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Social, Environmental and Economic Externalities Related to the Implementation of Wind Energy Projects on the Isthmus of Tehuantepec

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Abstract

This study aims to analyze the economic, social, and environmental impacts caused by the development of wind projects in the Isthmus of Tehuantepec, in the Southwest of Mexico and, simultaneously, to evaluate, in a synergistic way, wind energy as an effectively viable option for the Mexican energy matrix by mapping and analyzing socio-environmental and economic externalities. The development of these parks represents, in this region of the country, a successful model for reducing GHG emissions, but there are controversies such as land displacement and lack of local development, which have generated socio-environmental conflicts that remain in force today. Therefore, the methodology adopted was based on a systematic literature review, as well as on the application of semi-structured interviews conducted in field research in situ. Because of this study, it was possible to increase the compression about the following paradox: the wind farms implemented in the Isthmus of Tehuantepec contribute to mitigating GHG emissions; however, according to the results of this work, this environmental benefit did not bring any improvement in their socioeconomic vulnerabilities to local communities.

Keywords: Isthmus of Tehuantepec, socio-environmental impacts, Southwest Mexico, sustainable development, wind energy

1. Introduction

The global energy model is characterized by the intense use of fossil fuels, such as mineral coal, oil, and natural gas. Such nonrenewable fuels, in addition to having contributed to the economic growth of developed and developing countries have directly affected the increase of greenhouse gases (GHG) in the atmosphere, eventually causing irreversible environmental problems, such as global warming. To reduce the consumption of non-renewable natural resources and minimize the negative externalities related to the environment, a transition of the energy model has been initiated, encouraging the use of alternative energies that use renewable sources that cause less environmental impacts. In fact, according the majority comprehension of science, the human being and their economic activities are the main responsible for the climate change (IPCC, 2022). Moreover, based on the conclusions of the Physical Bases of the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change, the IPCC, with high confidence, the global warming tend to reach 1.5 °C before the end of the current century. This threshold of 1.5 °C can be reached between 2030 and 2052, compared to the Earth's average surface temperature in the pre-industrial if it (GHG emissions) continues to increase at the current rate (IPCC, 2021).

To reduce the consumption of non-renewable natural resources and minimize the negative externalities related to the environment, a transition of the energy model has been initiated, encouraging the use of alternative energies that use renewable sources that cause less environmental impacts.

Clean energy such as solar, wind, geothermal, and hydropower energies establish a new technological paradigm aimed at improving the processes and the development of new alternatives (Furtado & Perrot, 2015), providing energy supply to the population with a more integrated and sustainable focus. On the other hand, such a transition brings some difficulties in implementing these technologies given that the economic model (particularly, financial capitalism, and the related international financial system) and, to a lesser extent, society

itself is resistant to its acceptance. Therefore, considering that the current paradigm is based on the use of fossil fuels as the primary source of energy (Furtado & Perrot, 2015).

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Under this perspective, in general, national governments have been striving to improve their environmental policies and to mitigate the emission of GHG (IPCC, 2014; Benites & Amaury, 2017; International Energy Agency, 2018), in addition to other strategies aimed at addressing the consequences of climate change (such as actions in the area of adaptation and the field of environmental education).

Considering that the fossil resources are finite and cause global environmental problems, investment in renewable energies proves to be a route of action. Thus, the government of Mexico has adopted the position of reducing GHG emissions by the various sectors of activity in the country through alternative systems of energy generation that are cleaner and have less impact on the environment (Mexico, 2016b). The ultimate aim is for Mexico to achieve or get as close as possible to the precepts of sustainable development. This commitment was confirmed when, in 2016, the country ratified the Paris Agreement; in fact, there are, within this ratification, a series of strategies for mitigating GHG emissions already outlined until the year 2050 (Mexico, 2017).

Data from PROMÉXICO, the Mexican government agency that promotes international trade and investment (Mexico, 2016), indicates that the country's effective installed capacity for electricity generation, until 2014, was 65.5 GW, of which, 24.5% refers to renewable energy sources. The most relevant hydraulics, solar, and wind energy – the latter, according to Gibson et al. (2017) is the safest renewable energy, causing the least damage to the environment. In this context, the use of renewable technologies has increased in Mexico during the past 2 decades – which is gradually encouraging a certain diversification of the energy matrix.

In the context of wind energy, it is emphasized that the Wind Corridor implemented in Isthmus of Tehuantepec in the State of Oaxaca, Mexico, is one of the main examples of these intentions. The region has been characterized by the remarkable growth of wind farms since 1994. Currently, in this region of the Southwest of the country, there are 24 parks installed that take advantage of the wind potential, which is permanent for almost the whole year. In addition, three more parks are being built to operate in the short term (i.e., in the next 2–3 years), in the same location.

The implementation of wind farms, in addition to showing (by the Federal Government and, in particular, by the private sector) a strong interest in favor of reducing GHG emissions, has implied the expansion of socio-environmental vulnerabilities in the region, hardly visible to most Mexican society. This panorama has been established, mainly, in the locality of Juchitán de Zaragoza, where the (apparently meager) benefits to local communities, mostly of indigenous origin, are questionable.

The relationship with the global processes that drive the development of alternative technologies, called by Raman (2011) as a technological economic proficiency, has implications that change the social dynamics of some communities. The link between the implementation of this kind of renewable energy and the search for compliance with the principles inherent to sustainable development (Note 1), represents a challenge for the various actors such as the government, civil society, and the private sector, on whether local development will also imply a positive overall impact. Thus, in particular, regarding combating climate change and its deleterious consequences for Earth's biotic systems (IPCC, 2014).

The drive and growth of wind farms in the Isthmus of Tehuantepec region seem to focus only on reducing GHG emissions. After all, no economic or social development plan by the federal or state government contributes to the improvement of the quality of life of the inhabitants of the communities in the region, most of whom are indigenous.

This study aims to investigate, in a panoramic and synergistic way and, mainly, from the perspective of sustainability, the implementation of wind farms in the municipality of Juchitán de Zaragoza, in the State of Oaxaca. We seek to infer to what extent the use of wind energy can effectively contribute to mitigating GHG emissions that directly contribute to global warming, the most prominent phenomenon associated with climate change. Furthermore, we intend to investigate why local communities have not seen or perceived themselves as benefiting from these projects.

2. Wind Energy in Mexico

Renewable energies are a growing trend in the world. At the global level, the development and implementation

of projects based on non-finite natural resources are being served by the agendas of governments and the private sector to reduce greenhouse gases emitted by the use of fossil fuels, such as oil and mineral coal (Gyamfi et. al., 2018).

It is estimated that considering only the implementation of more wind and solar energy projects, in the year 2030 they would constitute approximately 60% of the total global energy generated from renewable sources (International Renewable Energy Agency, 2015). Expanding the technology to alternative energies would help the energy sector to unlock barriers related to the costs and technology availability – which, in the case of developing countries, as a rule, has had limited growth.

The growth of wind energy has been attributed to the fact that its use generates relatively less negative impacts on the environment due to its characteristics, such as the natural origin of the wind (Abassi, 2013). However, due to its production costs, it is one of the least used energy generation technology in the world, as they are generally high compared to the costs of fossil fuel-based technologies (International Energy Agency, 2018). According to Abassi (2013), wind energy reaches only 0.2% of the total global energy demand, and only 1.8% of the global electricity generated, which shows the long way that this technology still has ahead even in comparison to other usual technologies used for alternative sources of energy, such as the hydraulic energy.

For the year 2050, this may change slightly. According to the Intergovernmental Panel on Climate Change (2014), the IPCC, in 2050 more than 20% of the world's energy demand will be supplied by wind energy. This means that to achieve this result, one would have to produce 50 times more energy compared to what is currently being generated (Abassi, 2013). In this context, Mexico is also seeking to maintain this trend of giving more opportunities to clean energy projects to contribute to its climate change mitigation goals. One of the main sources of energy that it has been developing since the 1990s was, precisely, wind energy, taking advantage of the potential of the non-seasonal winds available in part of the Mexican territory.

The main Mexican wind potential is located in three areas: the Isthmus of Tehuantepec or the Southeast Region, the State of Tamaulipas, in the Northwest, and the State of Baja California (Northeast) (International Renewable Energy Agency, 2015). However, in the last two years, the State of Yucatán was added as another region with high wind potential (Mexican Wind Energy Association, 2018a), which is still under development. The area with the greatest potential is the Isthmus of Tehuantepec, in the State of Oaxaca, with a potential above 6 GW for the year 2020 (International Renewable Energy Agency, 2015). La Rumorosa, in Baja California, has a capacity of 5 GW with potential that could also be exploited in the near future and thus contribute to the environmental goals that Mexico has been proposing under the Paris Agreement – within of the Mexican NDC (Nationally Determined Contributions).

The first wind farm, called "La Venta", was implemented and inaugurated, in 1994, in the area of the Isthmus of Tehuantepec, in the State of Oaxaca (Mexico, 2018). Therefore, La Venta is the precursor of what would be the most developed area in terms of wind energy produced in the country. Over the last 2 decades, the Isthmus of Tehuantepec has remained as a world reference area for this type of resource regarding energy generation (Yanes, 2014).

Since the creation of the first park, the federal government has been establishing strategies and actions focused on creating more wind farms to achieve that, in 2025, 10% (Mexican Wind Energy Association, 2018) of the energy generated in the country comes from using the strong winds of the country's southern region. The intentions to generate greater momentum for wind energy relates to the fact that this region has one of the greatest wind power in the world, allowing its safe development, both from an energy perspective and in terms of security in the multiplied return on investments (to society and financial returns – to the private sector, in this case). Moreover, in 2014, a potential of 71 GW of annual energy capacity was estimated, but only about 1.7% of this capacity is currently being used (Mexican Wind Energy Association, 2018), reflecting the timid use of this resource so far.

Wind energy is considered as the renewable technology that will be dominant until 2030, according to the *Remap* MEXICO Report developed by IRENA (2015). The installed capacity for this year tends to be 31 GW. The potential for wind power in Mexico is just over 50,000 MW; and, to reach the goal set by the government of 35% of energy generation from renewable energies for the year 2035 (Mexico, 2014), an average installation of 1.7% GW will be required per year from wind farms (Mexican Wind Energy Association, 2018). Such a context shows that there are still many efforts that must be made by the country to achieve this goal. And, among these efforts, two main problems arise: the need for capacity to install new transmission lines in areas with high wind potential that offer feasible investments (i.e., that can be assimilated by either the government or the private sector), and the implementation of measures to integrate renewable energies into the national energy system (International

Renewable Energy Agency, 2015).

The lack of transmission capacity in these areas has been one of the main hurdles to the implementation of wind farms (International Renewable Energy Agency, 2015), as not all states are interconnected (Yanes, 2014). Moreover, paradoxically, Baja California is connected to the United States' energy system (Yanes, 2014) due to the lack of Mexico's energy system, hindering the development of this energy source.

According to Yañez (2014), to develop wind energy projects, some requirements are necessary, as they are essential: access to power transmission lines, consumption restrictions, and the location must have a certain wind speed, and the shape of the terrain must allow the installation of turbines. This is reflected in one of the obstacles that Mexico will have to overcome: universal service and supply of electricity to the population. We emphasize that the population tends to increase considerably by the year 2050 when the population should be about 143,925,000 people (García Sandoval, 2013) – that is, 20 million people more than those considered in the last census conducted in 2015.

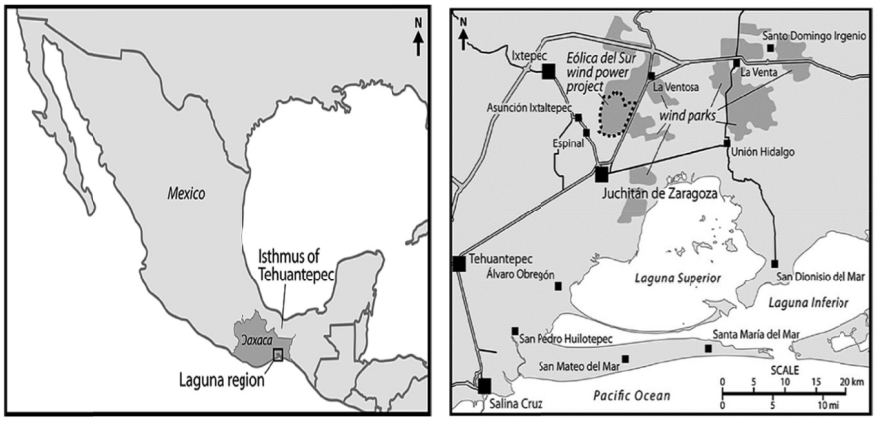
With the Energy Reform, the government developed several scenarios to be able to encourage the increase in the implementation of alternative energies, three of which stand out: the call for exclusive auctions for clean energies that allow an electrical coverage with the supply of basic services. In addition, the establishment of mechanisms for clean energy certificates that allow companies to acquire them and, in return, receive financial recognition for reducing greenhouse gas emissions, which allows the financing of energy projects. And, finally, the creation of mechanisms to foster the expansion and strengthening of the electricity grid and areas with high potential for the installation of new wind farms (Mexican Wind Energy Association, 2018).

According to García Sandoval (2013), a way to grow economically, while generating fewer greenhouse gas emissions, in addition to the transition to cleaner technologies, would be the improvement of the country's energy production and efficiency. Given this development orientation alongside sustainability, the government has been guiding, in practice, to give greater incentive to energy sources from oil and natural gas, despite the international environmental preservation agreements.

The increase in population, the commitments against global warming, and the widespread and pressing need to reduce fossil fuels are configured in some of the themes that the government must analyze to find the most appropriate way to establish a more sustainable agenda. Moreover, this agenda, ideally, should unite programs such as the development of wind energy based on building an equal society from a socio-economic and socio-environmental perspective.

3. Wind Energy on the Isthmus of Tehuantepec

The area comprised in the region known as the Isthmus of Tehuantepec, in the Municipality of Juchitán de Zaragoza, in the State of Oaxaca, as shown in Figure 1, constitutes a region of ethnic diversity composed of five groups: *zapotecas, huaves, zoques, chontales e mixes* (Note 2). The main economic activities are trade, manufacturing, power generation, and, to a lesser extent, agriculture and livestock (Mexico, 2002; Atlas of Indigenous Peoples, 2018).



1a 1b

Figure 1. Map of study area location – 1a: Mexico, the Oxaca State and the Isthmus of Tehuantepec; 1b: The Coastal Region of the Isthmus of Tehuantepec

Source: Dunlap, 2017 (maps by Carl Sack).

In this region, there are 24 wind energy projects with a production capacity of 2.3 GW (Asociacion Mexicana De Energia Eolica, 2018) in addition to another seven projects in the construction process that add up to a total capacity of just over 5 GW. The development of these wind farms, from the perspective of generating electricity, is an example of a project for renewable technologies that are among the most successful in the world, especially in Latin America.

For the area of the Isthmus of Tehuantepec, the Mexican federal government estimates that the implementation of wind farms will increase substantially increase. This is associated with the reduction of GHG emissions, contributing to the government's goals of reducing its ecological footprint, maintaining global leadership in this theme, and emphasizing sustainability as a central axis of the political agenda.

Former President Felipe Calderón highlighted this issue during the inauguration of some parks in this region during the period in which he was president, between 2006 and 2012 (Mexico, 2016). The Mexican Wind Energy Association, AMDEE, was founded in 2005, eleven years after the first installed wind farm. Its creation, to better regulate and manage this renewable energy, is also a testament to the structural valorization gained by the wind park installation projects.

Most of these parks are built to supply energy to the private sector, specifically transnational companies such as Bimbo, Grupo Peñoles, CEMEX, and Walt Mart (Mexican Wind Energy Association, 2018a) as shown below in Table 1. They use the energy generated by the wind to increase their profitability by reducing costs and impacts on the environment through this practice. However, its implementations are involved in controversies due to how the construction process has taken place. One of the main problems pointed out is the displacement and appropriation of the land of indigenous communities through lease agreements with companies, most of them of foreign origin, which allowed the construction of the infrastructure, which generates energy from the winds of the region (AIDA, 2012).

Table 1. Wind farms in the Isthmus of Tehuantepec until the year 2015

Project	Modality	Manufacturer	Date of operation	Capacity (MW)	User
La venta	FPW	Vestas	1994	1.57	CFE
La Venta II	FPW	Gamesa	2006	83.30	CFE
La Ventosa	Self-supply	Gamesa	2008	30.60	CEMEX
La Ventosa II	Self-supply	Gamesa	2008	49.30	CEMEX
Euros 1ra fase	Self-supply	Acciona	2009	37.50	CEMEX, ITESM
Euros 2da fase	Self-supply	Acciona	2010	212.50	Jugos del Valle
Bii Ne Stipa I	Self-supply	Gamesa	2010	26.35	Propimex; Jugos del Valle
La Mata-La Ventosa	Self-supply	Clipper	2010	67.50	Soriana; Cementos Apasco
Fuerza Eólica del Istmo	Self-supply	Clipper	2011	50.00	Peñoles
Oaxaca II, III, e IV	IEP	Acciona	2012	306.00	Grupo ACS
La Venta III	IEP	Gamesa-Iberdrola	2012	102.85	-------
Oaxaca I	IEP	Vestas	2012	102.00	Grupo ACS
Fuerza Eólica del Istmo	Self-supply	Clipper	2012	30.00	Met-Mex; Peñoles
Bii Ne Stipa II (Stipa Nayaá)	Self-supply	Gamesa	2012	74.00	Nestlé/ Alpla
Bii Ne Stipa III (Zopiloapan)	Self-supply	Gamesa	2012	70.00	Nissan; Alpla
Piedra Larga	Self-supply	Gamesa	2012	90.00	Bimbo; Friolsa Frigolicos
Bii Stinú	Self-supply	Gamesa	2012	164.00	-------
La Ventosa III	Self-supply	Gamesa	2013	20.00	
Eoliatec del Pacifico	Self-supply	Gamesa	2013	160.00	Walt Mart
Bii Ne Stipa II Fase III El Retiro	Self-supply	Gamesa	2013	74.00	------
Piedra Larga II	Self-supply	Gamesa	2014	138.00	-----
BII Hioxo	Self-supply	Gamesa- Fenosa	2014	227.50	Chedrahui; Cementos Moctezuma
Bi Ne Stipa II Fase IV Dos Arbolitos	Self-supply	Gamesa	2014	70.00	------
Sureste 1 Fase II (Energias Renovables La Mata)	IEP	Alstom	2014	102.00	----

Note. FPW: Financed Public Works; IEP: Independent Energy Producer.

Source: Adapted from Juarez (2014) and Mexican Wind Energy Association (2018).

Territorial conflicts, denial of access by communities to their resources, causing losses and changes in their cultural identities, degradation of the landscape, noise generated by wind turbines. In addition to this, causing other environmental problems such as displacement of local fauna, alteration of bird migration, and generation of waste by the oil used to produce the turbines, are some of the negative externalities associated with poorly planned wind energy projects (Brannstorm, 2017). Especially in Oaxaca, the lack of transparency and veracity of information is constant in these processes. Added to this, threats are targeting the population that opposes the operation of parks, highlighting corruption in different political levels that exist in the construction and development of wind power (Burnett, 2016; Von Bertrab, 2016).

Conflicts start in the absence of public consultation for the development of the process. And, this conflicts can be mitigated knowing the issues that are important to the community, recognizing their opinion, knowing whether or not they agree with the project, what its principles are, or simply considering them (Raman, 2015; Energy Company from Parana State, 2007; Urmee & Anisuzzaman, 2016; Horlings, 2015). All of these civilized principles should be an obligation (of an ethical and moral nature, in addition to the legal obligation) in all projects in which human capital is involved, especially those in which cultural value is very important in social dynamics.

According to Urmee and Anisuzzaman (2016), all projects must be thought of in different stages and the necessary aspects must be considered successful in accordance with the principles of sustainability. The main phase is engagement with society from the beginning (awareness) to the end of the projects (social feedback). The importance of this inclusion is perceived in the acceptance of the population, a factor that is not present in projects in the region of the indigenous communities in Isthmus of Tehuantepec. The concept of Diffusion of Innovation established by Urmee and Anisuzzaman (2016) defines some aspects that must be considered for the implementation of any type of technology in a community: analyzing the technology that will be implemented, validating the acceptance of society, checking government policies, and consider cultural and social factors.

Brannstorm (2017) states that the imposition of wind energy projects, built by mitigation or compensation, can generate conflicts because they do not consider any other factor, and the wind farms in the Isthmus of Tehuantepec seem to be a reflection and confirmation of this. In this sense, Velásquez (2012), through the concept called *Glocal* (word formed with the prefixes of "global" and "local"), mentions the importance of the relationships between these two spheres without forgetting that the social and historical landmarks embody and carry meanings for communities. Thus, it is possible to recognize and develop a local territory in the context of interrelationships that can benefit all parties.

The fact that the region's wind projects do not consider the local communities triggered a series of conflicts that, currently, have involved several groups such as government, the private sector, civil associations, and society (AIDA, 2012; Burnett, 2016; Von Bertrab, 2016), the latter being the most affected or least benefited by the decisions taken by the other spheres.

There is an apparent tendency for the government and companies to take advantage of the ignorance and lack of knowledge of the populations involved. That is why it is not surprising those areas where there is a high level of poverty, such as the communities of Juchitán, accept this type of project (Brannstorm, 2017). Also contributing to this situation is the fact that these populations have less access to the judicial system, which would facilitate protection by government entities, in favor of maintaining and stimulating citizenship and the empowerment of these communities, for the protection of their interests.

The territory issue is one of the most interesting parts of the Isthmus of Tehuantepec case. Leasing of land, whether voluntary or compulsory, from external pressure, is full of contradictions and lack of veracity. There are territories where a very high amount is paid to the landowners, and there are indications that they consist of influential people in terms of the power, or that they are linked either to the government or to business sector (Burnett, 2016; Von Bertrab, 2016). Thus, quite unlike the vast majority of the population, who receive a monthly income below the average even when compared to other parts of the world.

The concepts previously cited and analyzed are called "resource appropriation" (Smith, 1998) and "territory appropriation" (Velásquez, 2012), both terms that fit this process and that are more than twenty years old. In addition to paying low prices, there is a certain commercial blockade – due to economic appropriation (Velásquez, 2012) – for agricultural activities. After all, the government does not encourage trade in products from this region if people do not accept the installation of wind turbines (Burnett, 2016). The behavior of companies is also an important factor because, in addition to thinking about economic benefits, they should be obliged to perform some responsible involvement with the community, which receives or will receive wind projects (Nunes, 2017). In Oaxaca, there is a lack of regulation for foreign companies, which creates an

environment of excessive and even harmful competition for control of access, management of properties, and even sale of energy generated by the wind from the Isthmus of Tehuantepec.

After 23 years of the establishment of the first wind project in Juchitán, Oaxaca, social and environmental injustice are the most visible widespread problems. Several civil and non-governmental organizations (NGOs) and groups of external citizens offer support to the indigenous people so that they can demand the fulfillment of their demands peacefully, respecting their culture and their rights as human beings.

4. In Situ Research in the State of Oaxaca

For this research data and information collection, the main author of the present work, Eduardo Jonan Cervantes Lozornio, traveled to Mexico in late 2017. Subsequently, he carried out, for almost a month, field research in the Juchitán Region in the State of Oaxaca, in the southwest of the country and two more weeks in Mexico City, conducting interviews with different subjects: private sector, government, non-governmental organizations, and civil society, as shown in Table 2.

Table 2. Interviews with different subjects

Interviewees	Role/Association	Sector	Municipality
Bettina Cruz	Asamblea APIIDTT Leader	Civil association or NGO	Juchitán
Celestino Bartolo	Peasant resident near BiiXoo wind farm	Civil association	Juchitán
Carlos	Rádio Totopo member	Civil association or NGO	Playa San Vicente
Huvixa Guerrero Luis,	Comité Melendre	Civil association or NGO	Juchitán
Civil society representatives	Members of the Public Consultation of Unión Hidalgo	Civil association	Unión Hidalgo
Civil society representatives	Members of the Public Consultation of Unión Hidalgo	Civil association	Unión Hidalgo
Fatima de Cruz	Energy director of Ayuntamiento de Juchitán	Government	Juchitán
No identity	Inhabitant of La Venta	Civil association	La Venta
Radio Totopo	Rádio Totopo member	Civil association or NGO	Juchitán
Rodolfo Aguilar	Occupation and Territory Director of the Ministry of Energy	Government	Cidade do México
No identity	Inhabitant of La Venta	Civil association	La Venta
Civil servants	Ayuntamiento de Unión Hidalgo members	Government	Unión Hidalgo
Juan	Fundación Yamsa	Civil association or NGO	Ixtepec

Source: The authors, 2018.

The interviews were conducted during December 2017 and January 2018 using a semi-structured interview methodology, with the support of key informants that consisted of, mainly, the leaders of civil associations. The development of the interviews was different depending on the actor. In the private sector, it was impossible to obtain information; in fact, this sector refused to provide any interviews (or rather, no person working in the private sector who was contacted was willing to grant an interview). The closest that was achieved was to visit the company DELMEX (Eólicos Mexicanos) in the municipality of Unión Hidalgo. However, the people who, in theory, are responsible for social and environmental aspects were unable to assist me in any of the attempts, including visits and calls. The same happened with the Federal Electricity Commission (Comisión Federal de Electricidad – CFE), which is Mexico's state-owned electricity company.

5. Socioeconomic Externalities Associated with Wind Farms Implemented in the Isthmus of Tehuantepec

One of the main characteristics has been the conflict between the government-business binomial and indigenous communities that do not share the same vision or interest in the development of the area as a region that generates energy from the wind. The criteria under the logic of building wind projects are the following (Urmee and Anisuzzaman, 2016): land use, regulation of parks, public consultations, distribution and establishment of payments, the selectivity of the population, the interference in the way of living, the change in the social fabric, and the measures to mitigate the damage to the human populations that live in the region. The implementation of alternative energy projects must be planned to cover the precepts that outline sustainable development to

preserve the environment, generate economic development, and consider the needs of society in the short, medium, and long terms.

Urmee and Anisuzzaman (2016) through the concept "diffusion of innovation" emphasizes the use of technological advances for simple but fundamental things, such as access to electricity for the entire population of the countryside, and the promotion of human development through social rights (García, 2016; García & Sanz, 2018). In this process, there must be several steps that Raman (2015) defines as a sustainable assessment to ensure that the majority of the needs of all the actors involved in the project are being met. Thus, considering the demands of the population becomes a crucial issue both for ethical reasons (Horlings, 2015), and because it can be directly or indirectly benefited or harmed by the process.

In the case of most wind farms in Juchitán, the social factor was not taken into account – at least in the first instance by the absence of public consultations, which has given rise to several uncertainties that have worsened over the years and that reflect the current situation in that region.

The social and cultural dimensions must have some steps that facilitate the acceptance of the projects that will be implemented. According to Urmee and Anisuzzaman (2016), the process has 5 phases: (1) having awareness and information to understand the reason why the project is being implemented; (2) sharing information and assessments of possible impacts; (3) whenever this information has been shown, civil society decides whether to accept or reject the project; (4) if accepted, implementation. In addition, the last step (5) is that companies and the government itself must have feedback on people's satisfaction about the project. This methodology must consider the psychosocial processes (Horlings, 2015) that carry any innovation that changes the daily life of the communities; these, in turn, end up being internal processes of people who have dynamics within a social environment.

One of the main conflict factors has been the territory, since most wind farms are located on *ejidos* (Note 3) and communal land, which changes the sense of ownership since it becomes a social property (Velásquez, 2012) which differs it, structurally, from the concept of private property. This characteristic prevents the land from being leased by a person's decision, as there must be unanimous approval from the community through internal processes and meetings to decide what is best or not for the whole community.

Land processes are historically complex and this has been related to processes since the Mexican Revolution of 1920 (Abotes & Loyo, 2010), which eliminated land privatization. Therefore, peasants could have land to work. In this region, there are 68,102 hectares of communal land and there is a standard of 7 thousand *comuneros*, or the land leaders, to manage this extension of soil that belongs to the communities (García, 2016). In this context, trying to conform to territorial sustainability processes (Gomes & Moretto, 2011) is difficult even because of the existing organizational model in the Isthmus of Tehuantepec. Within this dynamic, the processes are also differentiated and even not very transparent according to the interviewees. And this because the negotiations to build wind farms have been between *ejido* leaders or representatives of the communities and the companies, which delegates to the population a third scope, being the last ones to know the decisions that were previously made. The fact that there has been no public representative of the municipal government in the Isthmus of Tehuantepec for 50 years, makes the situation more complex, after all, it is carried out without government supervision in any instance (Von Bertrab, 2016).

The lack of transparency is another important element in this process. For Urmee and Anisuzzaman (2016) and Horlings (2015), communication and transparency are basic in the implementation of all projects. The absence of these elements is clear from the first wind farms in the 1990s until most of the contracts that were signed in 2004. In fact, the prevailing characteristic is the lack of veracity and exploitation of the ignorance of the population, who, for the most part, did not have access to school education and who speaks language other than Spanish, the Zapotec.

These aspects caused the wind farms to be built without having sufficient knowledge of the implications and benefits that the construction of these wind farms offer. Faced with this type of recurring situation, in 2006 the Rádio Totopo project arose. It is a community radio station whose main objective is to inform the population about transnational projects that are being built and disseminated throughout the Isthmus of Tehuantepec region, as well as to strengthen the Zapotec culture (García, 2016).

A year later, APPIIIDT, made up of peasants and civil society, emerged as a way of trying to contain the immense growth of wind projects in the region, to seek regulation for the construction of parks, and to demand information transparency processes that have been denied since the beginning.

By law, for all cases, there should have been a Public Consultation guaranteed by Convention 169 of the

International Labor Organization (ILO) on Indigenous and Tribal Peoples (Note 4), which establishes in article six, the obligation to inform and include the participation of the population through a public consultation (IOT, 1991). Therefore, Convention 169 allows dialogue and free discussion on topics that directly affect the way of life of communities, such as the implementation of wind turbines.

Of 27 parks installed, 24 did not have this process as specified in the Convention to which Mexico is a party. The first consultation was held in 2005, but according to the interviewees, the process was permeated with irregularities because the participation of society as a whole was denied. After all, there were no previous meetings between leaders and companies, there was no reliable information that could be shared, and above all, corruption processes that include government officials and members recruited for such purposes by the population (Flores, 2015).

In 2015, the second public consultation was held, which resulted in an important conflict in the region. This was the case of the project of the company Eólica del Sur in the municipality of Álvaro Obregón, which was rejected by the community that decided not to accept the construction of wind farms despite the pressure and attacks that occurred (Lagunes, 2017). The consequences of this event even led the community itself to decide to self-govern under its right to use and customs, leaving the government without any direct interference with it (Lagunes, 2017).

The conflicts since the implementation of the wind turbines have been a constant and have led to levels that, today, there is a marked opposition between the population and the government-business binomial. Elliot (2006) attributes this type of socio-environmental conflict derived from processes of adaptation and interaction between social groups and which are the result of different modes of relationship, as in these cases in progress in Juchitán. In such context, according to the interviewees, the population, in general, is not against alternative energy projects as long as these projects bring development to their communities. The problem, therefore, is how all these wind farms have been developed, basically, without the effective consideration and participation of the population, even the one that resides in the surroundings. The sense of belonging is directly linked to the degree of citizen participation and their involvement with the themes that compete with their community (Urmee & Anisuzzaman, 2016). In the case under analysis, this sense does not exist because the costs and benefits of the projects were based, solely, on economic evaluations without due consideration to interior dimensions such as the cultural one (Horlings, 2015).

As time progressed, the number of wind farms in Juchitán reached 24 units, but three projects are already under development (Mexican Wind Energy Association, 2018a) – all of them starting, mainly from foreign investment. Currently, there is an expectation of an increase in the number of projects in the medium and long term due to the characteristic conditions of the region. Despite this growth in the implementation of wind projects and the associated increase in the number of parks in the region, the economy of the municipalities has not benefited in almost any sense. This results, basically, from the fact that the gains (profits) are only for private companies, whether national or foreign (Juarez, 2014). For the population, in general, as shown by the interviews with members of the community, there are typically negative socio-environmental externalities.

The implemented model of wind farms has also fostered greater inequality among its inhabitants by renting the land on which wind farms are built. The payments made are based on the location of the turbines: if they are built within the terrain or if the electrical installation passes through the land of some peasantry, which is also known as the "wind step" (Von Bertrab, 2017).

Direct beneficiaries for the construction of wind farms receive a monthly or annual income. However, the rest of the population receives nothing. According to the prevailing logic, this would be correct insofar as the installation does not pass through the land of these people or the companies, for the construction of the parks, have not chosen that such land. It is also important to note that the value of the rents varies depending on the project and the company to which they belong, as no regulation establishes the prices that must be granted to the owners of the land that are being used for the turbines (Burnett, 2016; Quintana, 2017).

The amounts paid to landowners range between 150 and 2,000 Mexican *pesos* per hectare (Note 5) (R$ 37.19 and R$ 495.81 Brazilian *reais*, respectively) if the land has a turbine installed. If it is just the "wind step", the value is much lower. These prices, in addition to being considered characteristically low due to the extent of the land and considering the Mexican economic reality, are also well below the international average, compared to countries like Germany, Spain or England (Burnett, 2016; Von Bertrab, 2017; Juarez, 2014). Thus, in addition to generating inequality between inhabitants who receive income and those who do not, there is also a difference between the amounts paid, including parks that are often within the same municipality. This generates great discomfort and discontent in the majority of society, which is increasingly heterogeneous given the income

unfairly distributed by the implementation of wind farms – contrary to what Vallance (2011) establishes in the idealistic conception of sustainable social development and homogeneity.

The fact is that the energy produced by the wind currents in this region is not distributed to supply communities. It is destined to connect to Mexico's electrical matrix and, in addition, most of the projects supply private companies like Walt Mart, Soriana and Coca-Cola, in particular (García, 2016; Von Bertrab 2017). The only benefit to which residents in this region were entitled was a minimum discount of 25% on the bimonthly payment of the electricity service for all inhabitants belonging to the Isthmus of Tehuantepec.

6. Social and Environmental Externalities Related to Wind Farms Implemented in the Isthmus of Tehuantepec

The use of alternative technologies allows minimizing negative externalities to nature, reducing the socio-environmental impacts related, in particular, to the use of fossil fuels such as mineral coal, oil, or natural gas. This energy transition seeks to reduce the emission of greenhouse gases (therefore, contributing to tackling climate change) and, at the same time, contributing to sustainable development (Elum & Momodu, 2017). It seems paradoxical because the very concept of "development" implies changes, and "sustainability" is connected to a meaning of permanence (Horlings, 2015). This intrinsic paradox presents itself as a dilemma due to any implementation of clean technology that, in theory, aims mainly at some level of benefit to the environment. In fact, wind energy represents, in itself, a model that fits this paradox. After all, it is considered one of the cleanest technologies and has the least negative externalities to the environment; however, despite using natural wind energy, wind energy has a wide range of negative implications.

These considerations make us question the extent to which the implementation of green technologies can effectively contribute to the preservation and conservation of the environment – or, from an analogous perspective, if the fact of developing this type of project relates to the care of nature. This question arises from the perception (resulting from the interviews) that these wind farm implementations, centrally, obey economic principles and that aim, in the last instance, the continuity of the developmental model, focused on economic growth (that is, in the increase of the Gross Domestic Product – GDP), and non-distributive (in terms of income) (Raman, 2015). This model would thus justify the dependence on natural resources and the implicit, correlated, and even inevitable (considering this model) degradation of nature (Benites & Amaury, 2017).

According to Brannstorm (2017), renewable energies have a philosophical basis linked to the harmony of the environment with humankind, putting the topic from an anthropogenic perspective, which also leads us to think that the focus is on a development that is based (much) more on the economic part than on the preservation of natural resources, *per se*. From this perspective, wind projects, despite being less environmentally harmful than the use of other energy sources (such as those of fossil origin), also have negative impacts for the environment. In such a context, it's possible to mention: (1) the death of birds due to collision with the turbines; (2) the noise that the magnetic waves from the turbines emit; (3) the oils that are used for the maintenance of the wind turbines, which drain to the ground and, sometimes, to the aquifers; (4) the destruction of the habitat of some animal species by building the infrastructure; and, finally, (5) the alteration of the landscape (Dai, 2014; Leung & Yang, 2011).

In this context, we emphasize that it is difficult to calculate the number of bird species affected by wind turbines because other basic factors must be considered, such as the presence of possible predators and the alteration of the migratory route (Dai, 2014). It is also necessary, in this same prism, to consider aspects such as the location of the turbine, their height, the wind direction, the migratory route, among other issues (Leung & Yang, 2011). According to Leung and Yang (2011), there are case studies that show that bird deaths are lower due to the operation of the wind turbines than by other factors. Even so, some wind farms in the world have developed collision protection and prevention systems with technology that uses radars that can detect their presence. In addition, subsequently, the turbine automatically stops working to enable free passage to birds through the area (Leung & Yang, 2011). In the case of the Isthmus of Tehuantepec, also known as the "Wind Corridor", there is a clear passage route for some species of birds. Thus, according to interviews with representatives of civil society, their presence has decreased since the wind turbines were established. According to information provided by the mayor of Juchitán de Zaragoza, there are reports of impact studies, but they are not official. Therefore, it is not certain whether the collisions of birds with wind turbines in the region represent a problem that needs to receive more attention from society and, in particular, from Mexican government departments linked to the environmental system.

Another damage to the fauna is directly linked to the alterations that generate the electromagnetic fields of the wind turbines in the marine fauna, because, according to some studies, deleterious changes occur in the

reproduction of some species (Dai, 2014). This, in turn, directly affects some economic activities, in particular fishing. In Playa San Vicente, which belongs to the municipality of Juchitán, this was evident in Laguna Mayor, where the population realized that fish populations are increasingly far from the turbines and their number has been decreasing considerably. According to officials interviewed, the federal government indicated the existence of a study related to this topic in another area within the same region. This study pointed to a connection between the use of batteries and the waste that is thrown into the lake, and not due to the magnetic vibrations that electric turbines emit; however, this study is also not official. Faced with this type of situation, the inhabitants of the region have asked for the implementation of some ecosystem protection system; however, any governmental authority or private companies have not provided this.

Figure 2. Photograph taken at Playa San Vicente with wind turbines in the background

Source: Eduardo Jonan Cervantes Lozornio (the first author), 2018.

The spillage of vegetable oil used for the proper operation and maintenance of wind turbines is another problem that has a direct impact on the population that lives near the turbines. The oil can drain and go straight to the fields of cultivation (of grains, in particular) or to places with accumulated water, generally, in the rainy season, between the months of May-September, soaking the fields and causing the marked loss of crops. This was the particular case of the interviewed peasants who argued that they have gone through several periods of loss of their watermelon, wheat, corn crops, among others, due to the same reason.

Another theme that causes a considerable impact refers to the noise (excessive sound, in terms of decibels) generated by the operation of wind farms. Studies indicate that this noise can be traumatic, especially for people who are predisposed to diseases related to headaches and nervous system disorders (Abassi, 2013). According to all interviewees in the community, this noise intensifies more at night than during the day – which makes this socio-environmental problem even more impacting (especially for human beings). The noise can be, in this case, related with two sources: mechanical, due to the proper functioning of the turbine; and aerodynamics, generated by the impact of the wind (Leung & Yang, 2011). The intensity also depends on the distance between the turbine and the population's homes. If this distance is up to 500 meters, the noise is very strong and can cause more severe problems in people's health. If it is a distance of up to almost 2,000 meters, the damage can still be consistent.

Almost all respondents highlighted this issue. In fact, two of them reported ear problems from the turbines that are very close to their homes – as shown in Figure 3. One of them even associates noise and electromagnetic waves as having caused a direct impact on human health, and that, in his opinion, has caused paralysis in a resident. However, according to the interviewees, there are also no formal studies that can assess whether the noise emitted by the turbines is affecting the health of the inhabitants of the communities.

Figure 3. Private house in the municipality of La Venta, which is typically close to wind turbines (less than 500 meters away, in this case)

Source: Eduardo Jonan Cervantes Lozornio (the first author), 2018.

The issue of altering the landscape may be the most subjective theme of all the damage mentioned, as it depends on people's criteria. Some respondents, in this case, find the view with the turbines pleasant, while others do not recognize any aesthetics associated with the wind farms. The perception can be so different, that there is a concept originated in England – Not In My Back Yard (NIMBY) – that expresses the nonconformity on the part of the population to have wind turbines close to their homes for the simple fact of changing the landscape (Dai, 2014; Abassi, 2013). It is, in fact, impossible to quantify or measure aesthetics despite studies that analyze people's sensory perception based on the alteration caused by the presence of wind turbines (Abassi, 2013). In the case of this research, some of the interviewees showed disagreement regarding the number of wind farms that exist, as this has increased the number of wind turbines, completely changing the visual aspect of their territory.

For the government, wind farms have also been used to attract tourism, mainly national, using it as a characteristic feature of the Juchitán region. However, the lack of regulation in environmental matters has led to different uncertainties regarding the possible environmental damage caused in the region by the implementation of the development of wind farms (Juarez, 2014). This lack of regulation, in principle, should impede the use of these enterprises as a tourist attraction; however, this activity is already underway.

Each company pays environmental validators that carry out pre-project monitoring. Moreover, during operation, this analysis focuses on the preservation of flora and fauna (mainly birds), reforestation actions, soil erosion control, and noise from wind turbines (United Nations Framework Convention on Climate Change, 2010; URS, 2008). However, these validators, in addition to not being directly controlled or supervised by governmental bodies, are external to the government, as in the case of Juchitán, a municipality that has 24 parks in operation, of which only three share their information with the municipality, after all, there is no legal framework that requires them to do so.

This practice is commonly registered in the context of some wind projects linked to the CDM, which, as part of the requirements, must show the positive and negative impacts that each implementation has. In this case, and just to mention the example of the La Venta project, one of the first projects to be built (United Nations Framework Convention on Climate Change, 2010). In addition to this environmental monitoring, workshops are held at the beginning of the project with the peasants, so that better control over environmental and social protection is established.

It is worth mentioning that not all damages have a direct impact on the inhabitants and not all of these impacts have caused changes in the integrality of the ecosystem. However, diverse deleterious consequences have occurred and have been recorded by the community and government since the implementation of wind projects. Furthermore, most of these ventures affect or bother people whom least benefit from these projects (Abassi, 2013). Binkowski (2018), in this context, reflects that environmental problems do not materialize by themselves

because they are built by individuals or organizations that carry out actions with impacts that, in these cases, are also negative.

The energy transition that vigorously contemplates clean energies must seek to reduce all negative impacts on the environment (where people and all other living beings coexist); so that it can, effectively, be considered as a sustainable model (Elum & Momodu, 2017), managing to achieve all the intrinsic objectives and established by the paradigm.

7. Final Remarks and Conclusions

In this study, data relating to the excessive use of fossil fuels, the exploitation of natural resources, and the high levels of consumption inherent to human activities over the past centuries were presented and analyzed. In particular, starting with the Industrial Revolution, a process that took place from the last quarter of the 18th century, when the technological consolidation of the steam engine allowed man to master the first energy source for production and wide use, i.e., the coal.

Among other externalities, this process (of intense economic development based on fossil energy sources), which started almost 250 years ago, has aggravated the phenomena associated with climate change (in particular, global warming), causing impacts that can be irreversible and with disastrous consequences for life on Earth. Thus, the energy transition (from fossil fuels – mineral coal, oil, and natural gas) to alternative energy sources that make use of resources considered infinite, such as the sun or the wind, become a necessary strategy in the face of the inexorable depletion of energy reserves.

However, the implementation of this type of technology is not without risks and impacts that can be considered as negative. Determining the viability of each type of energy is also related to different variables: geographic region, social conditions, and economic aspects. And, even, the cultural factors characteristic of the place where any project aimed at the extraction, production or use of renewable natural resources is being implemented (the same applies and even more carefully – given the wide range of potential risks and impacts – to natural or non-renewable resources).

In the specific case of this research, based on the implementation of wind farms, we sought to analyze the social and environmental feasibility of using wind energy in the Isthmus of Tehuantepec region, in the State of Oaxaca, in Southwest Mexico. To this end, the study in focus was developed from the systematic review of the literature and the realization of semi-structured interviews with different actors involved during field research. In this context, it is emphasized that, in this study, exhaustively, the positive and negative impacts, directly or indirectly, related to the construction of these projects from the 1990s to the present day (2022) were characterized and analyzed. This process made it possible to collect data and information that allow a better understanding of the socio-environmental conflicts that exist in this geographical area of Mexico.

The results indicate that the criteria with which wind farms were developed, from the design, construction to management stages, have been thought under the logic of generating profit from the preservation of the environment from a single perspective, namely, the (exclusive) focus on reducing GHG emissions, taking into account only the principles of global sustainability and ignoring local principles. In such context, it is opportune to mention that profit is related to greater economic gains, higher remuneration to the shareholders of transnational companies that lead the construction and operation of these parks.

Also known as, the Wind Corridor, the study region lacks an effectively holistic, integrating assessment, from the perspective of sustainability – as indicated by Raman (2015), which is, valuing the social and cultural aspects that predominate in the region of the Isthmus of Tehuantepec. Thus, the concept of Sustainable Development is poorly implemented or only partially adopted in the area by the Mexican government and the private sector because it does not consider these fundamental aspects established and inherent in this concept: sustainability.

The ambiguity characteristic of the aforementioned concept of Sustainable Development and even the (malicious or not) superficial interpretations of it makes each country have its definition of what sustainable projects actually mean (Benites & Amaury, 2017). This idiosyncratic framework allows certain governments and companies to try to hierarchize certain activities and actions considering them as coupled and adherent to this paradigm even without reaching it.

Concerning the axes of sustainable development, it was observed, centrally based on field research, that the social and cultural dimensions are not responsible for most of the negative impacts. Furthermore, it was found that the economic benefits are practically null or scarce for the communities since only those who rent their land where the wind turbines are placed benefit, also creating a visibly uncomfortable social gap within each community. As for the environmental aspect, the impacts should be minimized, but that also does not generate

the same damage as those associated with the use of fossil fuels, and also does not represent a threat to biodiversity and forests as, in general, causes the production and use of hydroelectric energy. Even so, again, it is emphasized, in the name of the preservation of bird species; in particular, that negative environmental externalities are not negligible in the case of the implementation of the analyzed wind farms

Although there is an obligation to carry out a prior consultation for each project that has been planned (especially in regions inhabited by indigenous peoples) and also considering that this obligation is supported by international provisions – such as Convention 189 of the International Labor Organization, the United Nations ILO – consultations have not been held in most wind farms. The only two consultations held failed due to the lack of regulation due to corruption processes involving different levels of government, private wind energy companies, and even some of the community leaders (Note 6).

The protection of traditions and other cultural factors is at the mercy of decisions outside the communities themselves; thus, it ignores what is important for them. This scenario allows the establishment of a phenomenon that Velásquez (2012) defines as territorial appropriation and that encompasses the cultural, social, and economic appropriation of a dynamic that previously existed, changing the *modus vivendi* and the social fabric built over centuries.

As mentioned during this research, the issue of territorial division represents a determining factor in the conflict. The fact that most lands are *ejido* and communal makes the process of installing wind farms more complex as there are several decision-making bodies (in theory, at least) to accept or reject projects. In this context, for more than 50 years, there has been a clear lack of authority on the part of the government in the sense that it is possible to define a much-needed regulation addressed to the lease or sale (sale) of land. However, after the information obtained in the interviews, this also seems to be a strategy by the government itself to avoid this issue. After all, the mere existence of a public official who regulates the territory could be an impediment to continue with the same dynamic of uncertainties and lack of information about the analyzed wind projects, which have resulted in huge economic gains in a non-transparent manner.

The implementation of the Energy Reform in 2014 has been the target of several negative criticisms (Clavellina, 2014; Vargas, 2014). Some of them are due to the sustainable discourse that is used and that is not implemented in practice. And this because although the use of oil from renewable energies is supported (focusing mainly on geothermal, wind, and solar energies), the intentions and plans are less substantial (due to the economic bias, in particular) in comparison to the strong support that fossil fuels have still received, mainly oil. The fact is that neither the auctions nor the green or environmental certificates originated with the reform have brought energy and economic development to the communities that inhabit the region where the 24 wind farms are located, which reflects what has already been mentioned: the projects, fundamentally, were not thought in favor of the local population.

Another aspect highlighted in this work is that the energy generated by wind farms is not used to supply electricity to the region's population. This generation of electricity is to meet the energy supply necessary for the development of the private sector, especially multinational companies, such as Coca-Cola, who use it as a (misleading) way of "proving" that they are "green companies", effectively committed to corporate social responsibility frameworks.

The analyses under the environmental aspect, one of the main axes of this research, resulted in the visualization of less powerful impacts when compared with fossil energy sources; however, the draining of oil, the noise of turbines, and the alteration of natural ecosystems are impacts mentioned by most of the people interviewed. After all, they are concerned that the damage may increase due to the abrupt growth in the number of wind farms that will be implemented in the region in years to come. What was clear, in this sense, was the lack of environmental regulation and control by the government, since each wind farm in operation has not been pressurized or charged in the sense that they deliver their reports without standards that are imposed by environmental authorities in the country. This allows the continued pollution of crops and aquifers that flow into the main lakes in the region and that is a source of food and work for the vast majority of the population in these municipalities (Ixtepec, Juchitán de Zaragoza, Unión Hidalgo, La Venta, and Playa San Vicente, among others).

There are no official studies on the impacts on fauna in the region; in particular, there are no scientific studies on birds that migrate under the same space where the wind turbines were built. There are also no studies focused on the impacts and damages that wind farms have generated on people's health, such as hearing problems, mental health problems (loud sounds for a considerable amount of time are, in general, inducing damage to people's mental health), headaches and even problems related to motor functions such as those mentioned in interviews with the population.

The lack of information and transparency is a persistent factor and is one of the main reasons why there are these socio-environmental conflicts in the region due to the implementation of the aforementioned parks. This has led to strong opposition to any project planned in the short and long term, creating a division between the populations. This opposition occurs between groups that are in favor of the continuity of the construction of wind farms and those groups (the vast majority of the population, in the case) that asks the government not to build more parks than those that already exist and to define regulatory frameworks adhering to national and international laws.

Opposing groups have organized themselves into associations such as APIIIDT and have been an opposing political force in the region, also affecting other struggles, such as social inequality from wind farms. The members of *Rádio Totopo* and Bettina Cruz are the main socio-environmental activists who lead these movements and who were interviewed in the context of the present research. In these interviews, both denounced the constant death threats they receive from groups involved with landowners and from private wind energy companies given their opposition to the parks. As an alternative to these movements, projects have emerged, such as the community wind farm that the Yansa Foundation and the *comuneros* of the Municipality of Ixtepec tried to develop. It is opportune to highlight that this community wind farm was prevented from being implemented by the government itself through various sabotages that included kidnapping attempts on project leaders.

The results and analysis inherent to the present research denote the socio-environmental and economic conflict in force in the region of the Isthmus of Tehuantepec. In addition, everything indicates that there is no expiration date for the end of these events; on the contrary, with the construction of future wind farms, the differences in views and attitudes tend to increase, causing a series of changes and even more conflicts in the territory.

The lack of regulation by the government at the three levels – federal, state, and municipal – is visible with the absence of public policies that assist in adherence and, perhaps, in proving sustainability precepts for the construction of future parks through regulatory processes that guarantee the respect and protection of the population's rights and care for the environment. Ideally, such regulations and procedures should prioritize benefits that foster economic and human development within communities.

Energy transitions should help to understand the dynamics of sustainable development and vice versa if policymakers (Furtado & Perrot, 2015) understood and heard the voice of the population and their demands and petitions. Thus, one could avoid conflicts that underestimate the importance of the nature and traditions of the indigenous communities of the Isthmus of Tehuantepec. For this reason, as one of the members of Rádio Totopo said: *en nuestra forma de ver la vida está nuestra Fortaleza para defender nuestro território*" (which means that "in our way of seeing life is our strength to defend our territory").

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Notes

Note 1. The Sustainable Development paradigm is based on the economic, social and environmental dimensions. However, some academics add other aspects such as the cultural and political factor, which, according to them, must be considered as important as the others in achieving the vision of this paradigm (Bursztyn & Bursztyn, 2012).

Note 2. These are pre-Hispanic cultures that, as they settled in the south-southeast region of Mexico, most of the people who belong to these ethnic groups speak only their mother tongue. However, new generations also speak Spanish, the official language of Mexico (Atlas of Indigenous Peoples, 2018).

Note 3. They are collective or shared territories that were granted by historical processes to the inhabitants of the communities, which implies that any decision about it has to be evaluated by all the owners of the property.

Note 4. It came into force in 1991. This law establishes and recognizes the rights of indigenous people to issues of health, education, territory and work, and protects the cultural, religious and spiritual beliefs of these original populations.

Note 5. The exchange rate value refers to May 18, 2022; on this day, one Mexican *peso* was equivalent to 0.25 Brazilian *reais*, according to the Investing Currencies website. Money converter. Mexican peso. Real Brasileño. MXN- BRL. https://br.investing.com/currencies/mxn-brl-converter, accessed on the aforementioned date.

Note 6. One of the interviews carried out in União Hidalgo was during a preparatory meeting for a public consultation that would take place a month later (February 2018) in this municipality for the construction of a new wind farm. Through the methodology of narrative analysis, it is possible to perceive the interests that exist of some people, so that the projects are carried out successfully. The arguments in favor have always been those of an economic nature. Despite the mention of benefits and collective interests for the whole community, coincidentally the leaders of this public consultation, who are also liaison with the government, civil society and the company that will develop the project, were also owners of land that would be leased to the company for the implementation of wind turbines. Thus, they were eager to receive a monthly payment for thirty years (or more), according to the contracts.