UNIVERSAL ACCESS TO ELECTRICITY AS A STRATEGY TO CLOSE SOCIOECONOMIC GAPS IN MEXICO

Neus PENICHE SALA*

Thank you Mau, Judith, Chava and Kenia

SUMMARY: I. *Introduction.* II. *Socioeconomic gaps*. III. *Regulatory framework*. IV. *Current strategies*. V. *Areas of opportunity (topics for thought)*. VI. *Conclusions*. VII. *Bibliography.*

I. INTRODUCTION

The new energy model has brought significant changes to Mexico. However, it is useful to examine the strategies aimed at meeting basic energy needs at the regional level and consolidate the programmatic instruments for carrying them out efficiently.

To date, the most notable advances in the energy sector usually tend to translate into large infrastructure projects, committed investments and the development of open markets, perhaps the most significant of which are those related to energy efficiency and the persistent inclusion of renewable energy in the national energy matrix. In this sense, according to Prospective of Renewable Energies 2016-2030, it is expected that 40% of energy generation will be from renewable sources by 2028,[1] resulting in an increased energy production from renewable sources and greater energy efficiency measures that will boost economic growth and social inclusion.

This paper seeks to show that Mexico's new regulatory framework for energy is not only designed for large projects and capital, but also offers

* Lawyer from Escuela libre de Derecho and Master in International Business Law from the University of Westminster (London).

[1] Secretaría de Energía, Prospectiva de Energías Renovables 2016-2030, México, 2016, available at: *https://www.gob.mx/cms/uploads/attachment/file/177622/Prospectiva_de_Energ_as_Renovables_2016-2030.pdf*.

specific alternatives that contribute to the country's reducing its ecological footprint (decarbonization) and boosting its economic development.

This paper is divided into 6 parts: the first one provides a conceptual description of the state of poverty in Mexico and Latin America, outlining the current panorama and the direct relationship that has been found between poverty and the absence of electric service.

The second part gives a brief description of the regulatory framework for energy, including the most important aspects of the electricity sector, as well as the new instruments for the energy transition.

The third point shows how this regulatory framework has been used, the progress made in the implementation of the new energy model and the existing tools to address shortcomings in energy competencies and education.

Point four presents the areas of opportunities that exist on this issue and the way in which the inequalities that persist throughout Mexico can be addressed by presenting the reader with some food for thought.

Lastly, some conclusions and reflections are drawn on the critical decisions that should be analyzed and the regulatory channels to advance the country's energy development and implementation of the new energy model, so that the benefits of this model can permeate the poorest sectors of the country and effectively contribute to narrowing the socioeconomic gaps.

Fuel poverty[2] regards the social deprivation of access to electricity and to the type of fuel needed for cooking (electricity or gas) as an element that latently contributes to poverty in a country, which is why poverty studies often highlight proposals associated with improving energy services (safe, clean, and accessible), as an indispensable factor in eradicating it.

II. Socioeconomic gaps

From an energy point of view and according to the World Bank, 1.06 billion people around the world do not have access to electricity and hundreds of millions more have insufficient or unreliable access.[3] In Mexico, the Federal Electricity Commission (CFE) estimated, at the end of 2018, 98.75% of the

[2] García, Rigoberto, *Pobreza energética en América Latina*, Chile, United Nations, 2014. The term was originally coined by Brenda Boardman and incorporated into UK legislation in 2000 with the passage of the Warm Homes and Energy Conservation Act, which formally spread the concept throughout Europe.

[3] World Bank, *Acceso a la energía,* 2017, available at: *https://datos.bancomundial.org/indicator/EG.ELC.ACCS.UR.ZS?end=2014&start=2014&view=map.*

national population had access to electricity, so there were around 2 million inhabitants without access to it.[4]

Although universal access is on the verge of being achieved in the country, the remaining 1.25%, serving some 1,549,781 people, is probably the most difficult area to cover as it is located in marginalized urban areas or rural zones.[5] In addition to this number, there are millions of inhabitants who, despite having access to electricity, do so insufficiently, interruptedly, at restricted hours and unreliably, risking the electronics and household goods that they have managed to acquire with great effort.

The geographic location of the population significantly defines the opportunities for energy services to which it can access and the economic and social problems stemming from their absence. For example, the index of the average duration of distribution outages for the southeast division was 50 minutes per outage in 2016 and about 70 minutes in 2017. The average frequency rate of distribution outages for the center/south division, the area with the highest average frequency of outages, was 1.07% in 2016 and 0.7% in 2017. The index of the average duration of distribution outages for users was 67 minutes in the Central Gulf area in 2016 and more than 100 minutes in 2017, followed by the southeast zone with 44 minutes in 2016 and 80 minutes in 2017.[6] According to the 2020 Reliability Report, the average duration of interruptions index shows that it remains at acceptable values, and presents mostly a trend of reduction in the last five years, which represents an improvement of the index. However, the North Gulf, Central Gulf, Central East and Southeast Gulf Divisions recorded slight increases in 2020 indicating an increase in events per user.[7]

According to Gerardo Esquivel,[8] 46.5% of the Mexican population lives in poverty. However, 1% of Mexicans amass 21% of the country's wealth.

---

4 Secretaría de Energía, *Programa Sectorial de Energía 2020-2024*, México, 2020, available at: *https://www.dof.gob.mx/nota_detalle.php?codigo=5596374&fecha=08/07/2020#gsc.tab=0*.

5 The National Development Plan 2019-2024 establishes that the new energy policy of the Mexican state will promote sustainable development by incorporating populations and communities to the production of energy with sources renewables, which will be essential for provide electricity to small communities isolated.

6 Comisión Reguladora de Energía, *Reporte de Confiabilidad del Sistema Eléctrico Nacional 2016-2017*, Mexico, 2018.

7 Comisión Reguladora de Energía, *Reporte de Confiabilidad del Sistema Eléctrico Nacional 2020*, Mexico, 2020, available at: *https://www.gob.mx/cms/uploads/attachment/file/693799/RCSEN_2020_VF.pdf*.

8 Esquivel, Gerardo, *Desigualdad extrema en México, concentración del poder económico y político*, Mexico, Oxfam, 2015, available at: *https://www.oxfammexico.org/sites/default/files/desigualdadextrema_informe.pdf*.

The wealthy class grew 32% between 2007 and 2012. Between 2018 and 2020, the percentage of the population in poverty increased from 41.9% to 43.9%, while the number of people in this situation went from 51.9 to 55.7 million people. The percentage of the population in extreme poverty increased from 7.0% to 8.5% between 2018 and 2020 and the number of people in extreme poverty increased from 8.7 to 10.8 million people.[9]

According to the National Council for the Evaluation of Social Development Policy (CONEVAL), poverty and extreme poverty in Mexico have historically had a rural mien.[10] However, the country is now predominantly urban and the demographic concentration in cities and metropolitan areas has given rise to phenomena of exclusion, inequality, unemployment, and poverty. In any case, poverty does not have the same characteristics in urban and rural areas, so the solutions to address the issue should be different.

The CONEVAL states that a person is in a situation of poverty when their income is not enough to acquire the goods and services required to meet their food and non-food needs, and when they have at least one social deprivation of the six indicators: educational lag, access to health services, access to social security, housing quality and space, access to basic housing services, and access to food.[11]

The General Law on Social Development establishes that the CONEVAL is to define and measure poverty using a multidimensional approach. Income poverty consists in comparing people's income with the monetary values of different items: food, capabilities, and assets.[12]

— Food poverty: Inability to obtain the basic food basket, even if the entire household income were used to buy only the goods in said basket.
— Capability poverty: Insufficient available income to afford the cost of the basic food basket and to make the necessary outlays for

[9] Consejo Nacional de Evaluación de la Política de Desarrollo Social, *Estimaciones de pobreza multidimensional 2018 y 2020*, México, 2020, available at: *https://www.coneval.org.mx/SalaPrensa/Comunicadosprensa/Documents/2021/COMUNICADO_009_MEDICION_POBREZA_2020.pdf*.

[10] Consejo Nacional de Evaluación de la Política de Desarrollo Social, *Pobreza urbana y de las zonas metropolitanas en México*, Mexico, 2014, available at: *https://www.coneval.org.mx/Informes/Pobreza/Pobreza%20urbana/Pobreza_urbana_y_de_las_zonas_metropolitanas_en_Mexico.pdf*.

[11] Consejo Nacional de Evaluación de Política de Desarrollo Social, *Medición de la pobreza, Glosario*, Mexico, 2017, available at: *https://www.coneval.org.mx/Medicion/Paginas/Glosario.aspx*.

[12] Cámara de Diputados, Ley General de Desarrollo Social, *Diario Oficial de la Federación*, Mexico, 20 de enero de 2004, available at: *http://www.diputados.gob.mx/LeyesBiblio/pdf/264_250618.pdf*.

health and education, even if the entire household income is used only for such purposes.

— Asset poverty: Insufficient available income to afford the basic food basket, or to make the necessary outlays for health, clothing, housing, transportation and education, even if the entire household income were used exclusively to acquire these goods and services.

Fuel poverty in Mexico and Latin America is marked by insufficient electrical services and the limitations they pose for the population.

1. *Poverty in Mexico*

Measuring poverty in Mexico is based on the social rights defined in the Constitution as: access to education, access to health services, access to food, access to social security, housing quality and space, and access to basic services (water, drainage, fuel for cooking and electricity).[13]

According to the Congress, poverty is aggravated or alleviated if any of these factors worsen or improve.

In the Ministry of Energy's 2013-2027 National Energy Strategy,[14] two strategic goals are established, namely, the growth of the GNP and social inclusion. The strategic areas of social inclusion are related to access to energy as an indispensable way to improve the quality of life of the population and the importance of considering it a priority for the advancement of every Mexican.

2. *Poverty in Latin America*

The Economic Commission for Latin America and the Caribbean (ECLAC) report, Social Panorama of Latin America 2017, indicates that poverty and extreme poverty levels have increased in Latin America. In

[13] Consejo Nacional de Evaluación de Política de Desarrollo Social, *Metodología para la medición multidimensional de la pobreza en México*, 3a. ed., Mexico, CONEVAL, 2018, available at: *https://coneval.org.mx/InformesPublicaciones/InformesPublicaciones/Documents/Metodologia-medicion-multidimensional-3er-edicion.pdf.*

[14] Secretaría de Energía, *Estrategia Nacional de Energía 2013-2027*, Mexico, available at: *http://infosen.senado.gob.mx/sgsp/gaceta/62/1/2013-02-28-1/assets/documentos/ESTRATEGIA_NACIONAL_ENERGIA.pdf*. On February 7, 2020, the most recent update of the Transition Strategy to Promote the Use of Cleaner Technologies and Fuels was published in the Official Gazette of the Federation.

2016, the number of poor people reached 186 million, or 30.7% of the population in the region, while extreme poverty affected 61 million people.[15] The year 2020 was characterized by a widespread increase in extreme poverty and poverty in the region; 33.0% of the population of Latin America was in a situation of poverty and 13.1% lived in conditions of extreme poverty, so that approximately 204 million people did not have enough income to cover their basic needs and that, of these, 81 million people lacked the resources even to acquire a basic basket of food.[16]

ECLAC and the United Nations Development Programme (UNDP) have carried out joint work to show the importance of access to quality energy services as a fundamental factor in reducing poverty and improving the environmental conditions of the most socially vulnerable groups.

In Latin America and the Caribbean, poverty reduction strategies and national development plans linked to the energy sector have not yet been fully addressed. There are factors that contribute to the emergence of economic and disparities in access to energy sources under equitable conditions: low income, absence of resources for building infrastructure, the unavailability of appropriate technologies, legal and institutional frameworks, and even the lack of political initiatives in the countries of the region.

Despite being part of the broader objective of achieving greater social inclusion, access to quality energy services as a fundamental factor in reducing poverty and improving the environmental conditions of the most socially vulnerable groups, is an issue that has little relevance in the official policies of Latin American and Caribbean governments.

Therefore, even though access to energy for the poor is not one of the Millennium Development Goals, it is a vital prerequisite for meeting said goals.

III. Regulatory framework

1. *New energy model*

The Constitutional Energy Reform in Mexico was a major transformation in the structure and operation of the energy sector in our country, since it

[15] Comisión Económica para América Latina y el Caribe, *Panorama Social de América Latina 2017*, Santiago, 2018, available at: *https://repositorio.cepal.org/bitstream/handle/11362/42716/7/S1800002_es.pdf.*

[16] Comisión Económica para América Latina y el Caribe, *Panorama Social de América Latina 2021*, Santiago, 2022, available at: *https://repositorio.cepal.org/bitstream/handle/11362/47718/1/S2100655_es.pdf.*

gave way to the involvement of the private sector in the exploration, development, production, transformation and marketing of hydrocarbons, as well as in the generation, transmission, distribution and marketing of the electrical industry.

The aim of the new model is to raise productivity in Mexico and increase the quality of basic services, as well as to have a direct effect on Mexico's economic growth through greater availability of oil, natural gas and their derivatives, along with a better quality public electric service, greater coverage and more competitive prices.

2. *Electricity sector*

The Mexican electricity sector is a key component for the country's development and re-structuring since the new energy model contributes to it growth. The Electrical Industry Law (LIE) comes out of this process, with the aim of allowing transparent regulation in the planning and control the Mexican Electrical Sector, the Public Electrical Energy Transmission and Distribution Service and other activities related to the electrical industry, as well as to promoting the sustainable development of the electrical sector and guaranteeing its continuous, efficient, and safe operation for the benefit of the users.

The Energy Transition Law (LTE), published along with the new energy model, aims to regulate the use of sustainable use of energy, the fulfillment of clean energy obligations, and the reduction of polluting emissions from the electrical industry, while maintaining competitiveness in the productive sectors and providing the gradual increase in clean energy participation and obligations in terms of sustainable use and energy efficiency.[17]

It also encourages signing conventions and coordination agreements with state governments, and where appropriate, with municipalities, to boost actions supporting social and industrial development for the use of clean energy, facilitate access to areas with high potential, and encourage the compatibility of land use for such purposes that establish land-use and construction regulations.

[17] Secretaría de Gobernación, Ley de Transición Energética Mexico, *Diario Oficial de la Federación*, December 2015, available at: *http://dof.gob.mx/nota_detalle.php?codigo=5421295&fecha=24/12/2015.*

3. *Social impact*

The LIE and the hydrocarbons law contain provisions on the social impact of public and private sector infrastructure projects, which will in all cases address sustainability and respect for human rights in the communities and peoples of the regions in which such projects are to be built, as well as implement the actions necessary to respond to the interests and concerns of such communities and safeguard their rights.[18]

The legislation imposes the obligation to conduct a social impact study of the areas object of the respective projects, and to present an appraisal containing the identification, characterization, forecast, and assessment of the social impacts that could stem from their activities, as well as the corresponding mitigation measures and management plans for the Ministry of Energy (SENER) to issue the corresponding decision.

IV. Current strategies

1. *Universal Electric Service Fund*

Since May 2017 and to date, the SENER envisaged the expansion of electrification in rural communities and marginalized urban areas where there is no access to this basic service.[19]

The Universal Electric Service Fund (FSUE)[20] contemplates the expansion of the CFE distribution network in locations where it is technically and economically viable. Meanwhile, in areas where it is not feasible, electrification will be carried out by means of individual systems with different technologies, such as, photovoltaic panels.

The FSUE announced that its first phase would focus on isolated electrification systems for rural communities and marginalized urban areas, benefitting around 180,000 Mexicans.

---

[18] Cámara de Diputados, Ley de Hidrocarburos, *Diario Oficial de la Federación*, 2014, Capítulo V, Título Cuarto, artículos del 118 al 121, and Cámara de Diputados, Ley de la Industria Eléctrica, *Diario Oficial de la Federación*, 2014, Capítulo II, Título Cuarto, artículos del 117 al 120.

[19] Secretaría de Energía, *Programa Sectorial de Energía 2020-2024*, México, 2020, available at: *https://www.dof.gob.mx/nota_detalle.php?codigo=5596374&fecha=08/07/2020#gsc.tab=0*.

[20] Fondo de Servicio Universal Eléctrico. Datos y Recursos, México, available at: *https://datos.gob.mx/busca/dataset/fondo-de-servicio-universal-electrico*.

It is believed that the plan for rural communities is a viable option in economic terms to supply electricity on a small scale that also represents an environmentally friendly solution.

The FSUE's goal is to reach 99% of the national electrical coverage by 2018 and to provide all isolated communities with electricity in order to reach the goal of having the country illuminated in its totality.[21]

2. *Electrification works*

In 2015 and 2016, CFE participated in the National Crusade Against Hunger in the basic services for housing campaign, which consisted of carrying out 2,202 electrification works in 385 municipalities in 27 states, benefitting more than 242,665 inhabitants in urban areas. In this same period, CFE undertook electrification works in rural communities that benefitted 80,020 people belonging to the indigenous population.[22] In 2019, the General Directorate of the CFE, in conjunction with CFE Distribution, defined the National Program for the Development of Electrification (PRONADEEL), which prioritizes the localities with the largest number of inhabitants pending electrification and with the highest rate of extreme poverty, according to the results of CONEVAL. Previously, rural communities and marginalized urban areas were electrified, based on the applications received, without a prioritization. In 2020, a coverage of the electric energy service of 99.08% was reached with the execution of 1,528 electrification works, benefiting 1,025 localities and 221,023 inhabitants.[23]

3. *Energy efficiency*

As of 2010, a collaboration agreement between SENER, the National Commission for the Efficient Use of Energy (CONUEE), the CFE and the National Bank of Public Works and Services (Banobras) marked the start

[21] Fondo del Servicio Universal Eléctrico, *Convocatoria para el Concurso Público Nacional*, Mexico, 2017, available at: *https://www.gob.mx/cms/uploads/attachment/file/227056/PRIMERA_CONVOCATORIA_FSUE_31_DE_MAYO_2017.pdf.*

[22] Comisión Federal de Electricidad, *Informe anual 2016 de la Comisión Federal de Electricidad*, Mexico 2017.

[23] Comisión Federal de Electricidad, *Informe anual 2020*, México, 2020, available at: *https://www.cfe.mx/finanzas/reportes-financieros/Informe%20Anual%20Documentos/CFE%20Informe%20Anual%202020.pdf.*

of the National Project for Energy Efficiency and Public Municipal Lighting.[24]

This project aims to promote energy efficiency by replacing inefficient municipal public lighting systems and reducing electricity consumption, as well as advancing in the transition to more efficient technologies and making better use of electrical energy. To date, 412,000 public lighting systems have been installed, using predominantly LED technology.

Similarly, the Energy Saving Program for the Electricity Sector (PAESE), targeted at CFE personnel and facilities, reported 63,669 people benefited from the IT activities on energy saving and its efficient use in 2016.[25] In 2020, the PAESE began the development of projects that truly result in energy efficiency processes within the CFE, parallel to the one promoted in the sector, through the evaluation of technologies, advice and dissemination of information.[26]

The PEASE implements four main activities, which include energy efficiency projects that consist of replacing old inefficient equipment in CFE facilities with new equipment and re-engineering projects in order to make better use of it; assessment of energy saving technologies; training in energy efficiency and information activities on saving and the efficient use of energy.

Implementing energy efficiency policies is a very important strategy; a less costly solution to energy supply issues is to conserve it through efficient use. In this way, the energy saved translates into less pollution and energy investment. In other words, it is more viable to save than to generate energy, which should be every energy regulator's mantra.

4. *Strengthening regulations*

The new energy model has stimulated private sector investment in various activities, including those related to increasing electrical coverage and diversifying the supply of energy for the population.

Through its Strengthening Economic Competition and Regulatory Improvement for Competitiveness initiative, the Ministry of Economy seeks to

[24] Secretaría de Energía, *Proyecto Nacional de Eficiencia Energética en Alumbrado Público Municipal*, Mexico, 2017, available at: *https://www.gob.mx/sener/documentos/proyecto-nacional-de-eficiencia-energetica-en-alumbrado-publico-municipal-proyecto-nacional.*

[25] Comisión Federal de Electricidad, *Programa de Ahorro de Energía del Sector Eléctrico*, Mexico, 2017, available at: *https://www.cfe.mx/productos/EvaluacionTecnologiasAhorradoras/Paginas/PAESE.aspx.*

[26] Comisión Federal de Electricidad, *Informe anual 2020…, op. cit.*

improve the business environment by enabling companies to open and grow, generate discussions on proposals to promote the country's development, boosting productivity, economic growth and the generation of higher quality products and services at better prices.[27]

In this sense, it is necessary to design, improve and strengthen electricity systems, as well as to continue with the development, implementation, and monitoring of the reliability criteria of the systems using institutional mechanisms that provide legal certainty.[28]

5. *Promoting cleaner technologies and fuels*

Currently, there are several tools that the SENER has made available as part of the initiatives stemming from the LTE, which seek to strengthen the operation and scope of the country's electricity sector.

The Transition Strategy to Promote the Use of Cleaner Technologies and Fuels, published on December 19, 2014, calls for the sustainable use of energy, improvements in energy productivity, and the economically viable reduction of pollutant emissions. To this end, four working groups are established: energy production, energy consumption, energy efficiency, and energy storage.[29]

The 2017-2031 Energy Sector Outlook, drafted by the SENER, predicts that by 2050, 50% of total energy generation will be clean. The SENER reported that in 2017, the installed capacity to generate electricity through clean energies represented 29.5%.[30]

---

[27] Secretaría de Economía, *Competencia y Mejora Regulatoria para la Competitividad*, Mexico, 2015, available at: *https://www.gob.mx/se/acciones-y-programas/competitividad-y-normatividad-iniciativa-para-el-fortalecimiento-de-la-competencia-y-mejora-regulatoria-para-la-competitividad?state=published.*

[28] The current National Development Plan 2019-2024 (PND) has as its objectives the "Rescue of the energy sector", based on the impulse provided by the Federal Government to Petróleos Mexicanos (Pemex) and the Federal Electricity Commission (CFE), which develop strategic activities in energy matters, so that they are the lever of national development, in such a way as to stimulate competitiveness, the promotion of economic growth and employment.

[29] Secretaría de Energía, *Estrategia de Transición para Promover el Uso de Tecnologías y Combustibles más limpios*, Mexico, 2014, available at: *https://www.gob.mx/cms/uploads/attachment/file/182202/20161110_1300h_Estrategia_CCTE-1.pdf.* On February 7, 2020, the most recent update of the Transition Strategy to Promote the Use of Cleaner Technologies and Fuels was published in the Official Gazette of the Federation.

[30] Secretaría de Energía, Press Release, Mexico, 2017, available at: *https://www.gob.mx/sener/prensa/electrificacion-de-comunidades-rurales-y-zonas-urbanas-marginadas-beneficiara-a-180-mil-mexicanos?idiom=es.*

Clean energy certificates (CEL) are requirement that accredit the production of a given amount of electrical energy from clean energy. These certificates are an instrument to promote new investments in clean energy and help turn an individual obligation into national goals for the generation of clean electricity more efficiently and at a lower cost for the country.

In 2015, SENER established a CEL requirement equivalent to 5% of total energy consumption for 2018. In 2016, it set a percentage of 5.8% for 2019. Finally, in March 2019 the requirements for 2020, 2021 and 2022 were determined at 7.4%, 10.9% and 13.9%, respectively.[31]

On the other hand, in accordance with the National Electricity System Development Program 2019-2033 (PRODESEN), investment needs are observed mainly in projects to meet demand, giving priority to projects that are related to the reactivation of CFE power plants, the incorporation in the medium term of combined cycle, geo-thermoelectric plants, efficient cogeneration and the rehabilitation and modernization of hydroelectric plants in operation. In this sense, it is estimated that between 2023 and 2024 2,557 MW of clean generation projects will be integrated by the CFE, mainly geothermal generation projects.[32]

6. *LP gas strategies*

On April 19, 2017, the Ministry of Social Development and the SENER signed an agreement to encourage the replacement of firewood and charcoal with LP gas in the most vulnerable areas of the country.

The agreement involves delivering gas stoves to more than 13,000 households living in extreme food poverty. According to data provided by the Ministry of Social Development, in 2017, more than 16 million Mexicans still used firewood and charcoal on open fires for cooking, and so this agreement aims to reduce the use of these fuels and avoid the health risks to which people are exposed.[33] According to data from the 2020 Population

[31] Comisión Federal de Competencia Económica, *Transición hacia mercados competidos de energía: Los Certificados de Energías Limpias en la industria eléctrica mexicana, Mayo 2021*, México, COFECE, 2021, p. 30.

[32] Secretaría de Energía, Programa de Desarrollo del Sistema Eléctrico Nacional 2019-2033 (PRODESEN), México, available at: *https://www.gob.mx/sener/articulos/prodesen-2019-2033-221654*.

[33] Secretaría de Bienestar, Sedesol and Secretaría de Energía, *Convenio para impulsar la sustitución de leña y carbón por gas licuado en zonas marginadas*, Mexico, 2017, available at: *https://www.gob.mx/bienestar/prensa/firman-la-sedesol-y-la-sener-convenio-para-impulsar-la-sustitucion-de-lena-y-carbon-por-gas-licuado-en-zonas-marginadas*.

Census, 13% of households in Mexico still used firewood or charcoal for cooking.[34]

It is important to promote greater access to sources of energy, as well as the availability of decent housing, protecting family finances and health, and the environment in the most vulnerable areas of Mexico.

V. Areas of opportunity (topics for thought)

Some current initiatives that set the path for medium- and long-term strategies to achieve a reduction in socio-economic gaps have been mentioned. However, there is still a long way to go to ensure that 100% of the country has effective access to energy.

It is worth reviewing these strategies to double their impact, so it is important to consider the following: What information is available to quantify the energy needs of the poor or to identify energy poverty throughout the country? What are the trends in the evolution of energy poverty in urban and rural areas? What impact have regulatory reforms in the energy sector had on poverty and equity?

According to information provided by ECLAC, although the poorest strata consume less energy, they spend a significantly higher proportion of their income on energy than the rest of the population does.

1. *An increase in Universal Electric Service Fund actions*

In its first stage and during the presentation of the FSUE on May 22, 2017, it was estimated that 45,000 Mexicans living in energy poverty would receive help from the first call for isolated systems with a 438-million-peso budget.[35]

On November 13, 2017, the FSUE ordered the allocation of almost 1.2 million pesos for the benefit of 200,000 Mexicans in remote and inaccessible areas. Likewise, for the FSUE's second call which was published on April 5, 2018, one billion pesos were earmarked for awarding projects

[34] Instituto Nacional de Estadística y Geografía, *Censo de Población y Vivienda 2020. Resultados complementarios*, 2020, available at: *https://inegi.org.mx/contenidos/programas/ccpv/2020/doc/Censo2020_Resultados_complementarios_ejecutiva_EUM.pdf*.

[35] Secretaría de Energía, Press Release, Mexico, 2017, available at: *https://www.gob.mx/sener/prensa/electrificacion-de-comunidades-rurales-y-zonas-urbanas-marginadas-beneficiara-a-180-mil-mexicanos?idiom=es*.

under the module for the installation of isolated electrification systems for rural communities and marginalized urban areas to benefit 74,000 people.[36]

The FSUE intends to meet the needs of 180,000 Mexicans, a goal to be achieved between 2017 and 2021. On July 28, 2020, two Resource Allocation Agreements were formalized with the Universal Electric Service Fund (FSUE), for the execution of 757 electrification works through extensions of the general distribution networks and individual solar modules, for an investment of 627.38 MDP, to benefit 67,710 inhabitants in 5 States of the Country.[37]

2. *Solar irrigation*

The Rural Energy Law is aimed at stimulating the country's rural development by establishing actions to boost productivity and competitiveness, as support measures to reduce disparities with other countries. The incentive prices and rates granted to producers must promote productivity and the undertaking of agricultural and livestock activities.

The Ministry of Finance and Public Credit (SHCP), along with the SENER, the then Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (Sagarpa),[38] and the Ministry of the Environment and Natural Resources (Semarnat), oversee establishing the incentive prices and rates for energy for agriculture and livestock, considering the economic and social conditions prevailing nationally and internationally.

The solar-based irrigation project is a plan that seeks to optimize the irrigation of agricultural crops through photovoltaic solar energy. Both the electrical power generated by photovoltaic panels and the water needs of crops are governed by the same variable, solar radiation; the greater the exposure to sunlight, the greater the need for crop water, but also the greater the capacity to produce photovoltaic energy.

For agricultural solar-based irrigation to be an efficient system, improvements must be made in water use at the plot level in the rural agricultural economic units by establishing modern irrigation systems that increase the technical and productive efficiency and save irrigation water drawn from wells.

---

36 Secretaría de Energía, Press Release, Mexico, 2017, available at: *https://www.gob.mx/sener/prensa/99-por-ciento-de-cobertura-electrica-nacional-en-2018-pjc.*

37 Comisión Federal de Electricidad, *Informe anual 2020*, …, *op. cit.*, p. 216.

38 Currently, Ministry of Agriculture and Rural Development (SADER).

The Special Energy Program for the Countryside regarding Electrical Energy for Agricultural Use establishes that those who carry out agricultural activities and use electricity for pumping and re-pumping water for agricultural irrigation will be beneficiaries of a 9CU energy quota (a service fee for pumping water for agricultural irrigation at low or medium voltage at a single rate).[39]

This fee is linked with a government contribution with the possibility for a farmer to cover the difference between the rate paid and the cost of supply from the CFE.

The farmer contribution plan and the corresponding entry are included in the Federal Expenditure Budget. The subsidy for electricity rates amounts to $50.18 billion Mexican pesos.

Promoting agricultural solar irrigation is an action that addresses more than one important problem. On the one hand, there is agricultural development in Mexico and electrification in rural communities that can benefit from energy generation. On the other hand, it could represent the possibility for the CFE to stop supplying electricity to a sector that generates significant financial losses while for the SHCP it is a possible way to reduce the aforementioned budget entry since farmers would be self-sufficient in terms of generating electricity for irrigation and other agricultural uses.

3. *Promoting the use of renewable energy sources for electricity generation*

Producing energy with renewable sources has the attraction of registering reduced, no or even positive environmental externalities. Therefore, implementing investment projects should receive adequate incentives to compete on equal terms with the existing conventional energy sources and related subsidies, and to drive supply and demand in today's electricity consumption market.

In 2015, the Semarnat published the "Guidelines for Programs Promoting the Generation of Renewable Energy", which explains the importance of the use of renewable energy compared to the use of fossil fuels.[40] These guidelines focus on disseminating public policies and programs to increase the participation of renewable resources in energy generation.

[39] Secretaría de Agricultura Ganadería, Desarrollo Rural, Pesca y Alimentación, *Programa Especial para el Campo en Materia de Energía Eléctrica de Uso Agrícola*, Mexico, 2016, available at: *https://www.gob.mx/sader/acciones-y-programas/programa-especial-de-energia-para-el-campo-en-materia-de-energia-electrica-de-uso-agricola.*

[40] Secretaría de Medio Ambiente y Recursos Naturales, *Guía de programas de fomento a la generación de energías renovables*, 3a. ed., Mexico, 2015, p. 13.

Renewable energy sources can be divided into two categories: non-polluting or clean sources and polluting sources. The former includes the sun (solar energy), wind (wind energy), rivers and freshwater streams (hydropower), the Earth's heat (geothermal energy), the seas and oceans (tidal energy, thermal gradient, salinity gradient), and waves (wave energy).[41]

Polluting sources are those obtained from organic matter or biomass and used directly as fuel. They are considered renewable energy because the carbon dioxide released will be used by the next generation of organic matter.

The production of energy from renewable resources has great environmental, economic, and social advantages. Mexico has a wide range of renewable energy sources.[42]

The CFE has established a series of general criteria that provide a common language to identify the real potential for the use of renewable resources, under the following categories:

Proved. This is the capacity identified by technical and economic studies to prove the feasibility of its use.

Probable. This is the capacity recognized through direct and indirect field studies but lacking sufficient information to determine its economic or technical feasibility.

Possible. This is the theoretical value of installable capacity and associated generation derived from indirect studies based on assumptions. It does not include field studies to prove its technical or economic feasibility.

Some of the economic advantages obtained from generating electricity with renewable resources include lower rates; the creation of direct employment; the creation of indirect employment, such as in agriculture through the expansion of irrigation systems, in livestock and poultry farming through the installation of electrified stables; in commerce and in services.

Another important advantage is the reduction in the cost of municipal electric power services (street lighting, water pumping and public buildings) since the consumption of electricity accounts for a high percentage of their operating expenses, while the social advantage could be achieved by taking electricity to remote communities and encouraging the development of these communities.

41 Biblioteca de Publicaciones Oficiales del Gobierno de la República, *Guía de programas de fomento a la generación de energía con recursos renovables*, Mexico, June 2018, available at: *https://www.gob.mx/publicaciones/articulos/guia-de-programas-de-fomento-a-la-generacion-de-energia-con-recursos-renovables-142904?idiom=es.*

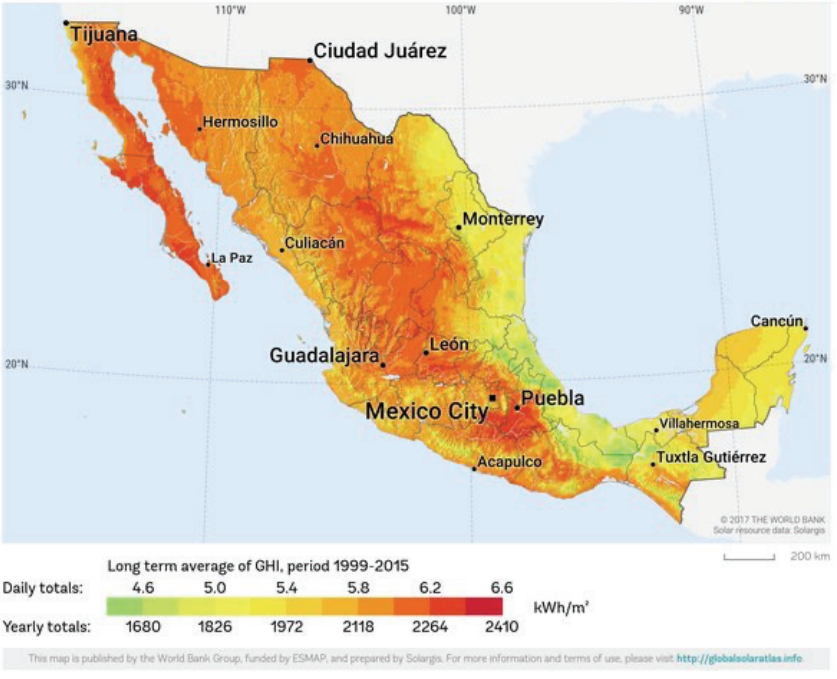
42 Secretaría de Energía, *Acuerdo por el que la Secretaría de Energía emite el Programa Especial de la Transición Energética*, Mexico, 2017, available at: *http://www.dof.gob.mx/nota:detalle.php?codigo=5484916&fecha=31/05/2017.*

It is worth pursuing strategies to stimulate the use of renewable energy in the medium- and long-term, focused on the use of Mexico's natural resources. The following are two examples of energy use.

A. *Harnessing solar energy*

Mexico is a privileged region in solar resources. The solar energy potential that exists in a country or territory is measured by its solar radiation, which in Mexico averages 5.6 kWh/m.[43]

The map below shows that the northwest of the country is located in an area with greater potential. However, the highest points of demand are in the center of the country, which would imply the electrification of areas without access to electricity near this area or an opportunity to improve the infrastructure of transmission to the center of the country.



FUENTE: © 2017 The World Bank, Solar resource data: Solargis.

43 Limón, Alejandro, *Energía solar en México: su potencial y aprovechamiento*, Centro de Investigación Económica y Presupuestaria, 2017.

The use of renewable energy for electricity generation is increasingly evident and has opened the area for the study of new alternatives. According to the above-mentioned in the LTE, Mexico not only has to satisfy the growing demand for energy consumption, but to do so with clean energy-based means that represent an economic advantage for the country.

B. *Harnessing wind energy in Mexico*

Another viable source of energy to be exploited in the country is wind energy, which is obtained from the kinetic energy of the wind and is directly related to the movement of air masses that move from areas of high air pressure to areas of low air pressure. February 15, 2018, saw the inauguration of the first stage of the "Mexican Wind Atlas" project coordinated by the National Institute for Electricity and Clean Energy (INEEL), with the participation of SENER, CFE and the National Autonomous University of Mexico.[44]

According to the information published in the SENER newsletter, the Mexican Wind Atlas received an investment of 34.6 million pesos. This investment consisted of the installation and operation of seven 80-meter-high towers equipped with anemometers, pyrometers, lightning rods, photovoltaic solar panels, and satellite link equipment to send accurate temperatures and wind speed data.[45]

By generating wind databases and high-resolution wind maps, developers and investors will have a free and accessible platform on the wind resources available in Mexico, which will generate interest and investment in the development of wind farms in the country.

4. *Renewable microgenerators that can sell energy*

Mexico seeks to build a reliable energy sector that attracts investment in electricity generation projects through clean energy, such as the installation of solar panels in homes and small- and medium-sized companies, thereby contributing to meeting the 50% target of integrating clean energy in electricity generation by 2050 and 100% of the country's supply.

[44] Secretaría de Energía, *Atlas eólico mexicano*, Mexico, February 2018, available at: *https://www.gob.mx/sener/prensa/se-pone-en-marcha-el-atlas-eolico-mexicano.*

[45] Secretaría de Energía, Boletín de prensa, Mexico, 2018, available at: *https://www.gob.mx/sener/prensa/se-pone-en-marcha-el-atlas-eolico-mexicano.*

Taking control of its own electricity generation or "democratizing the sector" reduces the possibility the CFE will not be able to supply the entire country in the short-term, in addition to the fact that investment in infrastructure to generate and transmit energy will be lower and will benefit from the decline in the use of fossil fuels.

The Energy Regulatory Commission published the regulatory instruments applicable to distributed generation power plants, in order to allow open access to the electricity grid, simplify procedures, facilitate the generation and sale of electricity on a small scale following the preferred system and incorporate clean energy into the Mexican electricity system.[46]

The development of distributed generation was limited. The electrical energy generated by solar panels was destined for self-consumption, without the possibility of selling it.

Distributed generation provides a viable alternative for those who do not have electrical energy. However, it is necessary to work on the obstacles it faces and rethink strategies in such a way that it works and is used to its full potential. Three strategies are given below.

A. *Electricity subsidy for residential rates*

This poses an obstacle to adopting distributed generation since it significantly and artificially lowers the cost of electricity for users whose light bills do not justify, in certain cases, the installation of photovoltaic equipment in their homes.

Studies carried out by the Mexican Institute of Competitiveness (IMC) and the Center for Economic Research and Teaching (CIDE) mention solar bonds as an instrument to finance or subsidize photovoltaic equipment on a one-time basis to users so that they can become self-sufficient and the energy they consume is no longer permanently subsidized.[47]

The economic variables of a solar bonus program would be advantageous for the State, the environment, and users. However, there are administrative impediments to its implementation, so it is undoubtedly an issue that merits further analysis and consideration.

---

[46] Comisión Reguladora de Energía, *Instrumentos regulatorios aplicables a centrales eléctricas de generación distribuida*, Mexico, 2017, available at: *https://www.gob.mx/cre/prensa/la-cre-aprueba-instrumentos-regulatorios-aplicables-a-centrales-electricas-de-generacion-distribuida-paneles-solares.*

[47] Instituto Mexicano de la Competitividad, *Por una agenda climática con visión de estado*, Mexico, 2018, available at: *https://imco.org.mx/wp-content/uploads/2018/03/AgendaClim%C3%A1tica_23-03-2018.pdf.*

B. *Financing mechanisms*

The financial feasibility of panels in many cases requires credit mechanisms to be made available to the communities in which distributed generation is possible, but the initial investment may not be affordable for all.

The Fund for the Energy Transition and Sustainable Energy Use (FOTEASE), managed by the SENER, is developing a financial mechanism so that both bank and non-bank financial intermediaries can offer favorable conditions for solar roof financing. This mechanism is currently being integrated and is critical to overcome the problem of the lack of financing.[48]

C. *Network capability*

Photovoltaic energy has an impact on the behavior of medium and low voltage electrical grids used to distribute energy to end users. The demand for electrical energy varies during the day, depending on the region in question. In hot regions, the time of peak consumption coincides with the increase in ambient temperature and the use of air conditioners in the summer. By contrast, in temperate regions, solar energy collected in the middle of the day is mostly fed into the grid, from where it is redistributed to homes and businesses without solar roofs.

Simply put, a limit could be put on the percentage of houses with solar roofs, but technology offers solutions, one of which is intelligent inverters that modulate the energy output of solar panels to regulate the low voltage circuit. Such technical and economic issues should be analyzed to find more appropriate sustainable solutions.

The potential of solar energy and the sustained cost reduction of photovoltaic panels is a great area of opportunity for supplying power to isolated communities. At the end of 2020, 63,402 services were interconnected in the Distributed Generation modality, which represents an increase of 14.56% compared to 2019 (55,346), with the Jalisco Division having the highest number of interconnected services (12,867) and the North Division with the highest growth of interconnected services (48%), comparing 2019 and 2020.[49]

[48] Secretaría de Energía, *Fondo para la transición energética y el aprovechamiento sustentable de la energía*, Mexico, 2018, available at: *https://www.gob.mx/cms/uploads/attachment/file/249307/Reglas_de_Operaci_n.pdf.*

[49] Comisión Federal de Electricidad, *Informe anual 2020*, …, *op. cit.*, p. 253.

5. *Strategic planning*

Market mechanisms alone cannot effectively and efficiently solve energy policy issues. An evaluation should be made of the goals that take into account rural electrification and the problems that exist in terms of access for all sectors of the population.

Quantifying the energy needs of populations living in poverty and urban poverty is key to designing a clear policy framework to eradicate energy poverty by region, bearing in mind the existing diversity.

Achieving energy efficiency in the country is the most economical and accessible response to the need to supply all communities and guarantee long-term energy supply. This should be the basic premise of any strategic planning in the sector.

6. *Analysis and tailoring energy access to meet the needs of rural and urban populations*

In terms of policies for rural areas, it is necessary to define mechanisms that will guarantee the continuity and expansion of supply to households, as well as to advance developing programs to ensure an energy supply that is sufficient to improve the productivity of the economic activities of rural communities to truly fight poverty.

In the case of urban communities, it is necessary to increase the number of energy efficiency policies ranging from the general to the particular; to find a way to regulate or determine energy efficiencies in appliances that, statistically speaking, are responsible for more than half of household electricity consumption, such as televisions, refrigerators, and washing machines, among others; and to set basic consumption standards.

An updated list of communities without electricity must be created in order to prioritize the objectives and come up with a strategy that adds these communities to the existing ones so as to possibly ensure that 100% of the population has electricity, while considering which energy requirements cover their basic needs and thus prioritize them.

Given that the fight against poverty and extreme poverty will not be won in the short-term, the efficient use of energy must be actively promoted, and a transition period must be established so that marginalized communities can gain access to modern, clean, and efficient energy sources.

7. *Public policies designed for energy access*

Designing public policies is a task that requires knowledge in various fields, like economics, politics, statistics, public administration, and communication, among others.

It is advisable to carry out a problem analysis to establish objectives and analyze actions and best practices with a view to create an energy access action plan in terms of quality, quantity, and prices.

Drafting public policies from a sustainability perspective should be nourished from local and regional realities.

8. *Energy subsidies*

A subsidy is defined as the difference between the retail unit price of an energy product and the reference price, which represents the real cost.[50] In the case of electricity, the reference price is the cost of production.

With the deregulation of rates, as of 2019 users will be able to contract the basic electricity supply service with the company that offers them the best price or service. However, since the subsidy is currently proportional to consumption, the population that uses more energy is the one that benefits the most from a subsidy. Therefore, it is believed that subsidies should be properly targeted if they are to benefit the population lacking electricity services.

9. *Success stories in Mexico and Bolivia*

A. *Puertecitos, Baja California, Mexico*

The Puertecitos community consisted of 20 families, a school and shops. It was isolated from the national power grid with the closest one 40 km away.

As part of a project between the Autonomous University of Baja California (UABC) and the Conacyt-Sener-Hydrocarbons Fund, a solar/wind/diesel power plant with a battery bank was designed and built. It is made up

[50] Secretaría de Energía, *Prospectiva del sector eléctrico 2013-2027*, Mexico, 2013, available at: *https://www.gob.mx/cms/uploads/attachment/file/62949/Prospectiva_del_Sector_El_ctrico_2013-2027.pdf.*

of a solar farm with 184 panels of 300 Watts (12 strings of 13 panels and 2 strings of 14 panels) and an installed capacity of 55.2 kW; a 5kW wind turbine with a 6 m blade diameter located at a height of 20 m; a 75 kVA diesel generator and 174 maintenance-free 2 Volt batteries connected in series (1500 Ah).[51]

The system has a medium voltage distribution network that provides energy to 20 homes in the fishing and tourist town of Puertecitos, near Ensenada, Baja California. It is important to empower rural communities so that they can manage electrification projects, and for this type of project to moreover serve as a trigger to access other services like drinking water and drainage. Furthermore, they can enhance their productive activities by living in an organized and united community; families now have air conditioning equipment and other appliances that allow them to have fresh food.

B. *El Espino, El Carmen and Itayovai in Charagua Norte, Bolivia*[52]

The OLADE (Latin American Energy Organization) implemented various electrification projects in rural communities in 2017, most notably in the communities of El Espino, El Carmen and Itayovai in Charagua Norte, Bolivia, where a pilot program was started.

In these communities, photovoltaic panels were installed so that poultry farms could sell their products to businesses in the region. In addition, the Native Indigenous Municipal Government of Charagua has been prompted to set up other productive enterprises that would enable the sustainable development of the region.

The established farms are run by women. This decision was made by the members' assembly and is in line with the local Guarani population, which has a very complete organizational system where women are well represented. The group of women running the farms were trained in management, project marketing and even farm production management taught by a zootechnician.

The objective of this kind of project is to improve the living conditions of the inhabitants of rural communities. Energy is used as a tool to achieve long-term comprehensive rural development by establishing an

[51] Velázquez, Nicolás, *Microred Puertecitos*, Mexico, Centro de Estudios de las Energías Renovables, 2016, available at: *http://ceener.mxl.uabc.mx/microred-puertecitos/*.

[52] Organización Latinoamericana de Energía, "Olade finaliza implementación de Proyecto Inclusivo de Energización Rural", 2018, available at: *http://www.olade.org/noticias/olade-finaliza-implementacion-proyecto-inclusivo-energizacion-rural/*.

alliance among various actors, especially with organized communities that have seen their capabilities strengthened to manage the electricity supply project for their own consumption with a focus on sustainability and the creation of productive enterprises, as well as local socioeconomic growth of the energy system that has already been installed.

VI. Conclusions

Access to energy is essential to reduce poverty. From a financial perspective, it may seem that supplying marginalized and isolated rural communities is not cost-effective. However, there are social benefits arising from access to energy supply that afford these communities the opportunity to incorporate energy-efficient technologies, as well as decentralized renewable energy sources.

Access to efficient and effective energy sources is linked to strengthening human rights. Energy scarcity limits people's opportunities and their quality of life in terms of economic productivity, as well as access to education, food, and health.

The electricity sector in Mexico is currently in the process of growth and modernization. Today, there is greater investment in the expansion of the national transmission and distribution network, which could lead to greater growth in the country's economy by meeting the country's energy needs.

Energy poverty is different in rural zones and urban ones. Therefore, policy making to improve access to energy services should deal with rural and urban areas differently, bearing in mind geographic, cultural and climate diversity.

Energy is an essential aspect for the quality of life of humankind and is a very widespread input in all productive activities.

The use of renewable sources of energy is an opportunity for generation and cooperation that improves supply in rural areas. The uses of renewable sources along with electricity coverage is an indicator of sustainability, both of which must guarantee sufficient supply, access to clean energy, improved air quality and reduced greenhouse gas emissions.

The new energy model is working. However, it could have a more inclusive approach and become a tool to improve living conditions for many Mexicans. Mexico's productivity growth increased in the sectors that have benefited from the energy reform (electricity, oil and gas).

It would be advisable to comprehensively plan the design and implementation of public policies that promote meeting the country's energy

needs, quality and reliability in the coverage of services, as well as the efficient use of energy. It is also necessary to look at long-term global and sectorial planning to ensure that energy consumption in our country is sustainable.

VII. Bibliography

ALTOMONTE, Hugo *et al.* (coord.), *Contribución de los servicios energéticos a los objetivos de desarrollo del milenio o a la mitigación de la pobreza en América Latina y el Caribe*, Santiago de Chile, United Nations, 2009.

ASOCIACIÓN DE BANCOS DE MÉXICO, *Mercado de energía fotovoltaica de baja escala, generación distribuida*, Mexico, 2017, available at: *https://www.abm.org.mx/descargas/Paneles_Solares_2017.pdf.*

BIBLIOTECA DE PUBLICACIONES OFICIALES DEL GOBIERNO DE LA REPÚBLICA, *Guía de programas de fomento a la generación de energía con recursos renovables*, Mexico, June 2018, available at: *https://www.gob.mx/publicaciones/artículos/guia-de-programas-de-fomento-a-la-generacion-de-energia-con-recursos-renovables-142904?idiom=es.*

CÁMARA DE DIPUTADOS, *El acceso universal a la energía eléctrica, datos y referencias para un análisis legislativo*, Centro de Estudios Sociales y de Opinión Pública, Mexico, núm. 278, 2018, available at: *http://www5.diputados.gob.mx/index.php/camara/Centros-de-Estudio/CESOPudios-e-Investigaciones/Documentos-de-Trabajo/Num.-278.-El-acceso-universal-a-la-energia-electrica.-Datos-y-referencias-para-un-analisis-legislativo.*

CÁMARA DE DIPUTADOS, Ley de Energía para el Campo, *Diario Oficial de la Federación*, Mexico, 2012, available at: *http://www.diputados.gob.mx/LeyesBiblio/pdf/246.pdf.*

CÁMARA DE DIPUTADOS, Ley de Hidrocarburos, *Diario Oficial de la Federación*, Mexico, 2014.

CÁMARA DE DIPUTADOS, Ley de la Industria Eléctrica, *Diario Oficial de la Federación*, Mexico, 2014.

CÁMARA DE DIPUTADOS, Ley General de Desarrollo Social, *Diario Oficial de la Federación*, Mexico, 2004, available at: *http://www.12diputados.gob.mx/LeyesBiblio/pdf/264_250618.pdf.*

CHACÓN, Daniel, "Generación distribuida: el tercer pilar de la transición energética", *Energía a debate*, Mexico, núm. 83, 2018, available at: *https://www.energiaadebate.com/blog/3117/.*

COMISIÓN ECONÓMICA PARA AMÉRICA LATINA Y EL CARIBE, *Panorama Social de América Latina 2017*, Santiago, 2018, available at: *https://repositorio.cepal.org/bitstream/handle/11362/42716/7/S1800002_es.pdf.*

COMISIÓN ECONÓMICA PARA AMÉRICA LATINA Y EL CARIBE, *Panorama Social de América Latina 2021*, Santiago, 2022, available at: *https://repositorio.cepal.org/bitstream/handle/11362/47718/1/S2100655_es.pdf.*

COMISIÓN FEDERAL DE COMPETENCIA ECONÓMICA, *Transición hacia mercados competidos de energía: Los Certificados de Energías Limpias en la industria eléctrica mexicana, Mayo 2021*, Mexico, COFECE, 2021, p. 30.

COMISIÓN FEDERAL DE ELECTRICIDAD, *Informe anual 2020*, CFE, Mexico 2020, available at: *https://www.cfe.mx/finanzas/reportes-financieros/Informe%20Anual%20Documentos/CFE%20Informe%20Anual%202020.pdf*.

COMISIÓN FEDERAL DE ELECTRICIDAD, *Programa de Ahorro de Energía del Sector Eléctrico*, Mexico, 2017, available at: *https://www.cfe.mx/productos/EvaluacionTecnologiasAhorradoras/Paginas/PAESE.aspx.*

COMISIÓN FEDERAL DE ELECTRICIDAD, *Reporte Anual 2016 de la Comisión Federal de Electricidad*, Mexico, 2017, available at: *https://www.cfe.mx/inversionistas/Documents/reporte_anual/Reporte%20Anual%202016.pdf.*

COMISIÓN REGULADORA DE ENERGÍA, *Instrumentos Regulatorios Aplicables a Centrales Eléctricas de Generación Distribuida*, Mexico, 2017, available at: *https://www.gob.mx/cre/prensa/la-cre-aprueba-instrumentos-regulatorios-aplicables-a-centrales-electricas-de-generacion-distribuida-paneles-solares.*

COMISIÓN REGULADORA DE ENERGÍA, *Reporte de Confiabilidad del Sistema Eléctrico Nacional 2016-2017*, Mexico, 2018, available at: *https://www.gob.mx/cms/uploads/attachment/file/317909/Reporte_de_confiabilidad_de_Electricidad_.pdf*.

COMISIÓN REGULADORA DE ENERGÍA, *Reporte de Confiabilidad del Sistema Eléctrico Nacional 2020,* Mexico, 2020, available at: *https://www.gob.mx/cms/uploads/attachment/file/693799/RCSEN_2020_VF.pdf*.

CONGRESO DE LA UNIÓN, *Presupuesto de egresos de la federación para el ejercicio fiscal 2018*, Mexico, 2017, Anexo 21, Ramo 23.

CONGRESO GENERAL DE LOS ESTADOS UNIDOS MEXICANOS, Ley de Transición Energética, Mexico, 2015, available at: *http://dof.gob.mx/nota_detalle.php?codigo=5421295&fecha=24/12/2015.*

CONSEJO NACIONAL DE EVALUACIÓN DE LA POLÍTICA DE DESARROLLO SOCIAL, *Estimaciones de pobreza* multidimensional 2018 y 2020, México, 2020, available at: *https://www.coneval.org.mx/SalaPrensa/Comunicados prensa/Documents/2021/COMUNICADO_009_MEDICION_POBREZA_2020.pdf*.

CONSEJO NACIONAL DE EVALUACIÓN DE LA POLÍTICA DE DESARROLLO SOCIAL, *Pobreza urbana y de las zonas metropolitanas en México*, Mexico, 2014, available at: *https://www.coneval.org.mx/Informes/Pobreza/Pobreza%20urbana/Pobreza_urbana_y_de_las_zonas_metropolitanas_en_Mexico.pdf.*

CONSEJO NACIONAL DE EVALUACIÓN DE LA POLÍTICA DE DESARROLLO SOCIAL, *Metodología para la medición multidimensional de la pobreza en México*, 3a. ed., Mexico, 2018, available at: *https://coneval.org.mx/InformesPublicaciones/InformesPublicaciones/Documents/Metodologia-medicion-multidimensional-3er-edicion.pdf.*

CONSEJO NACIONAL DE EVALUACIÓN DE LA POLÍTICA DE DESARROLLO SOCIAL, *Medición de la pobreza, Glosario*, Mexico, 2017, available at: *https://www.coneval.org.mx/Medicion/Paginas/Glosario.aspx.*

ESQUIVEL, Gerardo, *Desigualdad extrema en México, concentración del poder económico y político*, Mexico, Oxfam, 2015, available at: *https://www.oxfammexico.org/sites/default/files/desigualdadextrema_informe.pdf.*

FIGUEROA, Francisco and ALTOMONDE, Hugo (coord.), *Energía y desarrollo sustentable en América Latina y El Caribe, guía para la formulación de políticas energéticas*, Santiago de Chile, United Nations, 2003.

FONDO DEL SERVICIO UNIVERSAL ELÉCTRICO, *Convocatoria para el Concurso Público Nacional*, Mexico, 2017, available at: *https://www.gob.mx/cms/uploads/attachment/file/227056/PRIMERA_CONVOCATORIA_FSUE_31_DE_MAYO_2017.pdf.*

GARCÍA, Rigoberto, *Pobreza energética en América Latina*, Santiago de Chile, United Nations, 2014.

HUACUZ, Jorge, *Energías renovables en el IIE, punto de apoyo para la transición energética de México*, Mexico, Instituto de Investigaciones Eléctricas, 2016.

INSTITUTO MEXICANO DE LA COMPETITIVIDAD, *Por una agenda climática con visión de Estado*, Mexico, 2018, available at: *https://imco.org.mx/wp-content/uploads/2018/03/AgendaClim%C3%A1tica_23-03-2018.pdf.*

INSTITUTO NACIONAL DE ESTADÍSTICA Y GEOGRAFÍA, *Censo de Población y Vivienda 2020. Resultados complementarios*, 2020, available at: *https://inegi.org.mx/contenidos/programas/ccpv/2020/doc/Censo2020_Resultados_complementarios_ejecutiva_EUM.pdf.*

INTERNATIONAL RENEWABLE ENERGY AGENCY, *Stranded Assets and Renewables: How the Energy Transition Affects the Value of Energy Reserves, Buildings and Capital Stock*, Abu Dhabi, International Renewable Energy Agency (IRENA), 2017.

LIMÓN, Alejandro, *Energía solar en México: su potencial y aprovechamiento*, Centro de Investigación Económica y Presupuestaria, 2017.

ORGANIZACIÓN DE LAS NACIONES UNIDAS PARA LA ALIMENTACIÓN Y LA AGRICULTURA, *Buenas perspectivas para los sistemas de riego con energía solar*, Roma, 2018, available at: *http://www.fao.org/news/story/es/item/1116521/icode/*.

ORGANIZACIÓN LATINOAMERICANA DE ENERGÍA, "Olade finaliza implementación de Proyecto Inclusivo de Energización Rural", 2018, available at: *http://www.olade.org/noticias/olade-finaliza-implementacion-proyecto-inclusivo-energizacion-rural/*.

ORGANIZACIÓN PARA LA COOPERACIÓN Y EL DESARROLLO ECONÓMICOS, *Estudios económicos de la OCDE*, Mexico, 2017, available at: *https://www.oecd.org/eco/surveys/mexico-2017-OECD-Estudios-economicos-de-la-ocde-vision-general.pdf.*

SCOTT, John, *¿Quién se beneficia de los subsidios energéticos en México?*, Mexico, Centro de Investigación y Docencia Económicas, 2011.

SECRETARÍA DE AGRICULTURA GANADERÍA, DESARROLLO RURAL, PESCA Y ALIMENTACIÓN, *Programa especial para el campo en materia de energía eléctrica de uso agrícola*, Mexico, 2016, available at: *https://www.gob.mx/sader/acciones-y-programas/programa-especial-de-energia-para-el-campo-en-materia-de-energia-electrica-de-uso-agricola.*

SECRETARÍA DE BIENESTAR-SEDESOL-SECRETARÍA DE ENERGÍA, *Convenio para impulsar la sustitución de leña y carbón por gas licuado en zonas marginadas*, Mexico, 2017, available at: *https://www.gob.mx/bienestar/prensa/firman-la-sedesol-y-la-sener-convenio-para-impulsar-la-sustitucion-de-lena-y-carbon-por-gas-licuado-en-zonas-marginadas.*

SECRETARÍA DE ECONOMÍA, *Competencia y Mejora Regulatoria para la Competitividad*, Mexico, 2015, available at: *https://www.gob.mx/se/acciones-y-programas/competitividad-y-normatividad-iniciativa-para-el-fortalecimiento-de-la-competencia-y-mejora-regulatoria-para-la-competitividad?state=published.*

SECRETARÍA DE ENERGÍA, Acuerdo por el que la Secretaría de Energía emite el *Programa Especial de la Transición Energética*, Mexico, 2017, available at: *http://www.dof.gob.mx/nota:detalle.php?codigo=5484916&fecha=31/05/2017.*

SECRETARÍA DE ENERGÍA, *Atlas eólico mexicano*, Mexico, 2018, available at: *https://www.gob.mx/sener/prensa/se-pone-en-marcha-el-atlas-eolico-mexicano.*

SECRETARÍA DE ENERGÍA, Boletín de prensa, Mexico, 2018, available at: *https://www.gob.mx/sener/prensa/se-pone-en-marcha-el-atlas-eolico-mexicano.*

SECRETARÍA DE ENERGÍA, Comunicado de prensa, Mexico, 2017, available at: *https://www.gob.mx/sener/prensa/electrificacion-de-comunidades-rurales-y-zonas-urbanas-marginadas-beneficiara-a-180-mil-mexicanos?idiom=es.*

SECRETARÍA DE ENERGÍA, Comunicado de prensa, Mexico, 2017, available at: *https://www.gob.mx/sener/prensa/99-por-ciento-de-cobertura-electrica-nacional-en-2018-pjc.*

SECRETARÍA DE ENERGÍA, *Estrategia de transición para promover el uso de tecnologías y combustibles más limpios*, Mexico, 2014, available at: *https://www.gob.mx/cms/uploads/attachment/file/182202/20161110_1300h_Estrategia_CCTE-1.pdf.*

SECRETARÍA DE ENERGÍA, *Estrategia Nacional de Energía 2013-2027*, Mexico, available at: *http://infosen.senado.gob.mx/sgsp/gaceta/62/1/2013-02-28-1/assets/documentos/ESTRATEGIA_NACIONAL_ENERGIA.pdf.*

SECRETARÍA DE ENERGÍA, *Fondo para la transición energética y el aprovechamiento sustentable de la Energía*, Mexico, 2018, available at: *https://www.gob.mx/cms/uploads/attachment/file/249307/Reglas_de_Operaci_n.pdf.*

SECRETARÍA DE ENERGÍA, *Mapas de ruta tecnológica de energías renovables*, Mexico, 2018, available at: *https://www.gob.mx/sener/documentos/mapas-de-ruta-tecnologica-de-energias-renovables.*

SECRETARÍA DE ENERGÍA, *Programa nacional para el aprovechamiento sustentable de la energía 2014-2018*, Mexico, 2014, available at: *https://www.gob.mx/cms/uploads/attachment/file/224/PRONASEpendt.pdf.*

SECRETARÍA DE ENERGÍA, *Programa Sectorial de Energía 2020-2024*, México, 2020, available at: *https://www.dof.gob.mx/nota_detalle.php?codigo=5596374&fecha=08/07/2020#gsc.tab=0.*

SECRETARÍA DE ENERGÍA, *Prospectiva de energías renovables 2016-2030*, Mexico, 2016, available at: *https://www.gob.mx/cms/uploads/attachment/file/177622/Prospectiva_de_Energ_as_Renovables_2016-2030.pdf.*

SECRETARÍA DE ENERGÍA, *Prospectiva del Sector Eléctrico 2013-2027*, Mexico, 2013, available at: *https://www.gob.mx/cms/uploads/attachment/file/62949/Prospectiva_del_Sector_El_ctrico_2013-2027.pdf.*

SECRETARÍA DE ENERGÍA, *Proyecto Nacional de Eficiencia Energética en Alumbrado Público Municipal*, Mexico, 2017, available at: *https://www.gob.mx/sener/documentos/proyecto-nacional-de-eficiencia-energetica-en-alumbrado-publico-municipal-proyecto-nacional.*

SECRETARÍA DE MEDIO AMBIENTE Y RECURSOS NATURALES, *Guía de programas de fomento a la generación de energía con recursos renovables*, Mexico, 2015,

available at: *https://www.gob.mx/cms/uploads/attachment/file/47854/Guia_de_programas_de_fomeanto.pdf.*

SUBSECRETARÍA DE AGRICULTURA, Sagarpa, *Eficiencia Energética en el Sector Agropecuario*, Mexico, 2016, available at: *https://www.gob.mx/cms/uploads/attachment/file/103037/Agropecuario.pdf.*

VELÁZQUEZ, Nicolás, *Microred Puertecitos*, Centro de Estudios de las Energías Renovables, Mexico, 2016, available at: *http://ceener.mxl.uabc.mx/microred-puertecitos*.

WORLD BANK GROUP, *Solar resource data: Solargis*, Washington, available at: *https://solargis.com/maps-and-gis-data/download/mexico.*

ZARCO, Jorge, "¿Por qué nos tardamos tanto?", *Pv-Magazine*, Mexico, 2018, available at: *https://www.pv-magazine-mexico.com/2018/07/31/por-que-nos-tardamos-tanto/*.