require them; and monitor the strategies for preventing, mitigating, and compensating social impacts and investments in shared social benefits. However, renewables companies opposed this proposal because they believed that regulation would generate a bureaucratic process that would increase time and costs in planning. They counter-proposed addressing social management through self-regulation or voluntary governmental guidelines, arguing that these options would produce a similar outcome but with methodological and implementation flexibility to the sector. To achieve this outcome, the companies mobilized the support of other government actors. For instance, the powerful Ministry of Finance and Public Credit, which is responsible for the design and management of the federal government budget, argued that the proposal was not financially viable due to the substantial investment required to build institutional capacities in SENER (e.g., enough trained personnel and offices for evaluating studies, conducting consultations, and monitoring local projects).

Thus, the companies and government actors created two controversies around SENER's design of the policy tool, which threatened its viability. The companies that would be regulated demanded greater flexibility without social actors involved that could balance the negotiation. Although the energy reform would attract a large number of private investments in the sector, and, therefore, boost the collection of taxes in the industry, the federal government was unwilling to make investments in developing the sector's capacity to regulate the social management of the projects. As a consequence, the proposal faced the real risk of being discarded from the new regulatory framework. A key policymaker involved in the negotiation pointed out that "the first drafts that began to circulate in the laws did not contain any elements for the projects' social management."

In this critical context, policymakers in SSE began to negotiate a new proposal that retained a certain degree of government supervision (e.g., establishing methodologies and procedures and evaluation of studies) but that was operational with SENER's existing institutional capabilities and granted greater flexibility to companies. For instance, social consultation would only occur when projects directly affected indigenous communities, without monitoring mechanisms or legal or economic sanctions, and companies would decide the amounts and type of investments included as Shared Social Benefits. This pathway was unsatisfactory for the policymakers involved in the design process but guaranteed its inclusion in the legal framework proposal, opening the possibility for NGOs and opposition parties to strengthen the policy tool during the legislative process.

In April 2014, the Peña Nieto government presented to the Mexican Congress a proposal for the Electricity Industry Law and the Hydrocarbons Law, which included SIA and the Indigenous Consultation process. During the parliamentary process, some leftist representatives expressed concern about the social impacts of the sector. However, at that time, after running for Mexico's presidency in 2006 and 2012 by the Democratic Revolution Party (PRD), Andrés Manuel López Obrador initiated the formation of a new political party, National Regeneration Movement (MORENA), and a majority of leftist voters were against private participation in the energy sector, particularly the oil industry (CESOP, 2014). MORENA was a political risk for the PRD and the other minority leftist parties; thereby, these parties refused to get involved in any aspect of the parliamentarian negotiations, which could be perceived as a betrayal to the left's historical agenda. As a result, in August 2014, the Congress passed both laws without any change to SIA's proposal.

Social Impact Assessment

Tracing the trajectory of this technological governance artefact provides critical insights about how this process of social and material making has influenced the legal and technical language in which its instructions are inscribed. The regulation does not simply exist as a self-autonomous text; its making reveals some of the critical features of its operation and results. The instructions contained in the SIA design establish a particular arrangement of the roles and activities that government, economic, and social actors play in the evaluation process.

The SIA was designed to evaluate projects' social viability before they are developed to ensure that social impacts are managed adequately, and benefits are generated for local communities. To manage SIAs, the Secretary of Energy (SENER) has created the General Directorate of Social Impact and Surface Occupation (DGISOS) to establish administrative procedures and methodological guidelines and to evaluate the quality of SIAs. Companies are responsible for the preparation of SIAs, which usually involves the hiring of external consultants. The preparation process usually takes between three and six months and involves fieldwork with and within communities (Rousseau; 2017; DOF, 2018).

The assessment analyzes the interplay between projects and communities to identify and evaluate positive and negative social impacts and determine whether the project is socially viable (**Table 6**). Based on these analyses, the assessment proposes a Social Management Plan, which includes measures for: a) expanding positive impacts; b) preventing and mitigating adverse effects; c) establishing a good relationship between companies and communities; and d) generating shared social benefits. The DGISOS evaluates the SIA over no longer than 90 days, during which time improvements can be required, and management strategies suggested. An SIA's approval is a prerequisite for obtaining a development permit, and reports should be

accessible to the public. Finally, companies are responsible for implementing Social Management Plans at all project stages (DOF, 2018).

In this arrangement, SENER and companies make decisions and carry out substantive activities: they are also the primary users of the assessment products. The regulatory design does not involve local communities in defining methodologies, impacts, and management strategies. Instead, these communities become objects of study to generate information that nourishes the evaluation process and its product. They are passive users of the strategies and measures designed and agreed by the companies and SENER. Therefore, this technological governance artefact embeds and reinforces the pre-existing asymmetric power relations among different groups existing in this sector and the philanthropic relationship that the government and companies have historically established with the communities.

Table 6. Social Impact Assessments in Mexico’s renewable energy sector.

Main components	Description
Project information	Main characteristics of the project such as the objective, technical features, infrastructure, development stages, location, time span, and surface area required
Project’s area of influence	Identification and delineation of the project’s core area, direct area of influence, and indirect area of influence, based on analysis of the project’s facilities and activities, human settlements, regional land use planning, socio-environmental characteristics, among other criteria
Characterization of communities	Identification and analyses of the demographic, socio-cultural characteristics, key local stakeholders, and cultural and historical heritage of the communities in the zone of direct influence establishing the "baseline" for socio-cultural indicators that could have changed as an effect of the project. It also examines the particular social effects on indigenous communities.
Identification, characterization, prediction, and evaluation of the project’s positive and negative social impacts	Identification of the origin, cause, and form of social impacts, and evaluation of their time span, reversibility, probability, spatiality, quality (positive or negative), and significance, based on the analysis of the interaction between the potential project and communities.
Social Management Plan	This section describes the measures and strategies to expand positive impacts and prevent and mitigate adverse effects. It also establishes the human and financial resources that the project will implement in the community for communication, participation, complaints, and social investments.

Source: Author.

The SIA procedure's legal form and scope is a hybrid between the regulation that SENER sought and the self-regulation that companies wanted. As it is addressed in depth in the next chapter, the SIA design has framed the performance of this artefact in practice. In theory, this policy tool allows the federal government to mediate between companies and communities and prevent the construction of

controversial projects. The SIA also produces a base of information on social environments used by companies to design their management and social relationship strategies, with broad flexibility in their implementation and limited government and social scrutiny. However, the SIA has failed to resolve the controversy that led to its formation. Between 2016-2018, companies proposed 56 large-scale wind and solar projects, and around 67% of them have experienced some level of social opposition (Gerth, 2018; Loderer, 2018; Zarembek et al. 2019). Moreover, as it is examined in more detail in the next chapter, local opposition groups and NGOs have questioned the positive social effects of the SIA, expanding the scope of the controversy on the social impacts of renewables.

3.5 Conclusion

The international political context prior to COP 15 and Mexico's position in the climate arena led to governmental incentives to seek rapid energy transition. Technical and political constraints on the development of renewable energies in Mexico framed the design of the 2008 LAERFTE as a new technological governance artefact. The form that this artefact took to assure the investment and cost-effectiveness of renewables and their access to transmission infrastructure, influenced the characteristics of renewable energy projects in Mexico. However, the socio-technical features embodied in the artefact led to projects in Tehuantepec having adverse effects on the indigenous Huave and Zapotec communities, which began using a local opposition discourse based on defending their cultures. The absence of a regulatory and institutional framework to address such sociocultural claims played an essential role in the growth of civil resistance actions and the political visibility that the conflict attained by 2012.

In the context of controversial energy reform, the effects of the conflict in Tehuantepec on regional governance and the companies' economic losses created a feedback loop into the technological governance artefact, calling for a regulatory framework to address social impacts. Therefore, the Mexican government sought to adapt the artefact further and eventually chose the Social Impact Assessment model to integrate into LAERTE. In SIA's design path, there were different possibilities regarding institutional arrangements, areas of intervention, scope, and regulatory form. But the lack of community involvement in this centralized process, the influence of companies, institutional priorities, and the refusal of the political left to get involved in any aspect of energy reform shaped the SIA design so that it proved unable to manage social controversy around renewables effectively. This case study has shown that the technological governance artefact idea offers valuable analytical power in tracing how the design of LAERTE exerts power to organize a new renewable energy arena, and how feedback loops can change this artefact, leading to further developments in the renewables industry.

The national climate mitigation goal and rising social opposition to renewables have promoted destabilizing changes in Mexico's energy sector's political regime. However, the existing social and material features of this sector have meant that entrenched industrial interests and values and bureaucratic decision-making norms have persisted in the way institutions process these agendas and the design of policies and regulations. The technological governance artefact, in other words, reflects and reproduces these entrenched elements. Importantly, this socio-technical arrangement has translated the historical dispute between the political left and right related to private participation in energy production and state control of the oil sector to the development of renewable energies to some extent.

Chapter 4

The effectiveness of the social impact assessment (SIA) in energy transition management: Stakeholders' insights from renewable energy projects in Mexico⁶

Abstract

Social opposition to renewable energy (RE) projects has become a significant issue both for the deployment of RE technologies and the social justice of this process. However, the policy tools oriented to address this issue have received little research attention, particularly in the Global South. Thus, this research analyses the effectiveness of the social impact assessment (SIA) in Mexico's RE sector. In 2014 the government of Mexico introduced the SIA in response to the social conflicts around RE projects. The SIA has generated some favorable changes in the sector's social

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management. Yet, its effectiveness is constrained by diverse issues related to its institutional and regulatory design, government implementation, practices of companies and consultants, and restricted social involvement. Moreover, the sector's sociotechnical arrangement (priorities, organization, experience, and policies) strongly influences the performance of SIAs and accounts for the lack of consideration of social aspects in project design and planning. We argue that without a substantial internalization of the social dimension in the priorities, policy, and planning of RE, the SIA would be limited to a problem-fixing role, which would constrain the effective management of social impacts.

4.1 Introduction

The transition of energy systems to renewable energy technologies (RE) is a central strategy in climate change mitigation and has encouraged the formation of robust political frameworks for RE deployment in at least 87 countries (WB, 2017). As a consequence, in the last decade, the Global South has taken the lead in the development of RE projects (WB, 2017; McCrone et al., 2018). However, there has been social opposition, mainly among local communities—in many cases rural and indigenous—which bear the brunt of the projects, especially in terms of the social and environmental effects of their infrastructure. These issues have led to the delay and cancellation of RE projects and, importantly, have raised broader questions about the implications for social justice of the ongoing energy transition (ET) (Hanna et al., 2014; Wlokas et al., 2017; Gorayeb et al., 2018; Huesca-Pérez et al., 2018; Khan, 2020). In response, governments, international banks, and companies have adopted and implemented regulations and policy tools for example, social impact assessments (SIAs), that aim to address the causes of social opposition (Hanna et al., 2014; Rousseau, 2017; Vammen-Larsen et al., 2018; Hanna et al., 2019; Vanclay, 2020; Khan, 2020). The performance of these policy tools has a practical implication for how social aspects are included in the decision-making process and planning of RE projects (Aledo-Tur & Domínguez-Gómez, 2017). Notwithstanding, this area remains under-researched, particularly in the Global South, where knowledge and insights are especially needed.

Diverse social, environmental, and institutional factors influence the social opposition to RE projects. Projects, for instance, have positive and negative social effects that are differentially allocated among actors and social groups (e.g., job creation, landowners' compensation, impacts on property value and traditional economic activities, increased inequality) (Huesca-Pérez et al., 2016; Rand & Hoen, 2017). Another set of factors are related to the local environmental impacts of projects, which can directly affect communities (e.g., health risks, esthetic and sound disturbances, pollution) and have generated concern on the part of social groups, such as NGOs, regarding local ecological degradation (e.g., landscape fragmentation and adverse impacts on wildlife) (Tsoutsos et al., 2005; Wang & Wang, 2015). Moreover, the political and regulatory framework for planning and development of projects

plays a critical role in the management of local impacts and social relations. For instance, the assessments of projects can limit, or even exclude, the involvement of local communities: this negatively affects their right to procedural and substantive justice, diminishes social trust, and undermines the comprehensiveness of management strategies (Stirling, 2008; Gorayeb et al., 2018; Vammen-Larsen et al., 2018).

Together, the characteristics of projects and the social setting frame the particularities of local effects and the nature of social opposition. There is a wide variation in the technical and social features of national energy systems (energy resource endowment, technologies, institutional and regulatory frameworks, and interest groups) and these influence the adoption and the design of ET policies (Bernauer, 2013; Hughes & Lipsy; 2013). The resulting ET policies are in general diverse, for instance, both in their regulatory form and orientation (market mechanism, regulations, subsidies) and technology choices (wind, solar, marine, hydro, biomass, geothermal energy) (Lachapelle & Paterson, 2013; Hughes & Lipsy; 2013). The design of these policies shapes the sociotechnical pathway taken by the domestic development of RE projects (technologies, scales, energy use, regions, and actors' involvement), and consequently, their particular local effects (Walker & Cass, 2007; Miller et al., 2013). To illustrate this point, in the last decade, the market orientation and the fast deployment targets of RE policies in the United States (US) have led to a significant increase in the scale of wind and solar photovoltaic (PV) facilities, framing the magnitude of the impacts over local geographies and communities (Phadke, 2013; Miller et al., 2015). These projects interact with vastly diverse environments (wind vs. solar; or offshore vs. onshore wind) and sociocultural contexts, influencing the way local communities interpret and respond to their effects (Walker & Cass, 2007; Lombard & Ferreira, 2014; Hanger et al., 2016). For instance, Devine-Wright (2011) found that variations in the place attachment and meaning between two communities in Northern Ireland generated differences in their social acceptance of a tidal energy project.

Against such a background, SIAs not only have practical implications for the interplay between projects and communities but are also a strategic site for information delivery on the institutional management of different types of social opposition. The SIA is a policy tool that analyzes the socio-cultural effects of a project to provide inputs to sociopolitical actors about its social viability; it also delivers management recommendations to address any adverse social effects the policy may have, with the emphasis on expanding its positive ones (Esteves et al., 2012). SIA design and practice comprise many different approaches, methodologies, and levels of actor involvement (e.g., top-down, objectivist, and technocratic vs. bottom-up, participatory, and constructivist). The performance of SIAs thus frames critical aspects related to the social opposition to RE projects, such as whether and how the perspective of local communities is incorporated into projects' decision-making processes, planning, and operations and thereby their future influence on social

impacts and interactions (Tang et al., 2008; Aledo-Tur & Domínguez-Gómez, 2017). Furthermore, SIAs— since their introduction in the 1970s in the USA— have been widely adopted by the Global South and by international actors such as the World Bank (WB) and the Inter-American Development Bank (IADB) which now play a key role in the diffusion of ET policies and the financing of RE projects (Esteves et al., 2012; Vanclay, 2020).

Different issues can negatively affect the performance of SIAs. A SIA, in most jurisdictions and sectors, is implemented as a component of an Environmental Impact Assessment (EIA), which can adversely affect its methodological development and also be responsible for its relatively low influence compared with other types of evaluation (Momtaz, 2013; Hildebrandt & Sandhan, 2014). Regulatory, institutional, and methodological weakness may constrain the enforcement of SIAs, as also may the reliability and influence of their outputs (Tang et al., 2008; Ahmadvand et al., 2009; Değirmenci & Evcimen, 2013). Quite aside from SIA design, the practices of the actors who help prepare these assessments are critical for the assessment's quality, applicability, and relevance (Değirmenci & Evcimen, 2013; Hanna et al., 2014). Shortcomings in the access of different actors to SIA outputs, and in the way those outputs are communicated or transmitted also limit the salience of SIA in the decision-making process (Feeney, 2013). Moreover, SIAs can exclude or restrict the involvement of affected local actors and interest groups; this means that their perspectives, knowledge, and experience are excluded, and this affects the quality of outputs and management strategies, as well as their legitimacy (O'Faircheallaigh, 2009; Nzeadibe et al., 2015).

In summary, SIAs play a practical role in the social opposition to RE projects, and previous research has provided insights into aspects of their design and practices that can affect their performance. However, there are significant knowledge gaps in this literature:

1. **Issue area.** Previous research has examined SIAs in different economic sectors such as mining, hydrocarbons, agriculture, and fisheries (e.g., Ahmadvand, et al., 2009; Feeney, 2013; Nzeadibe et al., 2015) but, with a few exceptions (e.g., Vammen-Larsen, et al., 2018; Hanna et al., 2019), little research has been conducted on SIAs in non-conventional RE projects (excluding hydroelectric). For example, in a systematic literature review about impact assessments of RE projects, Hanna et al. (2019) highlight the limited research on the assessment of socio-cultural impacts.
2. **Sociotechnical approach.** Prior research has examined the effectiveness of SIAs from diverse perspectives, such as their regulatory and institutional design, the preparation and quality of the assessments, the influence of SIAs on decision-making processes, and the level of social involvement in them (e.g., Tang et al., 2008; Ahmadvand, et al., 2009; O'Faircheallaigh, 2009; Hildebrandt & Sandhan, 2014). However, the relationship between the

technical and social characteristics of projects and the performance of SIAs remains significantly under-researched. As previously stated, the sociotechnical arrangement of projects and sectors strongly influences their local effects and interactions with communities (Walker & Cass, 2007; Miller et al., 2015; Martinez, 2020); a better understanding of these arrangements is thus required in terms of the capacity of SIAs to address and manage sociotechnical effects.

3. **Global South and knowledge justice.** A more extensive deployment of RE projects is currently taking place in the Global South, and countries such as China, India, Brazil, and Mexico are among the ten nations with the most significant investment in these technologies (WB, 2017; McCrone et al., 2018). However, social opposition and its institutional management in these geographies has received correspondingly less research attention (Rand & Hoen, 2017; Gaede & Rowlands, 2018). In countries like South Africa, Brazil, China, and Mexico, to mention a few, researchers have indicated how little research there is into their domestic institutional and socio-political conditions related to the social challenges of the ET (e.g., limited institutional budgets, social inequality, lack of community land use, land tenure insecurity) (Tang et al., 2008; Lombard & Ferreira, 2014; Rousseau, 2017; Gorayeb et al. 2018; Huesca-Pérez et al., 2018; Khan, 2020). Such conditions put a brake on research that could provide information about such challenges in the Global South, and they also make these challenges less visible on research agendas and in academic debates (Egert & Allen, 2019; Martinez, 2020). Moreover, given that the political conditions, certain project features, and local socio-cultural and environmental characteristics all influence social opposition (Martinez et al., 2016; Devine-Wright, 2011; Miller et al., 2015), the paucity of research in these geographies restricts the theoretical understanding needed about the contextual aspects of SIAs.

This study provides insights into these critical gaps by analyzing the effectiveness of SIAs in Mexico's RE sector using a sociotechnical approach. Mexico has built a robust climate and ET policy framework and is considered by the international community to be a leader in the area of climate change in the Global South. (Pulver & Sainz-Santamaría, 2018). However, the development of RE projects—mainly large-scale onshore wind and more recently solar photovoltaic (PV)—has caused social opposition and even conflicts in regions with indigenous communities, generating political controversy in the area (Nahmad et al., 2014; Huesca-Pérez et al., 2016). In response, the government of Mexico introduced the SIA to this sector in 2014, with a view to evaluating the social impacts of the projects, determining their social viability before their inauguration, and internalizing their social management (Grunstein-Dickter, 2016; Rousseau; 2017). Nonetheless, RE projects continue to cause social opposition, which has generated a debate among sociopolitical actors about SIA performance and social management practices in the RE sector (Zárata-Toledo et al., 2019). Against this background, this study specifically analyzes *i*) the effects of the

introduction of SIA in the management of social impacts of RE projects; *ii*) the aspects of the design and practice of SIA that effect its effectiveness; and *iii*) the influence of the sector's arrangement on the design and practice of SIA. By doing so, this study delivers policy orientations for improving the performance of SIAs in Mexico while providing critical insights into the current research on SIA effectiveness and social opposition to RE projects.

4.2 Background: SIA in renewable energy projects in Mexico

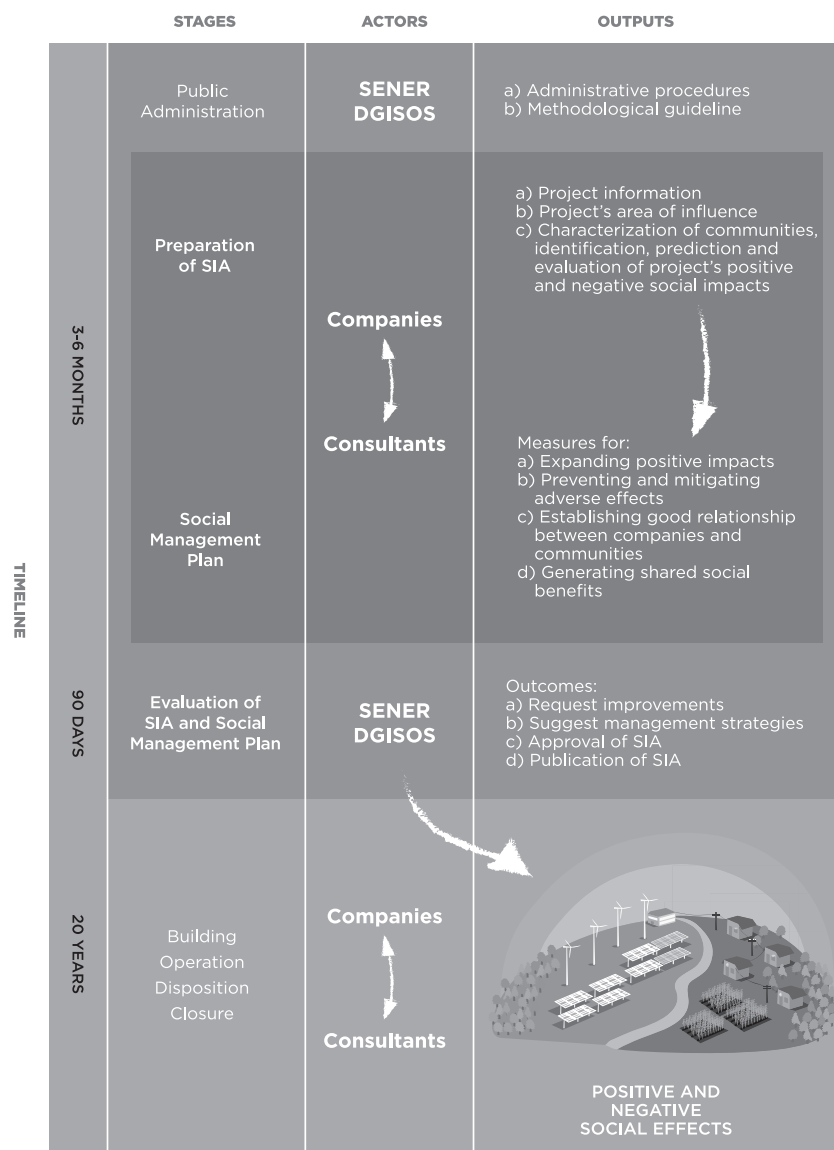
After the Durban Platform (2011), the discussion in the Framework Convention on Climate Change (UNFCCC) moved toward an international agreement in which emerging economies would assume climate change mitigation commitments (Bodansky, 2012). In this context, the government of Mexico adopted the Law for the Use of Renewable Energies and Financing of Energy Transition (LAERFTE) in 2008, which aimed to promote investment in RE projects, thereby facilitating the partnership between renewable energy companies and private consumers for the development of self-supply projects. The LAERFTE also strengthened the technical and economic viability of RE projects through different mechanisms such as the free use of transmission infrastructure and net-metering (Grunstein-Dickter, 2016). As a result, renewable energy companies, mostly European, which sought to expand to Latin America (**Table 2**), promoted the development of 25 large-scale onshore wind farms to supply large private consumers (e.g., Wal-Mart, Coca-Cola, and Heineken), located on the Isthmus of Tehuantepec—a region of Mexico with one of the highest worldwide potentials for wind energy (Howe et al., 2015; Rousseau; 2017).

Zapotec and Huave indigenous communities live on the Isthmus of Tehuantepec, where they uphold their cultural and traditional lifestyles, for instance, communitarian management of land and natural resources. The installation of wind farms in Tehuantepec has caused the emergence of local opposition groups, which have argued that the lack of local community involvement in the planning of wind energy enterprises has violated their right of self-determination over their traditional territory (Howe, 2014; Sellwood & Valdivia, 2018). These groups have also pointed out that the concentration of large-scale projects in Tehuantepec has been causing a rapid transformation of the territory and its social dynamics, thus negatively affecting traditional economic activities and community cohesion and equity (Nahmad et al., 2014; Huesca-Pérez et al., 2016). In 2012 the social opposition reached a high point, prompting social conflict around “Mareña Renovables,” a project that aimed to develop the largest wind farm in Latin America, with 132 turbines. Local groups, in collaboration with human and environmental rights NGOs, used existing legal mechanisms to try to block the plan, but once these were exhausted, the local opposition implemented civil resistance strategies, such as demonstrations

and roadblocks, and even formed a community police force to take control locally (Howe, 2014; Sellwood & Valdivia, 2018).

The conflicts in Tehauntepec caused a significant political controversy over the social impacts of RE projects. In Mexico, the EIA does not include a comprehensive assessment of social impacts; consequently, the federal government lacked an institutional mechanism to address the controversy surrounding them (Huesca-Pérez et al., 2018). It thus responded by introducing the SIA—for the first time in the country—into both the Electricity Industry Law and the Hydrocarbons Law (2014). The regulation required companies to conduct an SIA to evaluate the social viability of a project before its development and to implement Social Management Plans (SMPs) to address negative social impacts throughout all project stages and increase projects' positive social effects and benefits (Grunstein-Dickter, 2016; Rousseau; 2017). The process takes place as represented in **Figure 2**. The Secretary of Energy (SENER), through the General Directorate of Social Impact and Surface Occupation (DGISOS), establishes the administrative and methodological guidelines for SIAs and evaluates them. Companies then prepare SIAs, usually through external consultants (Rousseau; 2017).

Figure 2. Main stages and features of the Social Impact Assessment in Mexico.



Source: Figure created by the author.

Mexico replaced the LAERFTE with the Energy Transition Law (ETL) in the framework of the 2015 Paris Agreement. One of the objectives established by the ETL was for alternative clean energy technologies to reach 35% of national electricity generation by 2024. The ETL established obligations to large electricity consumers and provided market mechanisms such as “electric auctions” and Clean Energy Certificates (DOF, 2015). The ETL significantly boosted the deployment of RE projects. Between 2015 and 2017, electric auctions not only promoted the development of 56 large-scale wind and solar PV projects, but in 2016 and 2017 Mexico achieved the lowest prices worldwide for solar PV and onshore wind energy (McCrone et al., 2018).

Nonetheless, these projects continue to cause social opposition. Although there are no official statistics, Zaremborg et al. (2019) found media reports of 116 incidents of social opposition in 35 wind farms between 2006 and 2019. Similar to international trends, since 2015, solar PV has become particularly competitive (McCrone et al., 2018); consequently, some of the new conflicts are related to these technologies. For instance, large-scale solar PV projects in Yucatan have caused opposition from Mayan communities and other environmental groups, who argue that these projects could generate deforestation of traditional forests and adversely impact local economic activities (Lodero, 2018, April 2). The issue has caused legal disputes, delay and cancellation of projects and, importantly, more significant political debates on the social justice implications of ET in Mexico (Gerth, 2018, October 26). Governmental institutions, NGOs, companies, local opposition groups, international organizations, and some scholars are thus embroiled in a controversy about the performance of the SIA and the social management of ER projects (**Table 7**) (Martinez, 2020). This situation is thus creating a political climate for further SIA reform.

Mexican researchers have provided critical insights into different aspects of this controversy. Diverse studies have analyzed both the social and environmental impacts of RE projects in regions such as Tehuantepec and Yucatán (Huesca-Pérez et al., 2016; Zárate-Toledo & Fraga, 2016), as well as the formation of local social movements and their agendas (Howe, 2014; Howe et al., 2015; Sellwood & Valdivia, 2018). Previous research has documented inadequacies in the social management of the sector, such as the limited participation of local actors and the lack of access they have to information about projects and their local impacts (Howe, 2014; Huesca-Pérez et al., 2018; Zárate-Toledo et al., 2019). Furthermore, Grunstein-Dickter (2016) and Rousseau (2017) have examined the regulatory framework of the SIA, demonstrating issues such as the limited autonomy of the DGISOS, and the shortcomings in the mechanisms of social participation, and the definition of "local benefits." SIA performance, however, has not yet been analyzed. The present study thus builds on and extends previous research on Mexico in this area, and importantly, provides an orientation for sociopolitical actors seeking to improve the social management of this sector.

Table 7. Main actors related to the controversy about the performance of SIA.

Main groups	Example
Governmental actors	SENER and the Secretariat of Environment and Natural Resources
Local groups	Assembly of Peoples of the Isthmus in Defense of Land and Territory, Assembly of Defenders of the Maya Múuch 'Xiinbal Territory, and Articulación Yucatán
Local inhabitants	Residents in projects' areas of influence in places such as San José Tipceh, Yucatan, and Juchitán, Oaxaca.

Renewable energy companies and private sector organizations	Iberdrola, Acciona Energy, Vega Solar, Grupo México, Enel Green Power, Alten Energías Renovables, Mexican Wind Energy Association, and Mexican Solar Energy Association
Environmental and human rights NGOs	FUNDAR, Mexican Center for Environmental Law, Project on Economic Social and Cultural Rights, Project on Organization, Development, Education, and Research, Civic Collaboration Center, and OXFAM
International Organizations	IADB, WB, United States Agency for International Development, and German International Development Cooperation
Experts	Researchers in the field from national academic institutions such as Mexico's College (COLMEX), Latin American Faculty of Social Sciences (FLACSO), Center for Economic Research and Teaching (CIDE), Mexico's National Autonomous University (UNAM)

Source: Author.

4.3 Methodological Approach

This study, which addresses the perceptions of critical stakeholders in Mexico, is based on 42 semi-structured, in-depth qualitative interviews (Feeney, 2013; Hanna et al., 2014; Nzeadibe et al., 2015; Vammen-Larsen et al., 2018). Based on the objectives and outputs of SIAs established by national regulation (see, **Section 2**), the effectiveness of a SIA is defined in this research as a systemic process that guarantees the following to government, economic, and social stakeholders: *i*) that before the building of an RE project, any negative social impacts are considered to be insignificant; and *ii*) that SMPs are implemented to comprehensively manage negative social impacts, expand positive social effects, and generate social benefits.

A review of the research on the effectiveness of SIA, the Mexican case, and sociotechnical energy transitions informed the definition of the analytical categories included in the interview protocol. As illustrated in **Table 8**, the first category examined the changes that the introduction of SIA has generated in the management of social impacts in the sector, including aspects of its organization, practices, and relationships. The second category addressed the aspects that affect the effectiveness of SIA during its preparation, evaluation, and implementation, such as regulatory and institutional design and the practices of companies, consultants, and institutions. The third category examined the influence that the characteristics of the performance of SIA, including aspects such as institutional capacities and project planning and development procedures.

Table 8. Analytical categories included in the interview protocol.

Analytical categories	Definition	Aspects	References
i) The effects of SIA or related incentives in the sector for the management of social impacts	The changes generated by the introduction of SIA in the sector's dynamics, organization, and practices for managing social impacts	Changes in stakeholders' agendas, organization, management, and interaction to address projects' social impacts	Grunstein-Dickter, 2016; Rousseau, 2017; Huesca-Pérez et al., 2018; Zárate-Toledo et al., 2019; Martinez, 2020
ii) Aspects of the design and practice of SIA that influence its effectiveness	The preparation of SIAs	Conducting the different stages of the assessment and preparation of SMPs	Stakeholders' practices, regulatory design, methodological guidelines, and contextual factors that influence the development of SIAs, fieldwork, integration of the assessment, and design of SMPs
	Evaluation of SIAs	The evaluation of SIAs conducted by SENER, in which the institution validates that the technical quality of the assessment and the comprehensiveness of the measures and strategies for managing social impacts and delivering social benefits	Institutional and regulatory design of the evaluation process and its implementation
	The implementation of SMPs	The implementation of the measures and programs for preventing, mitigating, and compensating for negative social impacts, extending positive social impacts, and the social benefits generated by projects	The regulatory design and government implementation of this stage, and companies' practices in the implementation of SMPs
iii) The influence of the sector's arrangement on the design and practice of SIA	The sector's contextual factors that framed the design of SIA and influenced its practice	The role that the sector's objectives, organization, policies, and practices have had in the effectiveness of SIA	Walker & Cass, 2007; Stirling, 2008; Miller et al., 2013; Phadke, 2013; Miller et al., 2015; Martinez, 2020

Source: Author based on literature review.

Data were collected in three stages to encompass the broadest diversity of groups and stakeholders at the national and local level involved in: **i)** the design, practice, and implementation of SIA; **ii)** the controversy over its performance and sector's social management practices; and **iii)** the direct interplay with RE projects and the practice of SIAs (**Table 9**). In the first stage, we conducted interviews with government actors involved in the design and administration of the SIA, private

actors and consultants who prepare these studies and implement SMPs, NGOs and activists who maintain an active and critical position in the social management of the sector, other actors involved in area such as international organizations, and experts⁷. In the second stage, we conducted interviews with representatives of locally organized groups who have direct interaction with RE projects in diverse geographies and sociocultural environments, such as Baja California, Sonora, Chihuahua, and Oaxaca. In the third stage, we conducted interviews with local stakeholders and inhabitants related to the solar PV projects “Ticul A and B,” which have caused significant social opposition.

The interviews were conducted personally during 2018–2019, in Mexico City, Merida, and San José Tipceh, Yucatan following procedures of informed consent and confidentiality. The research protocol and procedures were reviewed and approved by UC Berkeley's Committee for the Protection of Human Subjects (**CPHS # 2018-04-10944**). The interviews lasted between 30 minutes and 3.5 hours, depending on the comprehensiveness of the topics and the time availability of the interviewees. Interviews were fully transcribed, and the resulting data examined based on the thematic analysis method (Wodak & Meyer, 2009), following the process now outlined: *i*) identification of main topics and classification by theme; *ii*), identification, systematization, and coding of stakeholder perspectives and arguments by major topic; *iii*) quantification of the number of times stakeholders mentioned a specific argument; *iv*) integration of results of main topics by theme, salience of topics by stakeholders, main stakeholders' perspectives by topic, agreements, and controversial aspects according to stakeholders' perspectives (See detailed results in **Annex 2**).

The limitations of our methodological approach must be considered. This research included the different stakeholders and social groups involved in the SIA, yet the information resulting from the interviews is framed by *i*) its top-down management of Mexico's energy sector and the lack of institutional mechanisms for communities and local groups involved in the SIA; and *ii*) the role taken by the different groups in the existing regulatory framework of SIA, and as a result their experiences and areas of concern (Rousseau, 2017; Zárate-Toledo et al., 2019; Martinez, 2020). These aspects generated variations in the focus of interest among different groups (e.g., consultants provided a more significant number of comments related to the preparation of SIAs). To address this issue, in the results, we give the same weight to all the areas of analysis (e.g., preparation, evaluation, and implementation) and issues reported by area; by doing this, we consider the number of mentions as an indicative value that did not reflect a relative weight of an issue. Thus, our qualitative approach and methodological choices allowed the identification

⁷ This process was informed by 11 months of participant observation (2017–2018) in Mexico City as a full-time policy advisor on the project “Communities and Renewable Energies,”⁷ with the first author actively involved in multi-actor work meetings and public forums related to social management in the RE sector.

of the different aspects that affect the performance of the SIA but do not establish their specific weight or relative relevance.

Table 9. Stakeholders interviewed.

Group	No. interviews	Rational behind their selection
Governmental actors	5	They participated in the design path of the SIA and can provide insight into the decisions and options available in this process. They have an essential role in the implementation of the SIA and have reviewed the reports of SIA and the SMPs that have been developed in the country; besides, they have direct interaction with different companies, types of technologies, consultants, opposition groups and communities.
NGOs	8	They have documented the social impacts of the projects and collaborate with local opposition groups in different regions such as Tehuantepec and Yucatán; in some cases, they have permanent operations and projects at the local level and lead the legal processes against the projects. They have carried out independent studies on the functioning of the SIA and maintain a critical position regarding the operation of this political tool.
Local groups	6	These groups, from different geographies and with diverse agendas, have substantive experience on how SIAs are developed at the local level, the implementation of SMPs, and the benefits, risks, local problems associated with RE projects.
Local inhabitants	6	They have the local and everyday experience on how the SIAs were prepared, the project development process, the implementation of the SMPs, and their perception of the positive and adverse effects at the local level.
Renewable energy companies and private sector's organizations	6	They have direct experience on the changes that the SIA has generated in the industry, the management that companies make on the SMPs, and the problems that from their perspective have the operation of these management tools.
Consultants	5	The consultants, in the practices, are the technical managers of the SIA, so they have experience in the methodological aspects of their preparation and the interaction established in this process with companies, communities, and government actors.
Experts	4	They conducted prior academic research on the regulatory design of the SIA and social opposition to renewable projects.
International Organizations	2	They have agendas and projects focused on improving the functioning of the SIA and the social management of renewable projects and have published reports with political orientations in the area.

Source: Author.

However, our analytical approach presented some advantages and innovations. Previous research has addressed the effectiveness of the SIA based on the comparative analysis of its regulation and methodological design regarding international guidelines and the quality of the SIAs reports (e.g., Değirmenci & Evcimen, 2013; Hildebrandt & Sandham, 2014; Khan, 2020). These approaches underestimate the gap between the normative design of SIA and its real implementation, which has been previously reported as a significant issue in the

Global South (Ahmadvand, et la., 2009; Rousseau, 2017; Gorayeb et al. 2018). Other studies have addressed the performance of the SIA based on case studies (e.g., Momtaz, 2013; Nzeadibe et al., 2015). Although this approach provides a rich account of the local and contextual experience, it provides less information about systemic issues. In comparison, our approach overcomes the normative dimension of SIA to provide insights into its implementation and practice and address broader structural and organizational aspects (e.g., knowledge, experience, of institutions, and the project planning process,) which tend to receive little research attention in the field.

4.4 Results

4.4.1 The effectiveness of SIA in the management of social impacts of RE projects

Stakeholders, particularly private and governmental actors, see the introduction of the SIA as having generated some positive changes for social management in the RE sector. Some companies have created an internal department for social management; projects have seen a relative improvement in this area; and social opposition has been less severe. Moreover, SIA has incentivized effects that go beyond direct project management. For instance, the sector's agenda has incorporated the social aspects; international and domestic banks currently require social safeguards for project loans; and there is a growing awareness of social management inside the Mexican government (**Table 10**). However, there is also a widespread stakeholder perception that, substantively, SIA has had only a small effect on the sector, which still sees the management of social impacts as a secondary issue. SMPs have a limited impact on the well-being of local communities. The government has failed to develop sufficient capacities for the administration of this policy tool. The influence of communities and civil society on project management is low. Stakeholders thus perceive that SIA has not been effective enough to deliver comprehensive management of the social impacts of RE projects.

Although social management has been incorporated into the sector's agenda and social conflicts have been less severe, the social aspects of RE projects are still secondary both to the economic and technical aspects of the sector and to environmental management. Governmental officials and NGOs pointed out that associations of RE companies have created working groups on social management, and in the last few years, RE sector forums organized by the government and the private sector have included panels of experts on related social issues. Governmental officials believe that the SIA has initiated a learning process among governmental and economic actors about the function of social management in the sustainability of the sector. According to governmental officials and private stakeholders, since the introduction of SIA, social opposition has been less severe than in previous conflicts such as “Mareña Renovables.” However, in general, stakeholders believe that economic and technical considerations are the central focus of project planning and

decision-making and that SIAs are a bureaucratic procedure rather than a management area.

Table 10. The effects of SIA on sector governance.

Topics	Main changes	Main limitation
Sector governance	Less severe social conflicts Stakeholders learning how to use SIA's outputs Stakeholders' incentivized to learn social management Social management being incorporated into the sector's agenda	The management of social impacts remains a secondary issue
Private sector	Internalization of social aspects by some companies in project planning and decision-making process The requirement of social safeguards for project loans.	Limited implementation of SMPs
Government	Growing awareness of the relevance of projects' social management	Insufficient development of institutional capacities for administering SIA
The communities and Civil Society	Creation of an institutional channel to look at actors' claims regarding projects' social impacts Relative improvement in companies' social management	Lack of involvement by communities and civil society in the evaluation, design, and implementation of SIAs

Source: Author.

While the SIA has influenced changes in companies and among private actors, the social management of projects is still limited. Government officials and private actors indicated that RE companies are incorporating Corporate Social Responsibility Policies (CSRPs) and that some have not only created internal departments and procedures to evaluate social risks in project decision-making but are also implementing social management practices. Private actors pointed out that international financial institutions and private banks are requesting SIAs as a social safeguard before approving project loans. Government officials and private stakeholders argued that such an initiative generates the perception that social conflicts are a financial risk, thereby creating an incentive for companies to devote more attention to the issue. However, stakeholders, particularly NGOs, saw that the effect of implementing SMPs has been small in terms of addressing social impacts and generating benefits to communities.

While the interest of Mexican government institutions in the social management of RE projects is growing, the government itself has not yet provided adequate resources for the administration of SIA. Governmental officials and private stakeholders considered that decision makers in SENER and other environmental institutions had the most interest in improving the implementation of SIA and the

social management of projects; some officials and NGOs argued that the environmental policymakers are more interested in the implications of social opposition for achieving national targets on energy transition and compliance with international commitments on climate mitigation, which—if they fall short—could generate a reputation cost for Mexico's government. However, according to governmental officials, private stakeholders, and NGOs, these concerns have not yet translated into government action to create the institutional capacity required for SIA administration.

The introduction of the SIA has provided a relative improvement in the social management of projects, yet community and civil society involvement with regard to project-related decisions and management strategies remains narrow. Experts indicated that communities and NGOs now can target DGISOS with their demands regarding social impacts and, in some cases, they have access to SIAs: this has strengthened their position when arguing against projects and improved their capacity to negotiate better management strategies. Local groups, NGOs, and experts pointed out that the decision-making process around project social management is mainly restricted to SENER and companies, and that, in practice, communities and civil society lack any direct involvement in the preparation and evaluation of SIAs and the implementation of SMPs. The local inhabitants also indicated that although the company is implementing social management strategies, they have low involvement in the drawing up of SIAs and in access to their outputs.

4.4.2 The design and practice of SIA

The preparation of SIAs

At the SIA preparation stage, the work of consultants is critical. A continual flow of information between experienced consultants and the RE companies is vital for fieldwork, relationships with communities, and the design of management strategies. Consultants are the main group responsible for drawing up SIAs, and their input is essential. Other critical factors, however, outside consultants' scope of responsibility, affect both the practice of consultants and the quality and comprehensiveness of the assessment. These include: gaps in essential aspects of the regulation, inadequate government implementation, and the lack of professional training in companies within this area. The characteristics of the site being investigated and the time that this takes place also play an important role in SIA preparation (**Table 11**). Thus, improvements in the design of government regulation and the practices of consultants and companies will improve the quality of SIA.

Table 11. The preparation of SIAs.

Topics	Major concerns
Consultants' practices	Consultants' low qualification and experience on social management Problems in the translation of consultants' outputs into the companies' decision-making process and management Lack of ethical or professional guidelines for fieldwork Limitation in official social information sources Budget restrictions for the design of SMPs
Regulatory design	Low social involvement in the drawing up of studies Limited scope in the definition of social impacts Lack of methodological specification by project and technology type
Companies' practices	Some companies lack specific personnel or management able to integrate SIA outputs into project design and management
Government implementation	Lack of official guide on SIAs has generated legal uncertainty about methodologies and definitions
Local factors	Characteristics of the place and time span of the project can add complexity to conducting SIAs

Source: Author.

The lack of experience in SIA, referred to above, influences the way an assessment is conducted as well as relationships with the community, which undermines SIA quality and causes negative perceptions about the project. Consultants indicated that the introduction of SIAs has created a business opportunity for legal and environmental consultants, and some firms provide this service without making the internal adaptations required to carry out a proper assessment—for instance, failing to hire personnel with experience in social research, to organize the assessment with regard to the specificities of each case, and to internalize the ethical codes required for implementing research with human subjects (e.g., research approaches that fits the socio-cultural characteristics of communities; informed consent and protection of personal information).

The relationship between the company and consultants forms the basis for the framing of the SIA. According to the consultants, the reliability of the output is dependent on the degree of autonomy the company gives the consultants. Consultants argued that some companies expect a specific result or fast-track preparation, which compromises the capacity of consultants to deliver an ethical and professional assessment. Usually, companies have no specific department or manager to monitor the preparation of the assessment. This adversely affects consultants' access to project information and their capacity to communicate their findings to the company.

Economic and time-based considerations influence the conduction of SIAs. Consultants argued that some projects have a tight budget or a rigid schedule for SIA preparation, which limits the quality of the fieldwork. For instance, in some projects, consultants only have enough budget to spend a few days in a community, and thus need to base their assessment mainly on official statistical information or previous social research. In other cases, they have a few months to deliver the final product, but traditional or isolated communities need a more extended interaction with consultants before they are willing to participate in the fieldwork. Consultants

highlight the fact that, unlike in legal or environmental assessments, the quality of an SIA depends on the willingness and trust of local actors to participate in its preparation, which in some cases requires flexibility in the fieldwork.

The design of management strategies is fundamental for the effectiveness of SIAs in addressing social impacts, with the most critical phase being the translation of this information into the management strategy. Consultants indicated that companies usually have a budget for social management established before the preparation of SIA. However, according to consultants, an assessment can identify more significant social impacts or shared social benefits for the community that exceeds a company's budget. Consequently, the design of the management strategies depends on the company's willingness to increase its social investment, where necessary.

The SIA regulation does not define critical aspects for community participation. According to NGOs and some consultants, although the regulation indicates that SIAs must be based on participatory methodologies, it defines neither what these methodologies are, nor the conditions for their implementation. The implementation of these methodologies is oriented toward gathering social information rather than delivering a substantive influence on the assessment. This was a particularly significant issue for local groups, which pointed out not only the lack of substantive social participation but the problems that this generates for companies. For instance, a solar project was built on an area with periodic flooding in the rainy season, which could have been prevented by incorporating local knowledge. The local inhabitants indicated their limited involvement in the preparation of the SIA (through a survey that covered social aspects) and even their lack of participation in formulating it. Moreover, local groups, NGOs, and government officials indicate that although the regulation establishes that projects need to generate shared social benefits, it does not define what constitutes "social benefits" are as opposed to "positive impacts" or "compensatory measures," or even how such benefits might be estimated or conceived.

The regulation provides a narrow definition of social impacts, which constrains the scope of the SIA. NGOs and experts argue that assessments do not include the social effects generated by projects during their planning phase; for example, projects can cause land speculation, thus reducing access to land for local people. According to NGOs and local groups, the regulation does not cover cumulative or synergistic impacts, which are particularly relevant in areas with extensive project development. They also point out that the regulation does not consider subjective social impacts, which are especially important for indigenous and rural communities with different values and relationships with local landscapes. Government officials and consultants indicate that the regulation does not provide specificity for the assessment of different scales and technologies, which in their experience are fundamental factors in shaping the magnitude and type of social impacts.

Some companies have not yet internalized social management, and this influences the preparation of SIAs. NGOs and consultants argue that some RE companies still do not see their projects as having any negative social impacts because the said projects are contributing to climate change mitigation and job creation. Consultants and private stakeholders indicate that this belief is related to the lack of attention some companies give, not only to SIA preparation and incorporating the necessary information into their SIAs, but also to providing personnel and procedures to follow up on results. There is a widespread perception among consultants, companies, and NGOs that companies require specific departments and personnel to facilitate and follow up on the making and implementation of SIAs, even if these studies are carried out by external consultants.

A delay in the publication of the official administrative guidelines has affected the practice of SIA and contributed to the social controversy around this policy tool. After the approval of the SIA regulation, DGISOS provided a provisional guideline for the preparation of the assessment; however, the publication of the permanent guidelines took over three years. Government officials argue that this was due to the sector's lack of experience and knowledge and also to the diversity of projects and interests affected. Consultants and local groups, however, consider that the delay gave rise to different interpretations among consultants, companies, and civil society, about the scope and function of an SIA, which inhibited professionalization in the area and generated social controversy.

The characteristics of the social context frame the drawing up of an SIA. Experts and consultants indicate that social factors can, in some cases, determine how exhaustive an assessment is. For instance, the fieldwork can be compromised by previous conflicts, a high level of violence, or the lack of interest in interacting with foreigners. Consultants and NGOs also hold that some events such as electoral processes, socio-cultural festivities, or environmental disasters can temporarily change the social dynamic, limiting, or even preventing, the preparation of the assessment. Consultants pointed out that these contextual factors are in themselves an indicator of the project's social risk, yet some companies persist in developing them rather than evaluating if the place or the time are appropriate for the project.

Evaluation of SIAs

According to stakeholders, including government representatives, several factors pertaining to institutional and regulatory design and government implementation affect the evaluation of SIAs. The objectives of the SENER are in conflict with the evaluation of SIAs, and institutional capacity is too low to follow up on the local

processes. The regulation regarding evaluation procedures is too generic, does not include a mechanism for social involvement, and leaves enforcement capacity to the DGISOS whose human resources are too small to conduct the evaluation: DGISOS is thus limited in the number of SIAs it can process and evaluate for quality, among other substantive aspects (**Table 12**). These design and practice issues are detrimental to the quality, reliability, and social legitimacy of SIA evaluations.

Table 12. Evaluation of SIAs.

Topics	Major concerns
Institutional implementation	Low institutional budget and human resources
Institutional design	Conflicting institutional objectives Lack of institutional capacity to follow up SIA at the local level Low formal linkage with other project assessments
Regulatory design	Institutional overload caused by the lack of regulatory specificity Lack of legal commitments by companies to incorporate evaluation's recommendations into SIA Lack of social involvement mechanisms

Source: Author.

According to NGOs, the SIA area is not a priority for SENER, which has shown little inclination to build the institutional capacities necessary to administer them. Governmental actors also pointed out that SENER has assigned only four personnel to DGISOS, which currently functions with eight personnel through temporary collaborative schemes with other governmental areas and NGOs. DGISOS is responsible not only for the management of SIAs but also other relevant policy tools, such as the Indigenous Consultations. The stakeholders mentioned believe that under such conditions, DGISOS cannot evaluate the more than 3,000 SIAs it receives annually. Moreover, governmental actors and NGOs argued that this issue also affects its capacity for conducting other strategic activities, such as using the knowledge and experience accumulated in the area to improve the evaluation procedures.

SENER has certain characteristics that make it ill-suited to implementing SIA evaluations. According to government officials and consultants, SENER has no regional offices, which restricts its capacity to incorporate the concerns of local actors into the evaluation process. The Ministry of Environment and Natural Resources (SEMARNAT), which administers EIAs, does have regional offices, which allows local perspectives to be incorporated into EIA evaluations. Moreover, one of SENER's central objectives is to promote investments in the RE sector, which for NGOs and other stakeholders is a conflict of interest for an institution that evaluates SIAs. There is thus a widespread perception among stakeholders that institutional design requires significant reform to increase trust and social involvement in this stage.

The regulation does not include mechanisms for social involvement and provides low specificity in the evaluation procedures, which affects the efficiency and

social legitimacy of this process. Government officials point out that the regulation sets up a general procedure for the preparation and evaluation of SIAs with application to a broad diversity of projects (e.g., medium- and large-scale) and technologies (e.g., hydraulic, geothermal, wind, solar). Based on their experiences, they argue that distinctive evaluation procedures by project type and technology could deliver a more comprehensive output and better management recommendations. Some local organizations, NGOs, and international organizations hold that the regulation does not contain channels for the participation of communities and civil society, whereas the evaluation of EIAs includes a social consultation procedure in which social actors can provide their opinions about the assessments. NGOs consider that this issue generates speculation and reduces the social trust of this stage. The local inhabitants also pointed out their lack of any kind of involvement at this stage or information about it.

The implementation of SMPs

According to stakeholders, particularly NGOs and local groups, gaps in the regulation and practices of companies pose constraints to the social management of projects. The absence of government monitoring and the low access of social actors to SIAs create an institutional and social environment with little supervision over the management of projects. Corporate Social Responsibility Policies (CSRPs) are not suitable for the socio-cultural characteristics of some regions. Moreover, the low professionalization of some companies in the area constrains the implementation of SMPs (**Table 13**). Although stakeholders identify projects and companies that implement proper social management, there is a widespread perception that SIAs are not obliged to provide systemic social management in the sector.

Table 13. The translation of SIA into project management

Topics	Major concerns
Company practice	Some companies do not incorporate the SMPs into project management Companies' social responsibility policies in the Mexican context Low impact shared social benefits in projects
Regulatory design	Lack of an institutional mechanism to monitor, evaluate, and sanction projects' social management
Institutional implementation	Low capacity to make the studies accessible to the public

Source: Author.

Social management has not been internalized by some companies, which limits the implementation of SMPs. Some RE companies currently have a specific Chief Executive Officer (CEO) who is responsible for the evaluation of the social risk of projects and the management of their social aspects; some also have local personnel trained to implement SMPs. However, stakeholders see that such measures are not universally applied. The majority of individuals interviewed—including some company representatives—considered the main problem to be the non-

implementation by companies of professional management strategies. Consultants and private stakeholders point out that some companies have not yet created the administrative departments and procedures to implement the SMPs; that there are still CEOs in the sector who believe social management to be a trend or that companies do not share responsibility for activities associated with the social agenda, thereby delaying the professionalization of some companies in this area.

CSRPs need to be adapted to Mexico's socio-cultural context. The majority of RE companies operating in Mexico are international, mainly from Spain, France, Italy, and the United States. According to private stakeholders and consultants, it is usual for international companies to adopt CSRPs that facilitate their social management, yet their CSRPs provoke criticism on the part of stakeholders. NGOs and experts argue that lower governmental supervision and social pressure over companies' activities create an incentive in the sector to reduce standards and investments in the project's social aspects. They also consider that CSRPs require substantive adaptation and innovations to suit them to Mexico's socio-cultural context. CSRPs designed for Europe and the USA are oriented to encouraging informed negotiation and fair compensation to landowners; NGOs and experts, however, argue that this approach is problematic in some Mexican regions. For instance, indigenous and rural communities can hold land in common and collaborate in natural resource management; they may have a deep attachment to local territories and different perceptions of well-being and development than Western societies do. In such a socio-cultural context, the current CSRPs are not only inefficient but also can generate negative socio-cultural impacts, such as the weakening of social ties or trigger conflicts inside communities.

The implementation of shared social benefits does not have a substantive impact on community well-being. Private actors pointed out that some RE companies are currently implementing innovative practices in this area, such as the provision of home solar panels to communities, scholarships, and gender workshops. However, all the NGOs interviewed argued against such practices in this area. For instance, the regulation does not define what the procedure is for estimating the amount of social investment required, the activities that can be included in this area, and the process for distributing and administering them. Some companies' "social" investment facilitates the projects' own operations and provides the infrastructure required by the project, such as the construction of roads that are used by the company. According to consultants, the main problem is that some companies have no personnel trained in social development to conduct these activities. Private stakeholders argue that, in some cases, local leaders negotiate investments for their own benefit or investments that have a low impact on communities' well-being (e.g., sponsoring sports teams or local festivities), and that they have a limited capacity to intervene in the local organizations or preferences. Local groups and inhabitants also indicated that there is a lack of transparency about who participates in the committees that administer and make decisions on the shared social benefits and that, in some cases, these

projects directly benefited local leaders or actors that support the development of projects. Overall, stakeholders perceive this as being one of the most problematic aspects of projects' social management and a significant cause of social opposition.

The regulation does not provide a mechanism for government supervision, and this reduces the accountability of corporate management. According to government officials, because of the lack of experience and knowledge in the area, the SIA regulation was designed to provide incentives and guide the sector's social management rather than to enforce sanctions for non-compliance. As a result, according to NGOs and consultants, DGISOS has no mechanism for monitoring and evaluating the implementation of SMPs; consequently, no-one is accountable for implementing measures to prevent adverse social impacts and manage shared social benefits. They compare, on the other hand, the government supervision of the Environmental Management Plans with their sanctions for non-compliance. Thus, the general perception is that the SIA regulation does not incentivize the implementation of the SMPs.

As public access to SIAs is inefficient, so too is the capacity of social actors to monitor companies' management of them. NGOs and international organizations point out that although, in practice, the regulation clearly puts SIAs in the public domain, SIA documents are not always accessible to communities or civil society, making it difficult for them to follow up on companies' commitments. Government officials argue that, unlike EIAs, SIAs contain personal and private data from local people and companies, which is legally protected under domestic law. Consequently, the DGISOS, with its limited personnel, needs to review the (usually) 300 pages plus of each SIA to encrypt personal information before the document can be published. Since 2018 DGISOS has required companies to issue a "public version" of the SIA, which according to government officials, will likely facilitate accessibility. However, this issue has limited the ability of social actors to hold SMPs to account and has undermined social trust in their implementation. For instance, local inhabitants expressed concern about their lack of access to reliable information regarding the link between the solar facility and a potential increase in the incidence of skin cancer and other potential health impacts, as well as potential environmental effects such as the rise in local temperatures.

4.4.3 The influence of the sector's governance

According to stakeholders, particularly NGOs and governmental officials, governance of the sector has deterred the SIA from internalizing the management of social impacts. The arrangement and capacities of SENER bring together both the implementation of SIA and the social effects of domestic RE policy. For instance, SENER has no social objective, no experience in the area, and no institutional

capacity at the local level, which has hindered both government implementation of SIA and its internalization by private actors. Moreover, RE policy has no perspective on the social effects of RE, establishing only some conditions for project planning and development that can undermine their social management (**Table 14**).

Table 14. The influence of sectoral governance on the performance of SIA

Topics	Major concerns
Energy policy	The lack of internationalization of social objectives
Institutional capacity	The reduction of government capacity to mediate relations between projects and communities
Limitations in knowledge and experience	Reduced information about the interplay between projects and communities in Mexico during the design of the SIA regulation
Electric Auctions	SIA design did not consider projects' social impacts and social management

Source: Author.

SENER and the national energy policy do not aim to manage the sector's social impacts, and this limits the internalization of this agenda by the RE industry. According to experts and NGOs, Mexican energy policy has historically been oriented toward reducing energy costs, generating investments, and providing enough and secure access to energy, all of which objectives have helped structure the institutional development of SENER. Thus, the organization, personnel skills, and decision-making procedures of this institution have evolved in order to achieve these goals, while the introduction of SIA is more recent (2014) and is not one of its legal mandates. Government officials believe that the low centrality of social aspects in SENER is related to the paucity of political and budgetary attention given to the DGISOS to develop the necessary capacities to administer SIAs. Even government officials argue that the main institutional decision-makers prioritize the development of the RE industry and the achievement of energy transition targets over the social management of the sector. Experts, and particularly NGOs, argue that the orientation of SENER causes private actors to believe that social management is secondary, or even negotiable, which is why some companies have shown little interest in the social agenda.

The energy institutions have a reduced structural capacity at the local level. According to NGOs and local groups, with the introduction of neoliberal policies in the 1990s, the role of the government in the energy sector has shifted from direct intervention through the state-owned companies to regulating the activities of private companies. This topic gives rise to different positive and negative opinions about the government's overall effects on the sector, the political and ideological ramifications of which exceed the scope of this analysis. However, stakeholders, particularly NGOs, experts, and some government officials, agree that the government currently has less presence in, and control of, the process at the local level, especially in isolated regions where the majority of projects are developed. According to NGOs and some government officials, this situation poses a structural

constraint to SENER in terms of following up the development of projects and mediating disagreements between companies and communities, and that this is a direct result of the limited government supervision in implementing SMPs.

At first, the sector did not have any experience or knowledge of social management, and this has affected the design of SIA and its implementation by governmental and private actors. Government officials point out that the lack of experience in SIA in Mexico was a significant obstacle when it came to designing the SIA regulation. Policymakers involved in this task did not have enough information to predict the functioning of SIA in the sociotechnical context of the energy sector (e.g., the different types of projects, technologies, and business models). Moreover, they had no insights into what kind of implementation procedure would be suitable, given the country's broad regional social diversity (e.g., different land tenure regimes, cultures, and social organizations). Policymakers thus designed the SIA to have low specificity, expecting that such a policy tool could evolve over the course of implementation. According to government officials, NGOs, and experts, these regulatory deficiencies, the low specificity of methodologies, the delay in the publication of the official administrative guidelines, and the limited experience of consultants all contributed to the current state of affairs.

The electric auctions do not take into account the social effects of projects, and there are several factors in the planning and development of the auctions that limit the scope of SIA. International organizations, NGOs, local groups, and consultants consider electric auctions to exemplify the gap between the sector's orientation and its social impact management. Electric auctions are the primary mechanism for promoting RE projects and focus on boosting the competitiveness of the sector and investment in it. In the auctions, the government establishes targets for electric power generation and potential, and companies compete to cover these targets based on the cost and technical viability of projects. However, the criteria of technical viability do not include a project's social feasibility or its potential social effects.

According to stakeholders, electric auctions are associated with diverse social management issues. For instance, companies and consultants argue that competition for lower prices reduces the margin that projects have to negotiate shared social benefits. According to NGOs and experts, this mechanism has incentivized the design of larger-scale projects in locations where land prices are lower, raising the potential magnitude of social impacts and setting the scene for community vulnerability. According to international organizations and governmental officials, companies compete in auctions without evaluating the social viability of projects, and during project implementation, the social opposition to projects causes delays and increases costs. Thus, the design of electric auctions delivers a context for the development of RE projects with SIAs that are limited in terms of addressing their social impacts.

4.5 Discussion

Our findings suggest that compared to the previous situation in which there was a lack of a social management policy in the RE sector in Mexico, the introduction of the SIA has influenced some favorable changes in the area (e.g., formation of institutional channels in the area, growing awareness about the relevance of social management, and the integration of the social agenda by some companies). However, there are diverse aspects of the design and practice of SIA that constrain its effectiveness. Similar to previous studies that address regulatory aspects (Grunstein-Dickter, 2016; Rousseau, 2017), our results show that the comprehensiveness and quality of SIAs are constrained by gaps in the regulation in critical areas such as the definition of social impacts, social involvement, and Shared Social Benefits, as well as the low professionalization of consultants and companies who conduct SIAs. In addition, this study identifies that the practice of the actors has a crucial role in the performance. For example, both the reliability and social legitimacy of SIA evaluations are limited by the low specificity of evaluation procedures, the lack of social involvement, and the limited institutional capacity for SIA implementation. The level of implementation of social management strategies is reduced by the low professionalization of companies in the area and scant government and social supervision over company management.

Similar to Zárata-Toledo et al. (2019), our results show that the current performance of the SIA in Mexico is insufficient to address the substantive demands of local groups and communities. The improvement of the implementation of SIA requires to strengthen the capacities and procedures of SENER, companies, and consultants (Ahmandvand et al., 2009; Değirmenci and Evcimen, 2013; Hanna et al. 2014). However, this normative dimension is insufficient to substantively address community concerns about social impacts and provide legitimacy to social management strategies. The regulatory and institutional design of SIA requires significant reform in order to expand the scope of the assessment, incorporate the perspective and knowledge of the communities and civil society in its preparation and evaluation, and provide mechanisms for government monitoring and social supervision over company management.

The lack of inclusion of social aspects in the sociotechnical arrangement of the sector frames and exerts a strong influence on the performance of the SIA (**Table 15**) (Stirling, 2008; Miller et al., 2013; Ottinger, 2013; Miller et al., 2015; Martinez, 2020). The scant knowledge and experience of the sector with respect to social management limited the design of the regulation, methodologies, and administrative procedures underlying the implementation of SENER and consultants. The low relevance of social aspects in SENER prevented the development of its own capacities to administer SIAs and created an institutional environment in which companies consider social management as a secondary issue. Moreover, the electric auctions, the central policy for promoting RE projects, fail to evaluate the social viability of

projects, generating a number of adverse effects in terms of social management within projects. On the one hand, projects are planned and contracted into scales, prices, and development timelines that not only increase the social complexity of projects but also reduce the time and resources the company has available for managing related social issues. On the other hand, SIAs are implemented before the main characteristics of the projects have been defined; this restricts the consideration of social aspects in the planning and design phases (e.g., changing the scale, the infrastructure allocation, or evaluating alternative locations). Therefore, the lack of internalization of the project's social dimension in the energy sector is causing related issues in both the implementation of SIA and the development of projects that frame the sector's social management.

Table 15. Links between the sector's sociotechnical arrangement and the effectiveness of SIA.

Issues in the sector's governance	Influence in the design and practice of SIAs
The energy policy does not provide a strong mandate to SENER to address social aspects	SENER's low political and budgetary attention to building the institutional capacities for the administration of SIA Low institutional pressure on companies to internalize social management
SENER's low presence and capacity at the local level	Lack of institutional capacity to incorporate local actors' concerns in the evaluation of SIA Lack of institutional capacity to monitor the implementation of SMPs
Limitations in the knowledge and experience regarding SIA design and implementation Lack of consideration of projects' social viability in Electric Auctions	Inadequate adaptation of SIA regulation to the sector's technical characteristics and Mexico's socio-cultural context The narrow scope of social impacts included in the SIA regulation Insufficient definition of projects' Shared Social Benefits Delay in the publication of the official administrative guidelines for SIAs Low qualification of some consultants Projects are designed and planned without considering their social impacts Time and budgetary restrictions for designing and conducting projects' social management Incentives for the development of projects at larger scales and in socially vulnerable regions

Source: Author.

4.6 Conclusion and policy implications

Before SIA, the RE sector in Mexico had no social impact management; its introduction has thus caused some positive changes in the area, such as the formation of institutional channels for the social agenda, growing awareness about its relevance, and the internalization of social management practices by some companies. However, the SIA policy tool has limited effectiveness in terms of

systematically ensuring that the projects which approved the assessment are socially viable and will conduct comprehensive management of social impacts.

Several factors related to design and practice negatively affect the performance of SIAs. The comprehensiveness and quality of the assessments are restricted by gaps in the regulation and by the low professionalization of consultants and companies. The reliability and social legitimacy of the government evaluation of SIAs are limited by unspecific evaluation procedures, insufficient institutional capacities, and a lack of social involvement. The companies' implementation of SMPs is constrained by the companies' management and the low governmental and social supervision of their activities. Under current design and practice, the SIA policy tool cannot guarantee a proper assessment of projects' social impacts and implementation of adequate management strategies. This situation not only affects the well-being of communities but is also a reputational and economic risk for companies, as well as a political threat for the national energy transition policy.

The regulatory framework of SIAs need a significant review. The conceptualization and definition of social impacts requires further elaboration to include the local effects that projects can generate before their approval and construction, cumulative and synergistic impacts, and the subjective evaluation, particularly in indigenous and traditional communities. The regulation must establish a definition of the shared social benefits, as well as guidelines for their estimation, transmission, and evaluation. It is also necessary to establish monitoring and transparency mechanisms of SMPs, which should consider their socio-cultural suitability. A particularly important area is the formulation of mechanisms and procedures for the substantive involvement of communities in the preparation, evaluation, implementation, and monitoring stages.

The practices of actors also require substantive changes. Companies require the formulation of specific procedures and specialized personnel for following the preparation of SIAs, transmitting their outputs to the decision-making processes and project planning, and implementing the SMPs and manage social relations at the local level. It is also needed a more defined professional profile of the consultants, and the adoption in this emerging guild of ethical procedures for the conduction of research with communities. The role of the government is particularly critical due to the public nature of its actions and decisions. One urgent measure is the strengthening of the institutional capacities for evaluating the quality of SIAs and SMSs and monitoring the local interaction between projects and communities.

The sector's sociotechnical arrangement exercises a strong influence over the performance of SIA, the social impacts of projects, and the scope of SIA to address these impacts. The scant knowledge and experience of social aspects in the sector are related to the issues arising from the regulatory design and the practices of actors. The low relevance of social aspects in domestic energy policy has prevented the

development of administrative capacities for SIA and generated an institutional environment in which companies consider social management to be a secondary issue. Moreover, the electric auctions, the primary policy mechanisms for promoting RE projects, provide incentives for planning projects in terms of scales, prices, and development timelines that reduce the capacity of companies to manage social aspects and increase the difficulty of this task. Within the framework of this policy, projects are designed without consideration of their social implications, which structurally limits the potential of the SIAs for delivering information that allows social impacts to be addressed once the project's design and planning process has begun.

Although there are several areas of opportunity for improving the design and practice of SIA, in the current sector's sociotechnical arrangement, the effectiveness of the SIA is intrinsically constrained to being a "problem-fixing" device. Internalizing the social implications of RE projects requires significant changes to be made in the design of energy transition policies, project design, and planning procedures, and the sector's business models. Finally, this study has implications for future research on SIA and social opposition to RE projects. First, the effectiveness of SIA is dependent on the sociotechnical arrangement of Mexico's RE sector; consequently, the analysis of other sectors' characteristics, such as hydrocarbons, mining, or tourism, could provide critical insights into the performance of SIA in these issue areas. Second, policy tools like SIA can contribute to addressing some of the causes underlying the social opposition to RE. However, more critical scrutiny of, and innovation in, energy transition policies, projects, and business models are required.

Chapter 5

Conclusion

This dissertation aimed to analyze crucial arenas in the construction of Mexico's controversy over the sociocultural impact of renewables, specifically: *i*) its epistemological development, *ii*) the formation of the policy aimed to address this issue, and *iii*) the subsequent implementation of these policy tools. By tracing and deconstructing these arenas, my collective findings show that the practices of knowing, governing, managing, and contesting renewable energy projects have been intimately intertwined: From international climate negotiations to Mexico's adoption of energy transition (ET) policies and the emergence of local opposition groups to the formation of policy tools for addressing social impacts, to the current uncertainty facing Mexico's climate policy. The interplay among research production, political agendas, and regulatory rules have influenced each other at the international, national, and local domains, co-producing Mexico's particular energy transition pathway, regional geographies of energy development, social movements, actors' practices, and societal views.

Therefore, I argue that the design of ET policy has played a crucial role in defining the characteristics that shaped renewable energy projects in Mexico. In turn, the contours of the controversy over the sociocultural impacts have been shaped by the interaction of these projects with the particular vision of the territory held by the indigenous Huave and Zapotec communities and their social organization and collective natural resources management. Among the diverse possibilities for addressing this controversy, the government response led to the design of policy tools that have limited the scope for altering the interplay between projects' socio-technical arrangements and local communities, preventing closure of the controversy. This issue has generated a context in which the current Mexican government can, ironically, perform a discourse to legitimize, to some extent, the advance of electric power and oil state-owned companies over renewable energies and climate mitigation goals. This undermines Mexico's energy transition.

5.1 The energy epistemics of social opposition

Researchers have addressed the nature of social opposition and its relationship with projects through different interpretative frameworks (e.g., positivist, pluralist, constructivist, and structuralist). These frameworks have influenced critical aspects of this research, such as defining the object of study (e.g., social externalities, social effects, social meanings, and social struggles), identifying the variables and factors of

analysis, selecting methodologies and even following the interplay with some geographies and social groups. These research practices integrate facts and evidence about some dimensions that make up this social phenomenon, which are interpreted and organized by researchers according to their interpretative frameworks for the making of academic knowledge. The resulting epistemics embed and reproduce to some extent the visions of the researchers and the social groups involved in their production, delivering widely different interpretations of the causes of social opposition and their possible solutions. Such solutions range from downstream policy fixes of projects externalities to upstream involvement of communities in projects' decisions and benefits.

I identified that these research practices do the following: **1)** address a politically disputed area with relevant effects for different actors and social groups; **2)** require the incorporation of information about, or the direct interaction with, social groups; **3)** occur in political contexts and locations with broad social inequities; **4)** portray and represent these groups, their perspectives, and interests through their results. Moreover, these research practices have provided insights into the sociopolitical arena, such as the activism of opposition groups and NGOs, the formation of social management policies, and private practices in the area.

My research findings suggest that when an issue-area of the social domain is the matter of political controversy, social research can provide relevant information for actors and social groups for their political definitions on the issue. Moreover, this authoritative role of research can acquire a particular social valence in some geographies and political contexts where sociopolitical actors face constraints in covering their epistemic needs, and there are disparities among these actors in influencing and gaining access to research production. Therefore, I argue that social research plays a central role in some components of ETs, and when these areas concern an unequal dispute between different interests and visions, then the production of knowledge, its outcomes, and its use can have vast energy justice implications.

Future research is needed about the valence of social research in different geographies and its political interplay, for instance, about the role of international organizations in the funding and production of studies in the Global South and its effects on the diffusion of policies related to diverse factors of ETs. Sociopolitical actors, particularly institutions that act and make decisions of a public nature. Thus, It is required further research about the institutional practices for acquiring knowledge inputs and implications in the conduction of their activities.

5.2 The social and material making of ET and its policy tools for social impacts

My findings suggest that the international political context prior to the UNFCCC COP 15 and Mexico's position in the climate arena led to governmental incentives to seek a rapid advance in its domestic energy transition. Existing technical and political limitations to the development of renewable energies in Mexico framed the design of the Law for the Use of Renewable Energies and Financing the Energy Transition (LAERFTE -2008). The solutions that this Law established to promote the investment and cost-effectiveness of renewables, and their intermittency and access to transmission infrastructure, influenced the characteristics that renewable energy projects took in Mexico – namely, private large-scale wind farms for the consumption of large corporations - and the geographic concentration of 21 projects in Tehuantepec. These socio-technical features drove the local effects of projects which in interaction with the vision held by indigenous Huave and Zapotec communities that inhabit Tehuantepec, generated a local opposition discourse grounded on sociocultural claims. The absence of a regulatory and institutional framework to address sociocultural claims played an important role in the local implementation of civil resistance actions and the political visibility that the conflict reached by 2012.

My research findings also suggest that in the context of a controversial energy reform that would open the sector to private participation, the effects of the conflict in Tehuantepec on the regional governance and the companies' economic losses by 2013 created strong government incentives to develop a regulatory framework for addressing social impacts. In this design process, the Mexican government had different possibilities regarding the institutional arrangement, areas of intervention, scope, and regulatory form. It could have simply extended the existing environmental impact assessment system to social impacts, managed by environmental institutions with higher local capacity; or developed non-binding social management guidelines for energy companies. The lack of community involvement in this centralized process, companies' influence, institutional priorities, and the refusal of the political left to get involved in any aspect of energy reform shaped the policy tools' design trajectory and their specific functions and actors' involvement.

This process delivered in 2014 a Social Impact Assessment (SIA): *i*) restricted to the energy sector; *ii*) mandatory government approval before projects' construction; *iii*) in which consultation procedures are implemented only for indigenous communities; *iv*) that mandates projects to generate social benefits, but without defining them; and *v*) without government or social monitoring mechanisms of social management measures. Therefore, I argue that although climate mitigation and the social opposition of renewables have promoted destabilizing changes in the political regime of Mexico's energy sector, the existing socio-technical arrangement of this system has meant that entrenched industrial interests and values, as well as

bureaucratic decision-making norms, have persisted in the way that institutions process these agendas and in the design of policies and regulations.

This case study has shown that the technological governance artefact idea offers valuable analytical power in tracing how the design of LAERTE exerts power to organize a new renewable energy arena, and how feedback loops can change this artefact, leading to further developments in the renewables industry. The design path of both LAERTE and SIA were influenced by some features of Mexico's energy sector, such as infrastructures, regulatory and cognitive rules, institutions, and even political visions. Thus, further research is required to undertake how the values, practices, and interests shaped within fossil fuel-based energy systems are integrated (or not) into the construction of energy futures.

5.3 The performance of the social impact assessment

My findings suggest that compared to the previous situation in which there was a lack of a social management policy in the sector, the introduction of the SIA model in 2014 has produced some favorable changes in Mexico's energy transition (e.g., the formation of institutional channels, growing awareness about the relevance of social management, and integration of the social agenda by some companies). However, the SIA has limited effectiveness in terms of systematically ensuring that the projects are socially viable and will conduct comprehensive management of social impacts beyond their completion.

The regulatory framework of SIAs needs a significant review. The conceptualization and definition of social impacts require further elaboration to include the local effects that projects can generate before their approval and construction, cumulative and synergistic impacts, and the subjective evaluation, particularly in indigenous and traditional communities. The regulation must establish a definition of the shared social benefits and guidelines for their estimation, transmission, and evaluation. It is also necessary to establish monitoring and transparency mechanisms of Social Management Plans (SMPs), which should consider their sociocultural suitability. A particularly important area is the formulation of mechanisms and procedures for communities' substantive involvement in the preparation, evaluation, implementation, and monitoring stages.

The practices of actors also need substantive changes. Companies require the formulation of specific procedures and specialized personnel for following the preparation of SIAs, transmitting their outputs to the decision-making processes and project planning, and implementing the SMPs and manage social relations at the local level. It is also needed a more defined professional profile of the consultants, and the adoption in this emerging guild of ethical procedures for the conduction of research with communities. The role of the government is particularly critical due to the public nature of its actions and decisions. One urgent measure is strengthening

the institutional capacities for evaluating the quality of SIAs and SMSs and monitoring the local interaction between projects and communities.

My research suggests several areas for improving SIA's design and practice, yet the findings also reveal that broader aspects of the regulatory and political framework of renewables influence the limited performance of SIA's and social management practices. For instance, the Electricity Auctions were designed to promote companies' competition for medium and long-term contracts based mainly on lower generation costs, encouraging the planning of large-scale projects, their location in regions with lower land cost, and a financial model prioritizing investment returns in the long term. Thus, the Electricity Auctions frame the magnitude of projects' local effects, the vulnerability of the communities with which they interact, and the companies' lower financial margin to implement comprehensive measures to prevent, mitigate, and compensate local effects. Therefore, I conclude that without a substantial internalization of the social dimension in the priorities, policy, and planning of RE, the SIA will be limited to a problem-fixing role, constraining the effective management of social impacts.

This study reveals some implications for future research. First, SIA's effectiveness is framed by the socio-technical arrangement of Mexico's RE sector; consequently, the analysis of other sectors' characteristics, such as hydrocarbons, mining, or tourism, could provide critical insights into the performance of SIA in these areas. Second, policy tools like SIA can contribute to addressing some of the causes underlying the social opposition to RE. However, more critical scrutiny of, and innovation in, energy transition policies, projects, and business models are required.

5.4 Envisioning a fair energy transition in Mexico

My research took place during critical moments in the development of this controversy: from the boom of the renewable industry in 2015 to the current impasses that face Mexico's energy transition. The path this controversy has taken is problematic for both climate mitigation and local communities. However, my findings show that there were other possibilities for thinking about, designing, and governing a fair energy transition in Mexico.

The unfair and disproportionate impact that the development of renewable energies had on the communities that inhabit Tehuantepec was not inevitable. The design of the LAERFTE (2008) and the later Electricity Auctions (2016-2018) framed the magnitude of projects' local impacts and their location in regions that have a critical sociocultural meaning for local communities. This suggested that the management of social impacts and relations could be largely internalized through the legal framework and the sector's planning procedures. Along with mitigation and cost-effectiveness goals, the legal framework could also weigh the local communities' involvement and benefits. In addition to the potential of renewables, electric power

demands, and transmission capacity, the sector's planning could consider the territories' sociocultural complexity and potential local effects through bottom-up procedures.

The experience of Mareña Renovables, the largest wind farm in Latin America and one of the country's leading infrastructure investments, demonstrates that companies need substantial reform of their practices. Along with the financial and technical requirements, companies could first evaluate whether or not local communities agree to the building of projects, and then assess the characteristics that their initiatives can take in that social environment. Through the communities' substantive involvement in the planning, companies could design projects that consider local visions and values in the arrangement and characteristics of, for instance, locations, infrastructures' features, scales, and supply chains.

The function of SIAs, Indigenous Consultations, and Shared Social Benefits are not predetermined. Their performance can also have different possibilities about their nature, organization, and outcomes. Some of these alternatives may substantively include the experiences and knowledge of local communities and opposition groups' views. These policy tools' function and political results are framed by those who participate in their design, implementation, and use of their outcomes. Improving the regulatory framework, the professionalization of consultants and companies, and the institutional resources to administrate these policy tools are relevant in the short run. However, the capacity of the policy tools to address the social impacts and relations and causes of social opposition depends on the substantive involvement of communities.

Although the possibilities I have exposed until now could improve the social outcomes of governmental/private-based projects, other compelling sociopolitical views dispute the meaning and organization of the energy transition and even the arrangement of Mexico's energy future. Grounded on traditional sociocultural identities and ways of life, there is a political vision in Mexico that proposes alternative development of renewables organized around communities' ownership and use. The communitarian vision questions not only the social effects of renewables but also their governmental/private governance, the private ownership of renewable energies, and market orientation. The development of social and communitarian projects of renewables could reorganize the material and symbolic roles of the institutions, companies, and local communities, and deliver positive outcomes for reducing energy poverty and insecurity and improving energy autonomy and democracy. There are possibilities to materialize this social vision. Yet, achieving it calls for social innovation. For instance, the formation of public and social financial models for these projects, the design of special Electricity Auctions that favor private/communitarian partnerships in some regions, and the creation of social/private companies that undertake their development.

Growing out of Mexico's Revolution (1910-1918) and the nationalization of the oil industry (1938), the country has long had a dominant sociopolitical vision of energy nationalism with a deep cultural root (Meyer & Morales, 1990). Some of the political actors and social groups that hold this vision perceived a transition to renewables as a risk for the energy state-owned companies, the oil industry, and national sovereignty. But there are possibilities for translating this view into a coherent and compelling narrative that undertake ET. This aim requires political and ideological innovation. In the last decade, domestic hydrocarbons production has faced a substantial decline, resulting in, for example, the increasing dependency of the electric power supply on gas imports from the US.

In this context, the future of state-owned companies – which the Leftist president AMLO wants to preserve – could depend on their transition to non-hydrocarbon-based technologies. The private development of renewables, but based on and governed in Mexico, can generate gains for domestic energy security and sovereignty compared to the current external dependency. In a context where the country faces a reduction in energy production and increasing energy demand, state-owned companies and private actors can complement their expertise in regions, activities, energy technologies, and market segments. The absence of the Mexican Left's vision on ET implies losing the opportunity to organize these technologies and their social relations around public models and social goals.

The national development of energy was critical during the twentieth century to make energy socially accessible and boost Mexico's industrialization. However, its development also led to vast social injustice: from the local communities exposed to air pollution from coal and fuel oil power plants and their health implications to several catastrophic accidents around oil pipelines to the displacement of rural and indigenous communities caused by dam constructions (Castelán, 2002; Lopez et al., 2005). Although in a context of less public scrutiny, PEMEX and CFE also generated broad regional transformation. For instance, rural and indigenous communities have opposed over 20 years to “La Parota,” a CFE's project to develop a large-scale dam (Sabás-Vargas, 2012). Moreover, centralized decision-making processes and top-down planning practices are the institutional heritage of Mexico's historical energy development. Likewise, the philanthropic and paternalistic practices for social management are grounded in how PEMEX and CFE have historically addressed local social relations (Castelán, 2002; Grunstein-Dickter, 2016; Chiang & Mejía, 2008; Rousseau et al., 2020). Therefore, the ET could also be a strategic project for addressing these social and environmental liabilities while fairly and democratically covering our energy needs. But to assure that the energy transition is truly fair, we need strong, community-based input into both local projects and the national vision.

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Annex 1: Publications - Chapter 2

No.	Research approach	Year	Full Reference
1	Positivist	2005	Huacuz, J. M. (2005). The road to green power in Mexico—reflections on the prospects for the large-scale and sustainable implementation of renewable energy. <i>Energy Policy</i> , 33(16), 2087-2099.
2	Positivist	2009	Lokey, E. (2009). Barriers to clean development mechanism renewable energy projects in Mexico. <i>Renewable Energy</i> , 34(3), 504-508
3	Pluralist	2009	Henestroza, O. R. (2009). Centrales. Elementos: <i>Ciencia y cultura</i> , 16(74), 39-44
4	Pluralist	2009	Oceransky, S. (2009). Wind conflicts in the Isthmus of Tehuantepec: The role of ownership and decision-making models in indigenous resistance to wind projects in Southern Mexico. <i>the commoner</i> , 13(winter), 203-22.
5	Pluralist	2010	Ruiz-Mendoza, B. J., & Sheinbaum-Pardo, C. (2010). Mexican renewable electricity law. <i>Renewable Energy</i> , 35(3), 674-678.
6	Structuralist	2010	Oceransky, S. (2010). Fighting the enclosure of wind: Indigenous resistance to the privatization of the wind resource in Southern Mexico. <i>Sparking a worldwide energy revolution: Social struggles in the transition to a post-petrol world</i> , 505-22
7	Positivist	2011	
8	Structuralist	2011	Rueda, E. C. (2011). Eólicos e inversión privada: El caso de San Mateo del Mar, en el Istmo de Tehuantepec Oaxaca. <i>The Journal of Latin American and Caribbean Anthropology</i> , 16(2), 257-277
9	Positivist	2011	Pasqualetti, M. J. (2011). Opposing wind energy landscapes: a search for common cause. <i>Annals of the Association of American Geographers</i> , 101(4), 907-917.
10	Structuralist	2011	Maya121, I. J. (2011). El Megaproyecto Eólico en el Istmo de Tehuantepec, Oaxaca. <i>Energías Limpias, Empresas Sucias y Resistencia Social. PLANES GEOESTRATEGICOS, DESPLAZAMIENTOS Y MIGRACIONES FORZADAS EN EL ÁREA DEL</i>

			PROYECTO DE DESARROLLO E INTEGRACIÓN DE MESOAMÉRICA, 217.
11	Structuralist	2011	PODER, PRODESC, El lado sucio de la industria eólica: El desarrollo y los Derechos Humanos en el Istmo de Tehuantepec, Oaxaca, PODER/PRODESC, Mexico, 2011.
12	Constructivist	2012	Hoffmann, J. (2012). The social power of wind: the role of participation and social entrepreneurship in overcoming barriers for community wind farm development: lessons from the Ixtepec community wind farm project in Mexico. Master Thesis Series in Environmental Studies and Sustainability Science
13	Positivist	2012	Mayor, J. J. D., de la Rosa Leal, M. E., & Martel, M. C. V. El impacto social de las compañías de energía eólica españolas en las comunidades campesinas de Oaxaca y su reflejo en las memorias de sostenibilidad. In XVII Congreso Internacional de Contaduría, Administración e Informática. Facultad de Contaduría y Administración.
14	Positivist	2012	Hamister, L. (2012). Wind Development of Oaxaca, Mexico's Isthmus of Tehuantepec: Energy Efficient or Human Rights Deficient?. Mexican law review, 5(1), 151-179.
15	Positivist	2012	Pasqualetti, M. J. (2012). The misdirected opposition to wind power. In Learning from Wind Power (pp. 133-152). Palgrave Macmillan, London.
16	Positivist	2012	MICI, BID, Informe de Verificación de la Observancia Proyecto Eólico Marina Renovables, MICI/BID, Mexico, 2012.
17	Positivist	2013	Secretaria de Gobernación, La energía Eólica en México: Una perspectiva social sobre el valor de la tierra, SEGOB, México, 2013.
18	Constructivist	2013	Simon, S. (2013). Friction in a Warming World: The Challenges of Green Energy in Rural Oaxaca, Mexico. Peace, Conflict & Development, (20).
19	Pluralist	2014	Juárez-Hernández, S., & León, G. (2014). Energía eólica en el istmo de Tehuantepec: desarrollo, actores y oposición social. Problemas del desarrollo, 45(178), 139-162
20	Positivist	2014	Torres, J. M. C., Nolasco, J. A. G., & Cortez, N. H. (2014). Social responsibility, human rights and wind energy: Oaxaca and chiapas, México.

21	Structuralist	2014	Sellwood, S. A. (2014). Interrupting'green capital': Transformative political practice at the frontiers of wind energy in Mexico (Doctoral dissertation, The University of North Carolina at Chapel Hill)
22	Pluralist	2014	CCC (2014). Historias de aprendizaje sobre el desarrollo de la energía eólica en México, CCC, Mexico.
23	Constructivist	2014	Howe, C. (2014). Anthropocenic ecoauthority: the winds of Oaxaca. <i>Anthropological Quarterly</i> , 87(2), 381-404.
24	Positivist	2014	Gartman, Victoria (2014). Challenges: Implementation factors regarding wind energy development, an international perspective, <i>AIMS Energy</i> .
25	Pluralist	2014	Nahmad, S., Nahón, A., & Langlé, R. (2014). La visión de los actores sociales frente al los proyectos eólicos en el Istmo de Tehuantepec. Oaxaca, Oaxaca: Consejo Nacional para Ciencia y Tecnología.
26	Positivist	2015	Banco Interamericano de Desarrollo, Políticas Públicas para maximizar los beneficios locales de proyectos eólicos en México, BID, México, 2015.
27	Structuralist	2015	Hernandez-Cortez, N., Gonzalez-Nolasco, J. A., Cordero Torres, J.M., (2012), Wind Energy Policy, Conflicts, and Human Rights in Mexico, <i>The International Journal of Social Science</i> , 37(1), 39-59.
28	Constructivist	2015	Howe, C., & Boyer, D. (2015). Aeolian politics. <i>Distinktion: Scandinavian Journal of Social Theory</i> , 16(1), 31-48.
29	Structuralist	2015	López Gómez, A. L. (2016). Cambio climático y conflictos ecológicodistributivos en regiones indígenas de México. El caso de la industria eólica en el Istmo de Tehuantepec, Oaxaca.
30	Positivist	2015	Hurtado Sandoval, A. (2015). Wind Energy Development in Mexico-A case study of the potential for local socio-economic benefits in Mareña. IIIIEE Master thesis.
31	Structuralist	2015	DÍAZ CARNERO, E. (2015). Energía eólica y conflicto social en el Istmo de Tehuantepec, Oaxaca, México. In III Simposio Internacional de historia de la electrificación. En Sunyer, P., Ribera, E., Checa-Artasu y M., Moncada, JO (Eds.). <i>Actas del III Simposio Internacional Historia de la</i>

			electrificación. Barcelona: Universidad de Barcelona.
32	Constructivist	2015	Howe, C., Boyer, D., & Barrera, E. (2015). Los márgenes del Estado al viento: autonomía y desarrollo de energías renovables en el sur de México. <i>The Journal of Latin American and Caribbean Anthropology</i> , 20(2), 285-307.
33	Constructivist	2015	Howe, C. (2015). Latin America in the Anthropocene: energy transitions and climate change mitigations. <i>The Journal of Latin American and Caribbean Anthropology</i> , 20(2), 231-241
34	Positivist	2015	Mendoza, E. M., Tovar, L. A. R., Lambert, G. F., & Vera, P. S. (2015). Social Perception of Wind Energy in the Isthmus of Tehuantepec. <i>Journal of Sustainable Development</i> , 8(9).
35	Positivist	2015	Casanova, W. M. S. La construcción social del riesgo ante la inserción de tecnología eólica en Ixtepec, Oaxaca.
36	Pluralist	2015	S. Nahmad, A. Nahón, R., Langlé, La visión de los actores sociales frente al los proyectos eólicos en el Istmo de Tehuantepec, CONACYT, México, 2014.
37	Pluralist	2016	Huesca-Pérez, M. E., Sheinbaum-Pardo, C., & Köppel, J. (2016). Social implications of siting wind energy in a disadvantaged region—The case of the Isthmus of Tehuantepec, Mexico. <i>Renewable and Sustainable Energy Reviews</i> , 58, 952-965
38	Constructivist	2016	Zárate Toledo, E., & Fraga, J. (2016). La política eólica mexicana: Controversias sociales y ambientales debido a su implantación territorial. <i>Estudios de caso en Oaxaca y Yucatán. Trace (México, DF)</i> , (69), 65-95.
39	Pluralist	2016	Friede, S. (2016). Enticed by the Wind. A Case Study in the Social and Historical Context of Wind Energy Development in Southern Mexico. Wilson Center.
40	Structuralist	2016	Dunlap, A., “The town is surrunted”: From Climate Concerns to Life under Wind Turbines in La Ventosa, Mexico, Colloquium Paper No. 4, 4-5, February, 2016, Global governance/politics, climate justice & agrarian/social justice: linkages and challenges, International Institute of Social Studies, The Netherlands.
41	Structuralist	2016	Cortez, N. H. (2016). Energía eólica, identidades políticas y discurso: los casos de Unión Hidalgo y

			Juchitán de Zaragoza en Oaxaca, México. <i>Fronteras</i> , 3(1), 9-33.
42	Positivist	2016	Grunstein Dickter, M. (2016). Contra el viento: regulación, crisis social y cambio institucional en el Corredor Eólico del Istmo. <i>Economía, sociedad y territorio</i> , 16(51), 485-517.
43	Constructivist	2016	Manderson, L. (2016). Ethnography at its edges: Forces in the wind. <i>American Ethnologist</i> , 43(4), 752-754.
44	Structuralist	2016	Gay-Antaki, M. (2016). " Now we have equality": a feminist political ecology analysis of carbon markets in Oaxaca, Mexico. <i>Journal of Latin American Geography</i> , 15(3), 49-66.
45	Structuralist	2016	Howe, C., & Boyer, D. (2016). Aeolian extractivism and community wind in Southern Mexico. <i>Public Culture</i> , 28(2 (79)), 215-235.
46	Structuralist	2016	López, C. F. L. (2012). La lucha indígena por la dignidad humana. Conflictos socioambientales y derechos humanos en el movimiento indígena del Istmo de Tehuantepec.
47	Positivist	2016	Hernández, L. S. G. (2016). ENERGÍA EÓLICA Y DESARROLLO SOSTENIBLE EN LA REGIÓN DE LA RUMOROSA, MUNICIPIO DE TECATE Un análisis multicriterio
48	Structuralist	2016	FUNDAR, Defensa del territorio frente a proyectos del sector eléctrico en México, FUNDAR, México, 2016.
49	Positivist	2017	USAID, Plan de Acción para la Implementación Efectiva de Proyectos de Energía Renovable y los Aspectos Sociales Vinculados, USAID, México, 2017.
50	Structuralist	2017	Amador, R. E. C. (2017). Resistance by Indigenous Peoples to the Wind Park on the Isthmus of Tehuantepec in Oaxaca. In <i>Mexico and the Post-2015 Development Agenda</i> (pp. 241-263). Palgrave Macmillan, New York.
51	Positivist	2017	Pérez-Denicia, E., Fernández-Luqueño, F., Vilariño-Ayala, D., Montaña-Zetina, L. M., & Maldonado-López, L. A. (2017). Renewable energy sources for electricity generation in Mexico: A review. <i>Renewable and Sustainable Energy Reviews</i> , 78, 597-613.
52	Positivist	2017	Jano-Ito, M. A., & Crawford-Brown, D. (2017). Investment decisions considering economic,

			environmental and social factors: An actors' perspective for the electricity sector of Mexico. <i>Energy</i> , 121, 92-106
53	Structuralist	2017	González, M. M., & Suárez, Á. G. (2017). Vientos del capitalismo verde: globalización, desarrollo y transición energética en el Istmo de Tehuantepec (Oaxaca, México). <i>Ciência & Trópico</i> , 41(1).
54	Pluralist	2017	Rousseau, I. (2017). La nueva regulación de la gestión social de los proyectos energéticos en México. Seguridad, sustentabilidad y gobernabilidad. <i>Revista mexicana de ciencias políticas y sociales</i> , 62(230), 197-219.
55	Structuralist	2017	Dunlap, A. (2018). Counterinsurgency for wind energy: the Bii Hioxo wind park in Juchitán, Mexico. <i>The journal of peasant studies</i> , 45(3), 630-652.
56	Structuralist	2017	Avila-Calero, S. (2017). Contesting energy transitions: wind power and conflicts in the Isthmus of Tehuantepec. <i>Journal of Political Ecology</i> , 24(1), 992-1012
57	Positivist	2017	Business & Human Rights Resource Centre, Investors Briefing: Renewable Energy Impacts on Communities: Managing Investors' Risks and Responsibilities, BHRC, UK, 2017
58	Pluralist	2017	Sovacool, B. K., Burke, M., Baker, L., Kotikalapudi, C. K., & Wlokas, H. (2017). New frontiers and conceptual frameworks for energy justice. <i>Energy Policy</i> , 105, 677-691.
59	Structuralist	2017	Altamirano-Jiménez, I. (2017). "The sea is our bread": Interrupting green neoliberalism in Mexico. <i>Marine Policy</i> , 80, 28-34.
60	Structuralist	2017	Avila, S. (2018). Environmental justice and the expanding geography of wind power conflicts. <i>Sustainability Science</i> , 13(3), 599-616.
61	Structuralist	2017	Cortez, N. H., & Castillo, A. M. J. (2017). Energía eólica, discurso y movimientos sociales indígenas: el caso de la APPJ en Oaxaca, México. <i>Revista del Centro de Investigación. Universidad La Salle</i> , 14(48), 31-63.
62	Structuralist	2018	Dunlap, A. (2018). "A bureaucratic trap:" Free, prior and informed consent (FPIC) and wind energy development in Juchitán, Mexico. <i>Capitalism Nature Socialism</i> , 29(4), 88-108.

63	Structuralist	2018	Lehmann, R. (2018). The conflict surrounding wind energy projects in the Mexican Isthmus of Tehuantepec. Renewable energies and politics of scale. Bioeconomy & Inequalities Working Paper No. 3.
64	Positivist	2018	AMDEE (2018). Buenas Practicas. AMDEE: Mexico.
65	Positivist	2018	Kim, E. (2018). Wind Energy Development in Mexico: At what Cost? Investigating Social Acceptance of Wind Farms in Oaxaca and Yucatán, Mexico (Doctoral dissertation, Harvard University).
66	Structuralist	2018	Sellwood, S. A., & Valdivia, G. (2018). Interrupting Green Capital on the Frontiers of Wind Power in Southern Mexico. <i>Latin American Perspectives</i> , 45(5), 204-221.
67	Structuralist	2018	Contreras, Gerardo A. Torres. "Two Decades Under Windmills in La Venta, Mexico."
68	Pluralist	2018	SENER, BID, Protocolo de Actuación sobre Beneficios Sociales Compartidos de Proyectos Energéticos, SENER/BID, México, 2018
69	Positivist	2018	Callejas Hernández, M. N. (2018). Evaluación de disposiciones administrativas sobre los estudios de impacto social en proyectos eólicos. El caso de Santo Domingo Ingenio, Oaxaca.
70	Positivist	2018	Torres, J. M. C. (2018). La responsabilidad social, eoloeléctricas y administraciones públicas: los casos de Eléctrica en el Valle de México y el Ayuntamiento de Asunción Ixtaltepec, Oaxaca. <i>Ciencia y Sociedad</i> , 43(4), 37-49.
71	Structuralist	2018	Feria, Y. G. (2018). Wind Power and Environmental Justice: The Case of Istmo de Tehuantepec. In <i>Green Crime in Mexico</i> (pp. 87-102). Palgrave Macmillan, Cham.
72	Constructivist	2018	Lucio, C. (2018). Winds of Resistance in the Isthmus of Tehuantepec. In <i>Social Environmental Conflicts in Mexico</i> (pp. 81-107). Palgrave Macmillan, Cham
73	Structuralist	2018	Suárez, Á. G., & González, M. M. (2018). Vientos de resistencia: Movimientos indígenas y parques eólicos en el istmo de Tehuantepec (Oaxaca, México). <i>Sociedad y Discurso</i> , (32), 103-126
74	Positivist	2018	Cortés González, A. (2018). Licencia social para operar en la industria eólica mexicana.

75	Pluralist	2018	Zaremberg, G., Wong Torres, M., & Guarneros-Meza, V. (2018). Descrifrando el desorden: instituciones participativas y conflictos en torno a megaproyectos en Méxic
76	Structuralist	2018	Dunlap, A. (2018). Insurrection for land, sea and dignity: resistance and autonomy against wind energy in Álvaro Obregón, Mexico. <i>Journal of Political Ecology</i> , 25(1), 120-143
77	Pluralist	2018	Huesca-Pérez, M. E., Sheinbaum-Pardo, C., & Köppel, J. (2018). From global to local: impact assessment and social implications related to wind energy projects in Oaxaca, Mexico. <i>Impact Assessment and Project Appraisal</i> , 36(6), 479-493.
78	Positivist	2018	Déniz Mayor, J. J., Verona Martel, M. C., & De la Rosa Leal, M. E. (2019). Materialidad de los impactos sociales en la memoria de sostenibilidad. El caso del sector eólico y los pueblos indígenas en Oaxaca, México. <i>Spanish Journal of Finance and Accounting/Revista Española de Financiación y Contabilidad</i> , 48(4), 492-524.
79	Positivist	2017	Rand, J., & Hoen, B. (2017). Thirty years of North American wind energy acceptance research: What have we learned?. <i>Energy research & social science</i> , 29, 135-148

Annex 2: Interview results-

Chapter 4

The effects of SIA on sector governance				
Topics	No. Comments	Main concerned stakeholders	Main changes	Main limitation
Sector governance	28	Governmental actors (36%), private sector (32%), and NGOs (18%)	Less severe social conflicts Stakeholders learning how to use SIA's outputs Stakeholders' incentivized to learn social management Social management being incorporated into the sector's agenda	The management of social impacts remains a secondary issue
Private sector	35	Private actors (46%) and government officials (31%)	Internalization of social aspects by some companies in project planning and decision-making process The requirement of social safeguards for project loans.	Limited implementation of Social Management Plans
Government	20	Private actors (30%), NGOs (25%) and government officials (20%)	Growing awareness of the relevance of projects' social management	Insufficient development of institutional capacities for administering SIA

The communities and civil Society	25	Local groups (60%), inhabitants (32%), Experts (12%) and NGOs (12%)	Creation of an institutional channel to look at actors' claims regarding projects' social impacts Relative improvement in companies' social management	Lack of involvement by communities and civil society in the evaluation, design, and implementation of SIAs
The preparation of SIAs				
Topics	No. Comments	Main concerned stakeholders	Major concerns	
Consultants' practices	56	Consultants (52%)	Consultants' low qualification and experience on social management Problems in the translation of consultants' outputs into the companies' decision-making process and management Lack of ethical or professional guidelines for fieldwork Limitation in official social information sources Budget restrictions for the design of Social Management Plans	
Regulatory design	65	NGOs (25%), local groups (21%), inhabitants (15%), and consultants (14%)	Low social involvement in the drawing up of studies Limited scope in the definition of social impacts Lack of methodological specification by project and technology type	
Companies' practices	29	NGOs (28%), consultants (24%), and private sector (21%)	Some companies lack specific personnel or management able to integrate SIA outputs into project design and management	
Government implementation	22	Local groups (25%), government	Lack of official guide on SIAs has generated legal uncertainty	

		officials (18%), inhabitants (12%).	about methodologies and definitions
Local factors	16	Experts (25%), and consultants (25%), and NGOs (12%).	Characteristics of the place and time span of the project can add complexity to conducting SIAs
Evaluation of SIAs			
Institutional implementat ion	37	Government officials (32%) and NGOs (24%)	Low institutional budget and human resources
Institutional design	16	Government officials (38%), NGOs (19%) and consultants (19%)	Conflicting institutional objectives Lack of institutional capacity to follow up SIA at the local level Low formal linkage with other project assessments
Regulatory design	32	Local groups (31%), government officials (22%), inhabitants (22%), NGOs (12%)	Institutional overload caused by the lack of regulatory specificity Lack of legal commitments by companies to incorporate evaluation's recommendations into SIA Lack of social involvement mechanisms
The translation of SIA into project management			
Company practice	72	Consultants (24%), NGOs (21%), private stakeholders (21%), and inhabitants (14%)	Some companies do not incorporate the Social Management Plan into project management Companies' social responsibility policies in the Mexican context Low impact shared social benefits in projects
Regulatory design	37	NGOs (46%), consultants (22%) and government officials (19%)	Lack of an institutional mechanism to monitor, evaluate, and sanction projects' social management

Institutional implementation	26	Local groups (38%), NGOs (23%), inhabitants (15%) and government officials (12%)	Low capacity to make the studies accessible to the public
The influence of sectoral governance on the performance of SIA			
Energy policy	24	NGOs (42%), experts (21%), and government officials (17%)	The lack of internationalization of social objectives
Institutional capacity	25	NGOs (32%), government officials (16%), local groups (16) and inhabitants (8%)	The reduction of government capacity to mediate relations between projects and communities
Limitations in knowledge and experience	16	NGOs (38%), government officials (19%) and experts (19%)	Reduced information about the interplay between projects and communities in Mexico during the design of the SIA regulation
Electric Auctions	10	Private sector (30%), international organizations (20%) and consultants (20%)	SIA design did not consider projects' social impacts and social management