Mexico country report

International experiences in designing and implementing renewable energy auctions for sub-Saharan Africa

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Acronyms and abbreviations

CEL	Clean Energy Certificate (Certificado de Energía Limpia = 1 MWh of clean energy)
CENACE	National Centre for Energy Control (Centro Nacional de Control de Energía, independent system operator)
CFE	Federal Commission of Electricity (Comisión Federal de Electricidad, state-owned utility)
COD	Commercial Operation Date
CRE	Energy Regulatory Commission (Comisión Reguladora de Energía, independent regulator)
EvIS	Social impact evaluation (Evaluación de Impacto Social)
FAP	Proportional assignation factor
GW	Gigawatt
GWh	Gigawatt hour
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt hour
LIE	Electricity Industry Law (Ley de la Industria Eléctrica)
MW	Megawatt
MWh	Megawatt hour
OCGT	Open cycle gas turbine
PPA	Power purchase agreement
PRODESEN	Programme for the Development of the National Electric System (Programa de Desarrollo del Sistema Eléctrico Nacional)
SENER	Energy Secretariat (Secretaria de Energía)
SSB	Basic Services Provider (Retail services)
SSC	Qualified Services Provider
TPL	Total potential liabilities
TWh	Terawatt hour
UDI	Investment unit
UK	United Kingdom
US	United States

1. Introduction

Mexico embarked on a power sector reform programme in 2013 to develop a new electricity market. The reform objectives included modernisation of the industry, improving competitiveness and fostering social and economic development. On 20 December 2013, the Mexican government published the Energy Sector Constitutional Reform, with the following main objectives: attract investments to modernise the energy sector; increase Mexico's competitiveness; increase energy exports and reduce dependency on imports; reduce energy costs; and increase national energy security.

The key aspects of the sector reform included the following (with the associated Articles in the modified Constitution):

- Article 25: Establishes the Empresas Productivas del Estado for the vertical and horizontal unbundling and restructuring of the state-owned Federal Commission of Electricity (CFE).
- Article 27: Retains state ownership of the planning, power system control and dispatch power market functions, as well as the transmission and distribution services, but allows contracts with private sector providers.
- Article 28: CFE and private developers can carry out electricity generation activities in an open and fully competitive electricity market under a well-defined regulatory framework.

The sector reform included the following institutional reorganisation:

- SENER: The Energy Secretariat remained the lead institution for energy sector policy, planning and execution (including transmission projects).
- CRE: The establishment of the Energy Regulatory Commission as the independent regulator for the market participants.
- CENACE: The market operator – covering the power system dispatch and control functions that used to be part of CFE – was transformed into a decentralised public entity.
- CFE: The state-owned utility was segmented into 14 independent entities, each in charge of various parts of the value chain, with some, such as generation and retail services, focused on competing with the private sector.

Mexico executed three energy auctions in the post-reform period (2016 and 2017), which awarded 8 GW of new generation capacity at some of the lowest renewable energy prices worldwide, resulting in investment commitments of more than US$9 billion. The first auction awarded 6 wind and 12 solar contracts to 11 companies at an average price of US$47.79/MWh. The second auction awarded 10 wind, 33 solar, 6 hydroelectric, 1 geothermal and 6 combined cycle (gas) contracts to 22 companies with an average price of US$33.47/MWh. The third auction awarded 6 wind, 9 solar and 1 turbogas (open cycle gas turbine, or OCGT) contracts to 8 companies with an average price of US$20.57/MWh.

The results from these first post-reform energy auctions were shaped by the newly established competitive legal and regulatory framework, the competitiveness of local wind and solar resources, a strong local private sector response, and investors' expectations associated with the quickly evolving and growing electricity sector.

However, it was also expected that the reform would become the basis for strengthening CFE, which was not achieved during that period. In 2018, Andrés Manuel López Obrador won the presidential elections, leading to a major shift in Mexico's political landscape and government policies, shaped by a populist/socialist agenda. Government has, for example, paused some of

the sector reform processes and cancelled further energy auctions. This has understandably caused great uncertainty in the energy sector.

Government's current focus is to strengthen and improve the financial viability of CFE and promote their hydroelectric and natural gas projects, while also addressing issues of power system intermittency, reliability and transmission congestion. The current policy favours the dispatch of CFE baseload generation plants while limiting the economic dispatch from variable renewable energy sources. Investors and environmental groups are challenging the current policy and have been able to halt some of these modifications until a final decision is made by the courts.

Nevertheless, CENACE, the market operator, remains unbundled, and the independent regulator (CRE) remains mandated to fulfil its functions, providing the opportunity for a competitive market in generation. New auctions are expected to be revived in the near term by building upon the current legal and regulatory framework and the competitiveness of renewable energy sources.

The following sections provide an introduction to the country and power sector context; a description and analysis of the auction design, including auction volumes, qualification criteria and processes, bidder ranking and winner selection, buyer and seller liabilities and approaches to project and credit enhancement; an analysis of auction implementation arrangements, including key role-players/decision-makers and overall institutional context; and key lessons learned and implications for auction design and implementation in sub-Saharan Africa.

2. Country overview

Located in the southern portion of North America, Mexico covers 1 972 550 square kilometres (761 610 square miles) and is the 13th largest country in the world. With approximately 128 649 565 inhabitants (CIA, World Factbook, 2020 estimate), it is the tenth most populous country.

The United Mexican States are a federation comprising 31 states whose government is representative, democratic and republican, based on a presidential system. The Constitution establishes three levels of government: the federal union, the state governments and the municipal governments.

Mexico has the 11th largest economy in the world, but has underperformed since the 1990s in terms of growth, inclusion and poverty reduction compared to similar countries. Mexico maintained average GDP growth rates of around 2 per cent between 1980 and 2018, limiting progress in convergence relative to high-income economies. Total GDP came to US$1.22 trillion in 2018, with inflation at 4.28 per cent. On a per capita basis, economic growth slowed on average to 1.6 per cent during the last five years.

2.1. Mexico's power sector

As of December 2018, the total installed generation capacity was 73 206 MW, including CFE and Independent Power Producers (IPPs), reflecting an increase of 3.1 per cent from 2017 (67 958 MW) (IEA, December 2018). The electricity access rate was 99 per cent, as shown in Table 1, which also includes the installed capacity by technology (SENER, PRODESEN, 2019).

Table 1: Key information on Mexico's electricity sector

Total capacity (MW installed, 2018)	**73 206**
Combined cycle gas	25 569
Hydroelectric	12 610
Thermal conventional (fuel oil)	11 909
Coal	5 394
Wind	4 764
Bioenergy	3 503
Turbogas (OCGT)	3 222
Solar	1 821
Nuclear	1 611
Cogeneration	1 401
Internal combustion (diesel)	701
Geothermal	701
Electricity access rates	
Urban and rural	99%
Total energy production (GWh, 2018)	317 278 GWh

Source: Authors' compilation with information from PRODESEN, 2019

Electricity generation increased from 280 365 GWh in 2014 to 317 278 GWh in 2018 (Table 2). A significant increase in wind and solar generation (Table 3) was derived from private actors' self-supply projects. There were also projects pre-dating the clean energy auctions that deliver energy directly to CFE.

Table 2: Evolution of the generation mix in GWh per year

Technology	*2014*	*2015*	*2016*	*2017*	*2018*
Thermal	*215 566*	*225 977*	*235 698*	*243 265*	*243 740*
Hydroelectric	*38 875*	*30 858*	*30 847*	*31 903*	*32 436*
Nuclear	*9 677*	*11 577*	*10 567*	*10 883*	*13 555*
Bioenergy and geothermal	*6 341*	*6 693*	*6 558*	*6 628*	*5 974*
Wind and solar	*7 272*	*9 036*	*10 446*	*10 800*	*14 609*
Total	***280 365***	***287 660***	***298 426***	***309 371***	***317 278***

Source: Authors' compilation with information from PRODESEN, 2019

Table 3: Energy generated by source between 2014 and 2018

Technology	*2014*	*2018*	*Difference (%)*
Thermal	*184 587*	*221 359*	*20*
Hydroelectric	*38 875*	*32 436*	*-17*
Nuclear	*9 677*	*13 555*	*40*
Bioenergy and *geothermal*	*6 341*	*5 974*	*-6*
Wind and solar	*7 272*	*14 609*	*101*

Source: Authors' compilation with information from PRODESEN, 2019

2.1.1. Power sector structure

Before the reform, SENER was responsible for power sector policy and system planning, while CFE was responsible for the growth and development of the electricity market. Private sector participation was limited to IPPs selling electricity to CFE under specific contracts. The system operator was embedded in CFE and the regulator (CRE) only oversaw private sector projects.

The legal framework also allowed for the establishment of 'self-supply projects' where a private entity could build its own generation project. This led to the establishment of 'self-supply societies', where a private generation company owned by a group of partners could supply electricity to those partners and in some cases make use of CFE's transmission and distribution lines.

The reform opened up power generation and retail to the participation of the private sector to promote a more competitive model. It also expanded the scope of SENER and CRE's mandates and separated the market operator CENACE from CFE by creating a new independent entity.

CFE was divided into 14 subsidiaries and companies: CFE Corporate; six generation subsidiaries; one transmission subsidiary; one distribution subsidiary; one basic supply subsidiary (serving the regulated sector and subsidised customers); one subsidiary for legacy contracts (power purchase agreements [PPAs] signed prior to the reform); one subsidiary company for qualified supply (serving the non-regulated consumers); one subsidiary company for primary fuel purchase, CFE Energia; and one subsidiary company for international markets, CFE Internacional.

Based on this structure, CFE's income is obtained mainly from the sale of goods and services, in addition to various income streams derived from the company's activities, such as the sale of natural gas to third parties. CFE also receives tax revenue from subsidies and transfers from the federal government. Between 2012 and 2018, CFE's total revenue grew on average 2.1 per cent per year.

The new electricity sector structure is shown in Figure 1. Generation includes the power plants from the state-owned CFE generation projects, and the independent private generators. As of 2018, CFE owned 57 per cent of the total generation capacity, while 18 per cent was supplied by IPPs selling directly to CFE and 25 per cent was owned by the private sector as self-supply. CENACE is the market operator responsible for economic dispatch of generation assets and overall market operation oversight. Transmission and distribution are still controlled by the state-owned CFE subsidiaries, but private sector participation is allowed under a strict legal and financial framework. Retailing includes the following:

- CFE Basic Services is the regulated retailer, representing customers with loads below 1 MW. The regulation allows for the establishment of other regulated retailers, but to date there are none. The regulated tariffs are determined by the Treasury and CRE (with an associated subsidy). Since 2016, the regulated retailers must acquire their products and services through the energy auctions to ensure the lowest available prices.

- CFE Qualified Services subsidiary is one of the unregulated retailers in the market representing users with loads above 1 MW. The current framework allows other retailers to also participate. These retailers may acquire their products through PPAs, the spot market or through auctions. New customers with loads above 5 MW can acquire their electricity directly in the spot market, or from power producers through PPAs.

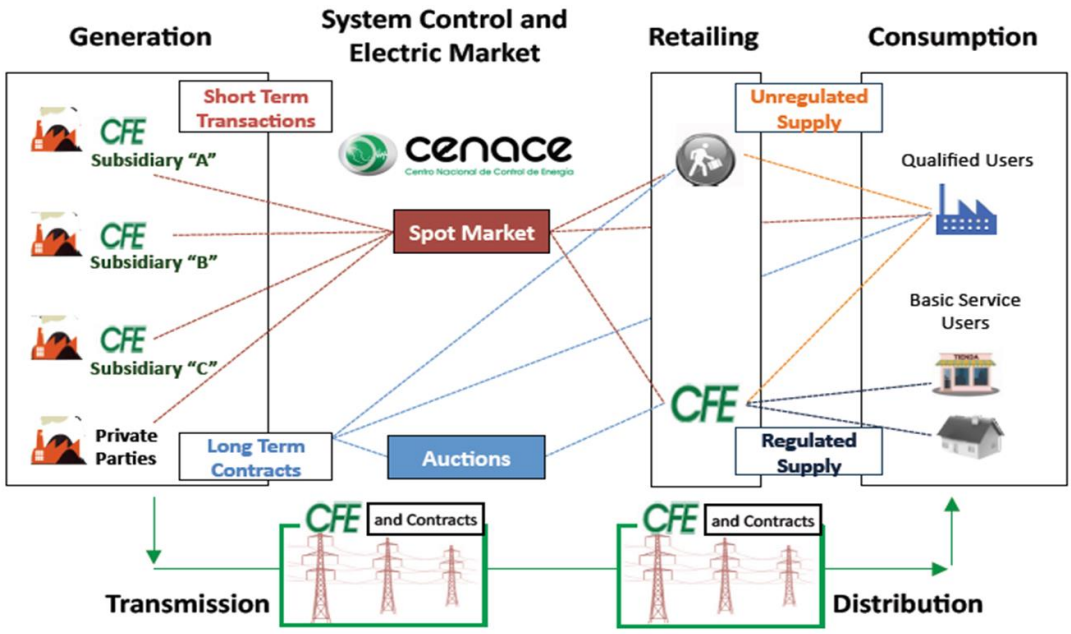

Figure 1: Structure of Mexico's electricity sector

Source:

Table 3 provides a brief description of the roles and legal mandates of the key institutions in the electricity sector.

Table 3: Key institutions in Mexico's electricity sector

Energy Secretariat (SENER)	Develops country's energy policy, within the current constitutional framework, to guarantee a competitive, high-quality, economically viable and environmentally sustainable supply of energy that is required for national development.
Energy Regulatory Commission (CRE)	Autonomous regulatory agency, meant to ensure market transparency and efficiency in service of greater competition and sustainability in the sector.
National Energy Control Centre (CENACE)	Power system dispatch and control (formerly part of CFE) is an independent entity whose purpose is to exercise operational control of the National Electric System, the wholesale electricity market operation and guarantee impartiality in access to the national transmission network and the general distribution networks.
CFE Transmission	Provide power transmission as a public service, including the financing, installation, maintenance, management, operation and expansion of the infrastructure.
CFE Distribution	Responsible for electricity distribution, including financing, constructing, maintaining, managing, operating and expanding the system.
CFE Basic Services Provider (SSB retail services)	Retailer to deliver electricity to anyone who requests it in terms of the provisions of the law. It has legacy contracts (prior to the reform), and new contracts from users with loads below 1 MW. The law mandates that CFE Basic Services must purchase all the required products through long-term energy auctions.
Qualified Services Provider (SSC)	Entity which purchases electricity from the wholesale electricity market in order to supply qualified users (loads above 1 MW) within the electricity supply contract under CENACE guidelines.
Generators	A permit holder that has power plants with capacities above 0.5 MW. Generators participate directly in the competitive wholesale electricity market and can participate in auctions to enter into contracts with qualified users and qualified service providers to sell their electricity and associated products.
Finance and Public Credit Secretariat (SHCP, Treasury)	Proposes, directs and controls the Federal Government's policy in financial, fiscal, spending, income and public debt matters. It has a significant role in the yearly definition of subsidised tariffs.

Source: Authors' compilation with information from SENER, CRE

2.1.2. Tariff levels and financial sustainability

CRE is officially responsible for tariff setting and publishes the methodology for calculating and adjusting final tariffs. However, Treasury is responsible for determining the subsidies to be allocated to specific tariffs, which CRE must apply. The tariff-setting methodology includes the charges associated with the CFE regulated rates of transmission, distribution, CENACE, and the regulated small to medium customers (Basic Supply) that are not included in the wholesale electricity market.

These tariffs are applied to consumers with loads below 1 MW, taking into account location/region, economic activity and consumption levels, among other things. Subsidised tariffs are included for the residential sector and some agricultural and aquaculture customers.

In the case of residential customers, a seasonal, regionalised and four-tiered consumption tariff-setting approach is used: (i) the four tiers (base, low, intermediate, high) are based on consumption ranges that also take household income into account – the first three tiers are partly cross-subsidised by the fourth; (ii) based on the associated climatic conditions, seven regions

are considered – this also impacts the ranges of the various consumption levels of the four tiers; and (iii) two seasons are considered, 'summer' and 'out of summer'. The four-tier consumption levels increase in the summer season.

This approach is based on the fact that electricity consumption is much higher during summer in certain regions of the country, and households with different incomes require different subsidy levels based on their consumption.

Table 4 provides an example of the tariff tiers grouping for Mexico City. Due to the region's climate, there are no seasonal tariff variations as for the rest of the country.

Table 4: Example of subsidies applied in domestic tariffs

	Subsidised			**Non-subsidised**
	Base	Low	Intermediate	High
	1–75 kWh/month	76–125 kWh/month	126–249 kWh/month	>250 kWh/month
MXN	0.837	1.012	2.962	4.372
US$	0.033	0.040	0.118	0.175
Difference from non-subsidised (%)	**81**	**77**	**33**	**-**

Source: Authors' compilation with information from CRE and CFE
Note: On 25 April 2020, US$1 = 24.98 MXN

For the country as a whole, and as of 2020, it is estimated that 98 per cent of residential customers are subsidised (more than 37.5 million customers) and only 2 per cent are in the non-subsidised blocks (750 000 customers).

The subsidy works as a transfer of resources from the federal government to CFE. The average subsidy granted during the last government period (2012–2018) was US$640 per customer over the entire period.

In order to reduce CFE's financial deficit (and consequent need for subsidies), CFE must purchase electricity through auctions at the lowest available prices. The bankability of the contracts is ensured through the financial strength of CFE Corporate as holding company.

During the third auction, buyers beyond CFE could purchase electricity through a market clearinghouse that centralised the transaction with the independent market operator CENACE. The market clearinghouse is a mechanism for addressing the complexity of an auction-based market with increasing numbers of buyers and sellers. It effectively binds all the future contracts for energy, capacity and Clean Energy Certificates (CELs), providing certainty to the market and in a sense acting as a financial guarantee mechanism by reducing the risk of contract failure. Further information on the clearinghouse and the pricing methodologies is presented in section 3.

2.1.3. Regulatory and policy framework

The electricity sector in Mexico has its regulatory and policy framework based in the Constitution, the Energy Transition Law (LTE), the Electricity Industry Law (LIE) and the associated regulations. These laws and regulations result in the development of a National Electric System Development Programme (PRODESEN) on an annual basis with a horizon of

15 years (PRODESEN, 2019). PRODESEN establishes 'the objectives, goals, strategies, and priorities that must be adopted to satisfy the demand in the National Electric System, while ensuring efficiency, quality, reliability, continuity, security and sustainability' (PRODESEN, 2019). PRODESEN is effectively a combination of the national policy with the results of the long-term power system planning outputs (using PLEXOS software).

PRODESEN's framework for public policy covering the period 2019 to 2033 includes the following objectives:

- Sovereignty, national energy security and sustainability;
- SENER directing the activities of the National Electric System, including generation, transmission, distribution and commercialisation, and coordination with other entities to issue policies and regulations to achieve rational and sustainable use of all energy resources;
- Guarantee the supply of electricity to all consumers, in compliance with the criteria of efficiency, quality and reliability;
- Application of the same regulation, competitiveness and transparency rules to all participants in the sector, including the establishment of tariffs with relation to costs;
- Compliance with international commitments on clean energies to address climate change; and
- Strengthening CFE as a state-owned company.

PRODESEN is an indicative instrument in terms of energy policy and potential generation projects, but it is a prescriptive instrument for transmission projects. Further information on the contents and objectives of PRODESEN is included in **Error! Reference source not found.**.

According to the LIE, all electricity consumers are 'obligated entities' that need to comply with clean energy requirements. All retailers (representing their clients) and other market participants must fulfil this requirement. To ensure compliance with the clean energy goals in the power sector, Mexico has implemented a CEL system. According to the current regulation, generators will receive one CEL for each MWh of clean energy generated, which can be sold in the market.

3. According to the LIE, 'clean energies are those from sources of energy and processes for electricity generation where emissions or waste, if any, does not exceed the thresholds established in the issued administrative regulations' (Art. 3, frac. XXII). Among the clean energy sources considered are wind power, solar radiation, hydro, nuclear, ocean energy, geothermal, bioenergy, methane and biogas, hydrogen, gasification from waste, efficient cogeneration, energy from sugar mills and energy from the sequestration of carbon dioxide. A more extensive and detailed list is included in Appendix B: Definition of clean energies

B.

SENER defined a clean energy target of 25 per cent by 2018 and 35 per cent by 2024, following Mexico's international commitments (Figure 2).

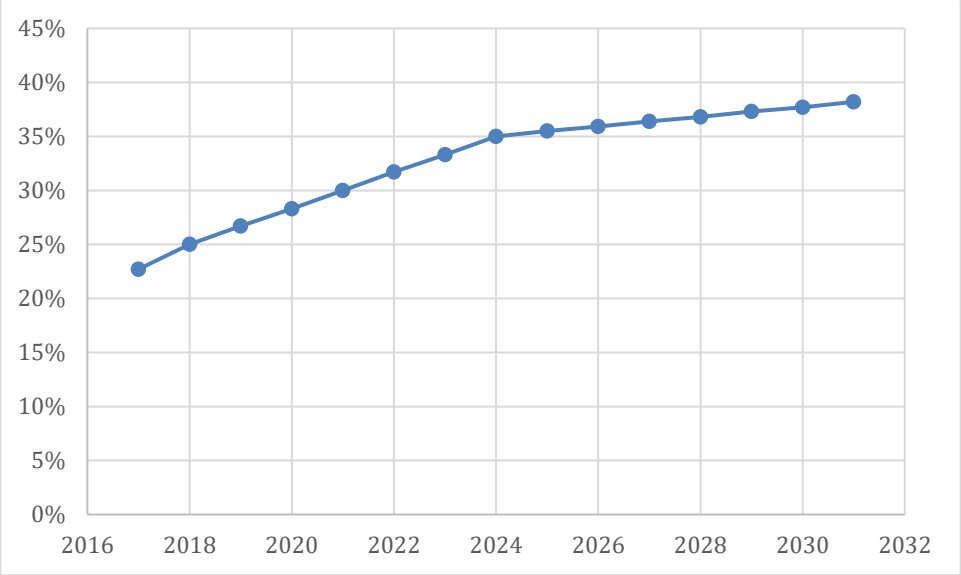

Figure 2: Clean energy trend 2017–2031

Source: Authors' compilation with information from PRODESEN, 2018

SENER sets the clean energy target for CFE during the first three months of each year for the following three years. Once established, the percentage cannot be reduced for a future year. The current requirements as a percentage of all the consumed electricity are shown in Table 1.

Table 1: CEL obligations up to 2022

Year	*Requirement (%)*
2018	*5*
2019	*5.8*
2020	*7.4*
2021	*10.9*
2022	*13.9*

Source: Authors' compilation with information from PRODESEN, 2018

A penalty is allocated to the obligated entities that do not meet the requirement and their obligation to acquire CELs will remain in place. Other non-obligated entities – as voluntary participants – may also acquire CELs through the auctions or in the open market.

3.1.1.1. Current status of the energy reform in Mexico

All energy reforms are iterative long-term processes, with governments normally issuing changes and recommendations, and addressing flaws, gaps or areas of opportunity. Such is the current case of Mexico, where some of the most prominent identified gaps relate to the competitiveness of CFE. The current government has indicated that they want to build on the power sector reform established under the previous administration to improve the conditions and stability of the National Electric System without negatively affecting the state-owned company or public finances.

Some of the main actions and reviews proposed by the current government to address the identified gaps and strengthen the position of the CFE are:

- Reviewing and updating the current model of transmission fees and tariffs to reflect the real costs associated with the services;
- Including any new PPA in the wholesale electricity market;
- Reorganising CFE to strengthen its generation divisions so that they are able to compete with the private sector;
- Amending secondary regulation so the CFE basic supplier is not bound to buy energy only through auctioned long- and medium-term contracts, but can also do so through taking advantage of commercial and market opportunities or to address emergency situations (such as the 2019 blackouts in the Yucatan Peninsula, or the 2020 electricity supply deficit in the Baja California Sur Peninsula);
- Replacing the governing body of CRE, including the appointment of new directors, to strengthen CFE in the market, including the review, modification and update of the current mechanisms to determine regulated fees and tariffs for generation, transmission and distribution to reflect the real costs associated with the services;
- Halting mid- and long-term energy auctions and other initiatives, such as the first private transmission auction, to review the conditions that limit the competitiveness of CFE generation and transmission companies. An example is the fact that the first three auctions were limited to delivering energy and products in less than three years, the project portfolios were limited to solar and wind power technologies, and other technologies such as hydro and biomass were excluded; and
- Reviewing the reorganisation of CFE as the new administration considers this unbundling as inappropriate and argues that it weakened CFE by resulting in increased costs, hampered administrative specialisation and created inefficiencies.

On 25 March 2019, SENER issued an amendment to the regulations which initially ordered this unbundling, now allowing the CFE generation subsidiaries to reorganise and reunify if required and to allow CFE to increase cooperation and coordination between its various entities, share employees and their capacities between divisions under certain conditions, and allow the use

of scale economies to improve operational efficiency and cost reduction in commercial activities.

4. Renewable energy auctions

The long-term auctions in Mexico are considered one of the cornerstones of renewable energy expansion in the country. The main motivation is to increase clean energy generation and capacity at competitive prices by fostering competition. CELs are the associated mechanism to ensure greenhouse gas emission reductions and are auctioned as an integrated package along with energy and capacity.

The post sector reform auction process was initiated in 2016. Since then, three auctions have been performed: two in 2016 (31 March, 23 September) and one in 2017 (22 November). CENACE is the main auction implementing entity due to its neutrality and technical capabilities to execute the process. During the transition period, SENER was in charge of leading the overall effort for the first three auctions, with CRE providing oversight and compliance monitoring. The fourth auction was supposed to see SENER passing on the responsibility to CRE, but keeping CENACE as the implementing entity.

The prices obtained for energy were combined with the CELs as a package. Table 7 provides a summary of the products, volumes, technologies and investments of the three auctions.

Table 7: Key auction information

Design		
	Frequency of auctions	Three auctions since 2016 One round per year Third round included market clearinghouse
	Products requested	Energy (MWh) Firm capacity (MW) CEL
	PPA length	15 years for energy, 20 years for CEL
	Currency	US$ (indexed)
Implementation	Policy and regulation guidelines	Energy Secretariat (SENER)
	Regulator	CRE
	Procurer	CENACE
	Off-taker	CFE (three auctions) Private sector (since the third auction)
Outcomes	MWh procured	20.16 TWh/y
	Technology procured	Wind, solar, hydro, turbogas (for firm capacity)
	Results' summary	**Auction 1 (31 March 2016):** 5.4TWh/y of clean energy 5.4 million CEL Average price of US$47.79 (MWh including CEL): • Wind: US$55.39 (25% of energy including CEL) • Solar: US$45.25 (75% of energy including CEL) Lowest solar bid worldwide at US$35.50 MWh 18 contracts awarded to 11 companies Estimated investment of US$2.6 billion Estimated capacity of 2 585 MW **Auction 2 (23 September 2016):** 9.27TWh/y of clean energy 8.9 million CEL

	Average price of US$33.47 (MWh and CEL): • Wind: US$35.29 (43% of energy and 41% CEL) • Solar: US$31.56 (54% of energy and 53% CEL) • Geothermal: US$37.31 (2% of energy and CEL) • Hydro: No energy assigned but 3% of CEL Solar bid: US$27.00 MWh 56 contracts awarded to 23 companies Estimated investment of US$4 billion Estimated capacity of 3 068 MW
	Auction 3 (22 November 2017): 5.49 TWh/y of clean energy 5.9 million CEL Average price of US$20.57 (MWh including CEL): • Wind: 45% of energy • Solar: 55% of energy • Firm generation capacity: 593 MW (Turbogas 84%, Solar 2%, Wind 4%) Lowest wind bid worldwide at US$17.70 MWh 16 contracts awarded to 8 companies Estimated investment of US$2.6 billion

Source: Authors' compilation based on information from SENER, CENACE, USAID MLED Program 2011–2018

CENACE plans and executes the auction based on the information contained in PRODESEN, starting with the issuing of bidding rules and a detailed calendar of the process.

4.1. Auction design

The auctions' main features include: multi-product – capacity, electricity generation and CELs; regional and hourly adjustments of bid prices; and technology-neutral auctions.

One of the key elements developed for the third auction is the 'market clearinghouse'. The risks associated with having multiple qualified buyers are mitigated through this clearinghouse acting as a 'single buyer, single seller', meaning that all generators and off-takers sign their contracts with the clearinghouse. It is in essence 'a mechanism to manage the contracts, risks and guarantees, allowing the participation of private buyers' (CENACE, 2017).

The clearinghouse is included as an independent mechanism for each auction and may be operated by an accredited third party, selected through a bidding process and assigned to an operator such as a financial trust fund or stock exchange company, but with the default operation done by CENACE. Further discussion on the mechanism is included in section 4.1.5.

Another key element in the auction design is the inclusion of a 'social witness'. This is a specialised civil society entity focused on monitoring, tracking and documenting the mandated compliance of the process. Usually, these witnesses are accredited non-governmental organisations. The function emanates from the constitutional mandate (Art. 134), in the sense that all acquisitions, leasing and purchases led by public officers must be executed by public bids with legality, transparency and impartiality.

The auction design is a multi-stage process with four main milestones (Figure 3).

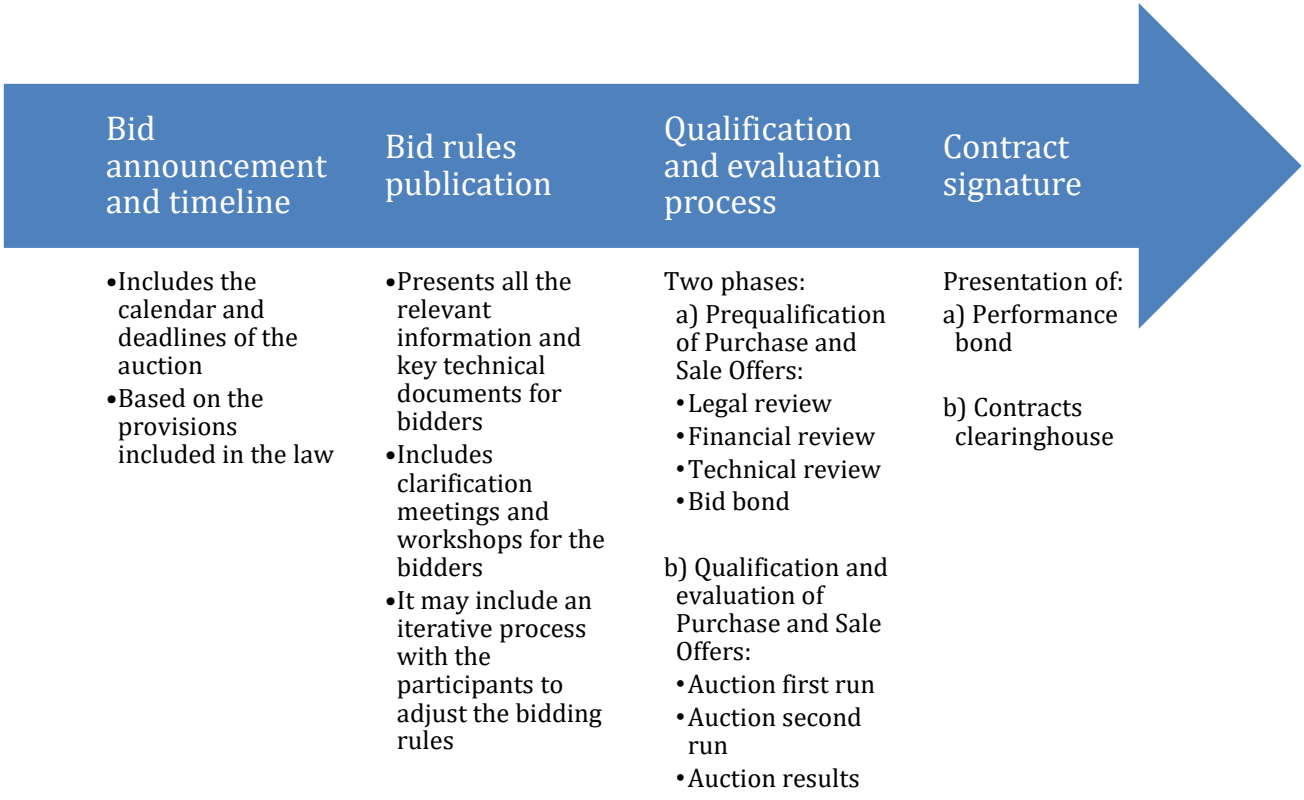

Figure 3: Auction stages

Source: Authors' compilation

The auction process starts with the bid announcement, which invites the sector to participate in the auction and provides the process milestones that each participant must go through. The bid rules are then issued to the public so potential bidders can decide whether they are interested in participating. If they decide to participate, they must pay an 'inscription' fee. The qualification and evaluation process is divided into two stages: the first focuses on the legal and financial capabilities of the bidders, both sellers and buyers; the second is the economic evaluation of the offers, based on an optimisation model of the prices and volumes of products offered, to maximise the benefits of the auction. Finally, the winning bids submit their performance guarantees and the contracts are signed.

There is usually enough time provided between milestones. The auction timeline from the bid announcement to the contract signature is around ten months: six months for the execution and award process and four months from award to contract signature, mainly to allow for the legal registration of the winning consortia and specific companies to be created for each of the projects. Once the contracts are signed, the projects are expected to come online in three years.

A detailed timeline for the third auction is shown in Table 8.

Table 8: Auction calendar

Stage	***Phase***	***Activity***	***Date or period***
Announcement	*0*	***Bid announcement and timeline***	*Day 0*
Bid rules publication	*1*	***Issue of the bidding rules to the public***	*Day 1*
	2	***Issue of the list of entities unable to participate*** *in the long-term auction due to conflict of interest*	*Day 7 (deadline)*
	3	***Payment for entry into auction*** *1. Bidding rules officially submitted* *2. Potential buyer registration* *3. Sales offer prequalification requests*	*1. Day 10 to day 100 (90 days)* *2. Day 10 to day 40 (30 days)* *3. Day 10 to day 100 (90 days)*
	4	***First training session*** *on the use of the dedicated website*	*Day 18*
	5	***Clarification meeting*** *1. Questions about the bidding rules and the annexes* *2. Questions about the clearinghouse operation guide and contract model* *3. Publication of answers to questions* *4. Questions period* *5. Publication of answers to questions*	*1. Day 24 to day 27* *2. Day 28 to day 29* *3. Day 35 (deadline)* *4. Day 36 (deadline)* *5. Day 41 (deadline)*
	6	*Issue of the* ***final version of the bidding rules***	*Day 49*
Qualification and evaluation process	*7*	***Second training session and potential buyers' registration, and offers initial submittal***	*Day 51*
	8	***Appointment of the social witness*** *for transparency*	*Day 52*
	9	***Publication of the potential buyer(s)*** *(either regulated or non-regulated)*	*Day 52 to 55*
	10	***Submittal of the regulated buyer purchase offers volume, prices and products to CENACE***	*Day 77 (deadline)*
	11	***Publication of the regulated buyer accepted purchase offers***	*Day 83*
	12	***Submittal of the non-regulated purchase offers volume, prices and products to CENACE***	*Day 92 (deadline)*
	13	***Publication of the non-regulated accepted purchase offers***	*Day 98 (deadline)*
	14	***Publishing of the maximum economic value threshold percentage****	*Day 99*
	15	***Third training session on submittal of technical offers for prequalification***	*Day 120*
	16	***Reception of prequalification applications for sales offers***	*Day 127 to 135*
	17	***Submittal of bid bonds***	*Day 138 (deadline)*
	18	***Issue of prequalification of qualified buyers and suppliers' certificates***	*Day 145 (deadline)*
	19	***Publication of the list of prequalified buyers and suppliers***	*Day 145 (deadline)*
	20	***Update of the prices for purchase offers for each product based on the exchange rate*** *(due to possible variations, CENACE may update the prices)*	*Day 145*
	21	***Fourth training session on presentation of economic offers***	*Day 149*
	22	***Reception of the first stage of economic sale offers***	*Day 154*
	23	***Reception of the second stage of economic sale offers***	*Day 159*
	24	***Review of the economic sale offers***	*Day 160*

	25	***Execution of the mathematical optimisation evaluation model of the economic sale offers***	*Day 161*
	26	***Execution of the possible additional iterations of the mathematical model of the adjusted economic sale offers***	*Day 162*
Contract signature	*27*	***Publication of the auction results and contracts award***	*Day 168 (deadline)*
	28	***Deadline for contract signature***	*Day 290 (deadline)*

Source: Authors' compilation based on information from CENACE

Note: * If this threshold is exceeded, then the auction is achieving the expected economic benefits; if not, the auction enters into the iterative process so the sellers may lower their prices.

The issuing of the bid rules starts the initial stage of the auction process. These rules contain the conditions participants must adhere to and the obligations they incur by doing so. The bid rules contain all the legal, technical and financial information required to participate in the auction, and include a comprehensive annex with a set of technical documents. All the involved and related government entities provide information and support for the execution of the auction (e.g. the National Institute of Archaeology and History in delivering recommendations on sensitive areas). A list of entities unable to participate in the long-term auction due to conflict of interest is also issued at this point. It is mainly focused on restricting government officers, consultants and suppliers that deliver products or services for the auction process from participating.

If the bidders decide to participate, they must purchase the bid rules to receive a code that gives them entry to the auction through a dedicated website. The proceeds are used to cover the costs of the auction.

Once the interested participants have paid for their entry, CENACE carries out the first technical workshop on the use of the dedicated website. All the legal, economic and technical documents and products delivered for the auction are handled through this platform. The platform not only eases the delivery of the documents but also ensures the traceability of the process.

In order to enhance the transparency of the process, a clarification meeting is carried out, providing a full review of the bid rules with the participants in several question-and-answer rounds that seek to clarify content, modify inconsistencies and/or add recommendations. The results of these meetings lead to the publication of the final version of the bid rules that are to be used during the auction.

4.1.1. Auction demand

Three products are auctioned: energy (MWh), generation capacity (MW) and CELs.

- Energy must be from any clean energy sources. The three auctions' results only included wind and solar energy (due to the requirement of reaching commercial operation in less than three years), but they may include small hydro, efficient cogeneration from natural gas (in compliance with current methodologies), biomass, ocean tidal and nuclear (restricted to government-controlled facilities).

- Each MWh from clean energy has an equivalent of one CEL. The offered portfolio can include integrated packages of energy and CELs, but they can also be separated products.

- Capacity can be from fossil sources (the auctions are open to include either energy, capacity or CELs, but it is not mandatory to include all of them). If no capacity was required in the auction, the ceiling price will be set at the marginal operating cost of existing projects.

The volume of the auction is dynamic and price sensitive. Each node submits a certain volume of purchase offers with accompanying maximum (ceiling) prices. CFE, as the retail services supplier, then submits the overall purchase volume and maximum prices for generation, CELs and capacity. CFE prioritises certain products and nodes based on its assessment of what is needed to fulfil the requirements of regulated customers. Since the third auction, once CENACE has reviewed the purchase requirements from CFE as retail services supplier, a list of the required products is published so the potential sellers may assemble their offers. Off-takers other than CFE retail services are also allowed to submit their purchase offers, which are included in the final auction volume.

The final auction volume is based on a system optimisation model that seeks to match the purchase offers and generation bids, taking into account the decommissioning of old facilities, electricity demand projections, transmission and distribution planning and constraints, fuel cost projections, clean energy requirements and international commitments. In practice, this means that the initial nodal purchase offers most likely do not end up determining what is procured, based on the optimisation of the overall system.

The CFE electricity demand requested in the third auction and associated bid ceiling prices are presented for the three products in Table 9 (generation capacity as requested for the three regions, and electricity and CEL requirements for the country as a whole).

Table 9: Products requested in the third auction

CFE generation capacity purchase offer requests for 15 years		
Region	*Quantity (MW/year)*	*Ceiling price per MW/year US$ (MXN)*
Baja California	*375*	*$83 730.88 ($1 673 752.12)*
Baja California Sur	*100*	*$71 198.70 ($1 388 374.60)*
National Interconnected System	*813.10*	*$54 550.90 ($1 063 742.54)*

CFE cumulative electricity purchase offer requests for 15 years (MWh/year)		
	Quantity (MWh/year)	*Ceiling price MWh/year US$ (MXN)*
	5 543 896	*$38.54 ($751.53)*

CFE CELs purchase offer requests for 20 years (CEL/year)		
	Quantity (CEL/year)	*Maximum price MWh/year US$ (MXN)*
	5 543 896	*$20.75 ($404.64)*

Source: Authors' compilation with information from CENACE

Note: US$1 = 19.50 MXN at July 2020

The third auction included private sector purchases by two buyers (Table 10).

Table 10: Products requested from the private sector in the third auction

Purchase offer requests from the private sector			
Entity	*Capacity for 15 years (MW/year)*	*Energy for 15 years (MWh/year)*	*CELs, 20 years (CEL/year)*
A	*77.11*	*35.57*	*9.49*
B	*2.42*	*1.12*	*0.3*

Source: Authors' compilation with information from CENACE

All these bid offers are presented to the system market operator, CENACE, who is responsible for assembling the purchase offer package presented to the sellers.

4.1.2. Site selection

Project developers are free to select their project sites, usually based on resource availability, land cost and interconnection availability, and linked to the auction requirements per area (nodes) where the energy and capacity are required (based on transmission and distribution capacity and decommissioning of plants).

To aid developers, SENER provides a National Atlas (AZEL) which includes solar radiation and wind speed data. The AZEL is also layered at a high level to the transmission grid, human settlements, roads and railroads, and excluded areas such as natural, archaeological or social protected areas.

4.1.3. Qualification criteria and process

The qualification process starts with CENACE delivering the third training session on submission of technical offers for prequalification – a technical workshop for the bidders to clarify questions on the format and requirements of the information, files and documents to be submitted for qualification. The technical, financial and legal qualification criteria include the following.

Technical experience

The bidder must have built and operated project(s) with a similar technology in the last ten years with a capacity equivalent to at least 33 per cent of the size of the capacity offered in the auction. In addition, bidders must commit to maintaining direct or indirect participation in the project company for a certain period. This is to avoid the scenario where a single company presents several projects and, once awarded, sells them to other unrelated companies.

Financial capacity

The financial review process assesses key economic and financial indicators related to the bidders' solvency (e.g. audited financial statements). Bidders also need to provide a letter of intention from lenders (banks and/or financial institutions). A key requirement is that the bidder must have obtained financing in the past of at least a similar amount to what is required by its offers in the auction.

Legal review

The review reduces the chance that a participant is unable to sign a PPA, obtain permits and carry out operations on the electricity market by not meeting the minimum requirements that the local mercantile legal framework establishes. Since the third auction, the contracts are standardised for both generators and off-takers and are signed with the clearinghouse.

Social aspects compliance

The local socio-economic development requirements are set out in the Administrative Provisions for Social Impact (*Disposiciones Administrativas de Impacto Social*). The regulations cover environmental and social criteria. The Environmental and Natural Resources Ministry regulates the environmental compliance. The Energy Ministry regulates social compliance. The process requires the provision of data from preliminary studies, social impact evaluations (*Evaluación de Impacto Social*, or EvIS), previous consultations, social investment and shared project benefit plans. Preliminary studies provide inputs for EvIS and the consultations. These in turn shape the project's shared benefits and social investment initiatives.

4.1.3.1. Level of project preparation

All projects are required to submit permits as part of the qualification process, including technical, environmental, interconnection and archaeological permits, as well as information attesting to the project's financial feasibility. The exact details depend on the requirements of each permit. For example, approved grid interconnection rights are mandatory, while the environmental, social and archaeological permit applications need to at least have been submitted to the authorities. Building, sewer and other structural permits may be at the pre-feasibility stage.

Starting with the second auction, land lease options and proof that projects will be able to obtain permits were also required. Land lease options are effectively 'pre-contracts' on the lease and use of the site, where the owner is willing to lease the land for preliminary studies. If a project is awarded, then the whole site will be leased for the term of the life of the project. Environmental and social qualification criteria were increased for the third auction, including the submission of all key permits and assessments to mitigate environmental and social risks.

The social impact assessment must be delivered to SENER prior to participation in the auction and, if required, the public consultation process must be performed prior to initiating construction. This depends on the project profile, location and characteristics of the local communities. The rules, methodologies and requirements are described in the Administrative Provisions for Social Impact.

Once the sellers fulfil the prequalification requirements, they will receive a certificate that allows them to present their economic proposals for participation in the auction.

For transparency and traceability of the process, CENACE publishes a list of the participants that have obtained a prequalification certificate. This is a major milestone that ensures the integrity of the participants.

All bidders are requested to present an auction participation guarantee as a bid bond to confirm their commitment to presenting an economic proposal, in order to cover the total potential liabilities (TPL) related to the volume of the products intended to be delivered. The requirement is for both sellers and buyers to confirm their intention of signing the PPAs. The bond is structured in four parts and linked to Mexican UDIs[1] established by the Mexican Central Bank. The UDI provides stability to certain markets because it is designed to retain its purchasing

[1] A UDI or 'Investment Unit' is an index unit of funds used in Mexico. It can be traded in many currency markets because its value changes with respect to currencies. Unlike currencies, it is designed to retain its purchasing power and not be subject to inflation. Its value is published periodically by the Bank of Mexico. The value of a UDI in March 2017 was around 5.7 pesos. US$1 = 19.5 pesos; 300 000 UDIs = US$88 000. In August 2020, the value was 6.53, which is 14 per cent above the price from 2017.

power without being exposed to inflation, but also without the risk of an exchange rate slide. As of August 2020, 1 UDI equalled US$0.30. The bid bond is structured in four parts: (i) 300 000 UDIs as initial bond to participate in the bid process, regardless of the number of offers and products presented; (ii) 65 000 UDIs per MW of capacity offered in the auction; (iii) 30 UDIs per each MWh of electricity offered in the auction; and (iv) 15 UDIs per each CEL being offered in the auction.

If the proposed project has already been interconnected, the TPLs are reduced by 50 per cent, and once the PPA has been signed, the auction participation guarantee is changed to a performance bond, as explained in section 3.1.5. If the project is rejected, the bid bond is returned to the bidder. Figure 4 provides a description of the guarantee mechanisms.

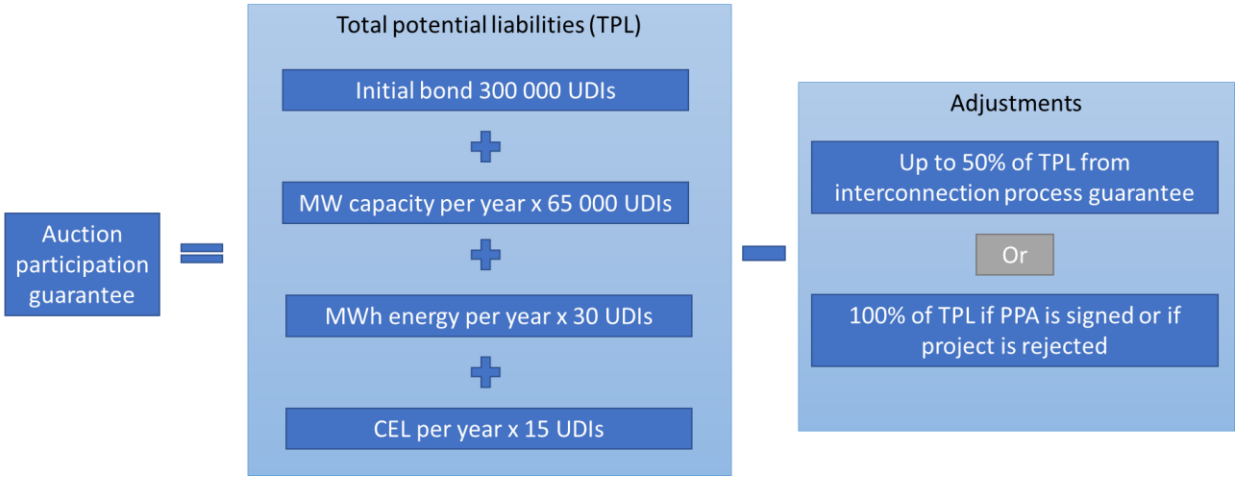

Figure 4: Auction participation guarantees

Source: Authors' compilation based on information from CENACE

4.1.4. Bidder ranking and winner selection

The methodology for pricing includes three types of adjustments on the pay-as-bid process (Del Río, 2017).

Nodal pricing

The regional nodal pricing adjustment is based on an hourly adjustment factor per zone which either rewards or penalises the zones depending on whether new generation capacity is needed or where production overcapacity exists. This internal evaluation adjustment factor does not affect the project's price, but is used for the evaluation of the bid. Nodal adjustment factors are defined for each new auction.

Hourly adjustment

Electricity from variable clean sources is paid at the price included in the seller's bid as adjusted up or down by 'hourly adjustment factors'. This is meant to account for the expected value of the energy delivered at the interconnection node relative to the expected average hourly price. This implies that more will be paid for electricity generated at times of higher demand and less

at times of lower demand. The hourly adjustments are used for the actual payments to the winning bidders[2].

Inflation and exchange rate adjustment

The price is also adjusted to account for inflation and variations in the peso/dollar exchange rate. Each bidder may choose that its payments be indexed to Mexican inflation or the peso/dollar exchange rate. At the commercial operation date (COD), the price offered in the bid will be adjusted to account for variations in the peso/dollar exchange rate (70 per cent weight), US inflation in proportion to the peso/dollar exchange rate variations (20 per cent weight) and Mexican inflation (10 per cent weight). This adjusted price is referred to as the 'initial price'. The initial price is multiplied by the average of the monthly adjustment factors (either exchange rate or local inflation, as initially selected by the bidder) to calculate the adjusted monthly prices for the corresponding year.

The bid evaluation process may have two or more stages to evaluate the sale offers and prices against the purchase offers through an optimisation model, considering an 'economic surplus threshold' (Figure 5). Once the reception of sale offers has concluded, the auction process is as follows:

- The 'electronically' sealed envelopes are opened;
- Offered pay-as-bid prices are readjusted upwards or downwards based on nodal congestion price considerations;
- Prices are compared and listed in ascending order;
- The lowest priced products are selected until the entire volume of the products requested is reached;
- If a pre-established economic surplus threshold is reached or exceeded, then the auction is considered closed and the sale offers selected proceed for contract signing. The economic surplus threshold is considered as reached when the bid offers (adjusted by the optimisation algorithm) meet the volumes requested at or below the price ceilings set by the purchase offers. If the threshold is not reached – meaning the volume offered is too expensive – then the auction enters an iterative process so the bidders can lower their offered prices, after which the algorithm is run again to check if the threshold is achieved;
- Rejected sale offer participation guarantees are returned to the corresponding participants.

[2] More information on the hourly adjustments is included in the bidding rules. Also, CENACE published a methodological note on the estimation of the marginal local prices and hourly adjustments factors; see https://www.cenace.gob.mx/Docs/MercadoOperacion/Subastas/2017/12%20Nota%20Explicativa%20de%20Metodo%20de%20Calculo%20de%20Diferencias%20Esperadas%20de%20PML%20v18%2005%202017.pdf.

Figure 5: Economic surplus thresholds for a single node

Source: Montenegro Gutiérrez Iván, 2019[3]

If a pre-established economic surplus threshold is not reached or exceeded, then the auction is considered open and a second run is activated, based on the following process: prices and volumes submitted are made public to all participants; the remaining percentage of the economic surplus threshold to be reached is made public to all participants; participants resubmit prices for the product volumes already offered; prices offered are readjusted upwards or downwards based on nodal congestion price considerations; prices are compared and listed in ascending order; the lowest prices are selected until the entire volume of the products requested is reached.

The process is repeated until the economic surplus threshold is met, or until no new prices are received that are at least 1 per cent lower than the previous iteration.

Once the results of the model are known, CENACE validates them through a review performed by academic institutions. This review process includes a social representative to guarantee transparency before the final official results are given.

At this point the auction is considered closed and the sale offers selected proceed for contract signing. Rejected sale offer participation guarantees are returned to the corresponding participants.

The auction results are published by CENACE and the participants are given enough time before contract signing for the creation of the legal entities required to represent contracts. The signature ceremony concludes the auction process.

[3] https://almanaque.colmex.mx/wp-content/uploads/2019/11/subasta.pdf

4.1.5. Buyer and seller liabilities

4.1.5.1. Financial prequalification and penalties

The PPA length is 15 years covering energy and capacity, and 20 years for the CELs. Projects are eligible to operate as merchant plants once the 15-year period has concluded.

In the first two auctions, the contracts were signed between CFE as the main off-taker and the generators, but since the third round of auctions, the operations are to be implemented through a contracts and guarantees management clearinghouse acting as a 'single buyer, single seller' (it acts as a buyer for all sellers, and as a seller for all buyers), with all contracts signed within the clearinghouse (see section 3.1.6).

All participants are required to present a contract compliance guarantee (performance bond) issued at the signing date of the PPA for the duration of the contract. The performance bond will cover the following based on the auction offer: 65 000 UDIs per MW of capacity, 30 UDIs per each MWh of electricity, and 15 UDIs per each CEL.

The amount of the performance guarantee varies if certain milestones are fulfilled (option to reduce amount) or not fulfilled (obligation to increase amount). Failure to achieve specific milestones (interconnection, operational tests) before scheduled COD will result in a 0.75 per cent reduction in the contract price of the PPA. Delays in reaching the scheduled COD also require that bidders increase the performance guarantee by 10 per cent (delay attributable to electricity generators), 2 per cent (delay attributable to federal government) and/or 5 per cent (delay attributable to state/municipal government) for each month's delay, subject to an overall cap of two times the original guarantee amount. Generators may defer up to 12 per cent of the contracted CELs to be delivered to the off-taker for up to two years, but any CELs so deferred shall be increased by 5 per cent (in volume) for each deferred year. If after deferring for two years there is a deficiency in CELs, the generator must purchase CELs in the market. If commercial operations are not commenced by the scheduled COD, the awarded bidder must pay a penalty equivalent to 5 per cent of the monthly payments under the PPA for every month of delay.

Since the third auction, the off-taker (buyer) must provide guarantees to be issued not later than 30 days after COD until end of contract: 32 500 UDIs per MW of capacity, 15 UDIs per each MWh of electricity, and 7.5 UDIs per each CEL.

For off-takers, the performance bond covers the fulfilment of the purchases and payments. If the off-taker does not pay, or is unable to take the products, the guarantees are executed through the clearinghouse.

4.1.6. Securing the revenue stream and addressing off-taker risk

The creation of a contracts clearinghouse, acting as a 'single buyer, single seller', helps to secure the revenue stream of the projects. For example, if a generator fails to deliver the promised energy block, the clearinghouse will compensate the buyers by acquiring the energy from the wholesale market until the next auction is performed and will seek to be compensated for this cost by the generator under the contractual regime. The same inverse scenario occurs if a consumer fails to acquire the energy block stipulated in the contract.

As the clearinghouse is a legal entity, it has the capacity to bill and collect payments. Further, it manages the guarantees and quantifies the risks on every project associated with each

portfolio. It also has the ability to execute the guarantees, suspend bilateral transactions or terminate contracts.

With regards to the auctions, the clearinghouse operates as follows:

1. A project portfolio is created for each auction.
2. The terms and guidelines for each portfolio are independent of other portfolios.
3. The balance and payments are related to the same portfolio.
4. Each buyer receives a proportional assignation of each of the sale offers selected as winning offer and related to the proportional participation in the auction. This is called a 'proportional assignation factor' (FAP).
5. The FAP determines the amount corresponding to each of the products delivered by the sellers. Figure 6 shows an example of the assignation in terms of capacity offered to the auction (MW).

Figure 6: Buyers' assignation in terms of products offered

Source: Compilation based on information from CENACE

6. The assignation is independent in each auction. The signature of new contracts from the same participants in previous or future auctions does not alter the contract awarded in the specific auction.
7. Each bidder will be assigned a contract to sell all its products to the clearinghouse. In the case of a buyer failing to fulfil its contract, the clearinghouse will cover its payments. Figure 7 shows an example of the assignation in terms of the price and payments, based on the same FAP.

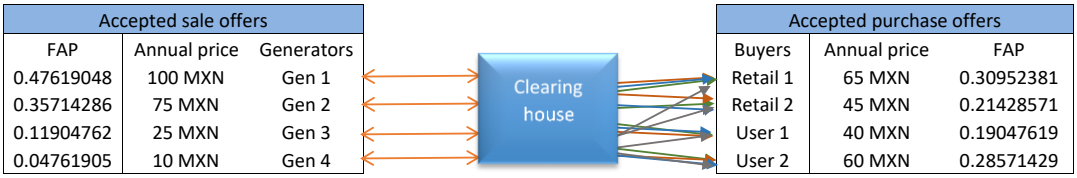

Figure 7: Bidders' assignation in terms of prices offered

Source: Compilation based on information from CENACE

Note: US$1 = 19.50 MXN

It is important to mention that the clearinghouse is not a guarantee. It receives and manages the individual guarantees and a reserve fund. This reserve fund is used to cover the immediate failures in obligations from either seller (by acquiring the missing products from the spot market) or buyer (by covering the missing payments). Eventually the guarantees are executed, and the clearinghouse seeks to procure the missing parts in a new auction.

The clearinghouse is complemented by the performance bonds, a reserve fund paid by the participants in the form of an initial fee and a financial credit line to be used as an immediate response instrument.

4.2. Auction implementation

By legal mandate the auctions are carried out by CENACE and led by SENER. The process is supported by other government institutions such as the Environmental Secretariat, the Social Development Secretariat and the Anthropology and History Institute, among others.

CENACE was selected as the technical administrator of the auctions, being the independent system and market operator with the staff to carry out the processes required, including having the legal attributes to sign and execute all the contracts. CENACE delegated its contract-signing authority (but not its legal responsibility) to the market clearinghouse in the third auction.

Auction participants indicated that the timely and effective implementation of the auctions reflected the capabilities of the implementing institutions. The bidding process and rules, and the legal and regulatory framework which was developed during the sector reform, also contributed to bidders' perceptions of the integrity of the process.

As noted, a 'social witness' provides oversight during the entire process, and the optimisation algorithm is reviewed and audited by a renowned university to ensure the validity of the results. In addition, the auction includes a highly structured and transparent communication process (including training on the bidding platform). All auction-related information and documents are published on the SENER website and Mexico's Official Gazette.

A challenge during the implementation of awarded projects was the ability to get permits, either at a federal or state level, including construction permits and land acquisition contracts. SENER has sought to address some of these issues through requiring social impact assessments (including community consultations) as part of the bidding package.

5. Results

Mexico's long-term energy auctions achieved some of the lowest average renewable energy prices at the time.

The combined results of the three auctions include: 1 780 MW for capacity, 19 558 443 MWh/year in cumulative energy and 24 363 975 CEL/year; combined cycle and turbogas (OCGT) were the predominant technologies associated with providing firm generation capacity; wind and solar were the predominant technologies in cumulative energy (MWh/year) provided; and wind, solar and geothermal were the technologies selected to deliver CELs.

Table 11 summarises the products awarded in the three auctions.

Table 11: Summary of the products awarded in the three auctions

	Capacity (MW)	*Capacity (%)*	*Energy (MWh/year)*	*Energy (%)*	*CEL/year*	*CEL (%)*
Solar	*194*	*11*	***11 648 653***	***60***	***12 159 497***	***50***
Wind	*211*	*12*	***7 711 026***	***39***	***7 694 193***	***32***
Hydroelectric	*0*	*0*	*0*	*0*	*314 631*	*1*
Geothermal	*25*	*1*	*198 764*	*1*	***4 195 654***	***17***
Combined cycle	***850***	***48***	*0*	*0*	*0*	*0*
Turbogas	***500***	***28***	*0*	*0*	*0*	*0*
Total	***1 780***	***100***	***19 558 443***	***100***	***24 363 975***	***100***

Source: Authors' compilation based on information from CENACE

Table 12 provides the number of projects awarded by technology in each of the three auctions.

Table 12: Technologies awarded in the three auctions

Auction	***No. of projects by technology***					
	Solar	*Wind*	*Hydroelectric*	*Geothermal*	*Combined cycle*	*Turbogas*
First	*12*	*6*	*0*	*0*	*0*	*0*
Second	*33*	*10*	*6*	*1*	*6*	*0*
Third	*9*	*6*	*0*	*0*	*0*	*1*
Total	***54***	***22***	***6***	***1***	***6***	***1***
%	***60***	***24***	***7***	***1***	***7***	***1***

Source: Authors' compilation based on information from CENACE

The first auction only delivered energy and CELs from renewable sources (wind, solar and geothermal) as the auction ceiling price for capacity was low due to the surplus available at the time. The second auction included generation capacity from geothermal and combined cycle gas turbines, as well as from the CFE hydroelectric plants which were already constructed but were able to deliver CELs, and from wind and solar generation projects. The third auction was again dominated by wind and solar projects but with the participation of a turbogas plant delivering capacity.

A disaggregation by the technology and the volume of products awarded is provided in Table 13.

Table 13: Products awarded by technology in the three auctions

	First auction			*Second auction*			*Third auction*		
Technology	*Capacity (MW)*	*Energy (MWh)*	*CEL (#)*	*Capacity (MW)*	*Energy (MWh)*	*CEL (#)*	*Capacity (MW)*	*Energy (MWh)*	*CEL (#)*
Solar	-	*3 772 028*	*3 754 955*	*184*	*4 836 597*	*4 933 382*	*10*	*3 040 028*	*3 471 160*
Wind	-	*1 384 021*	*1 384 021*	*128*	*3 874 458*	*3 828 757*	*83*	*2 452 547*	*2 481 415*
Hydroelectric	-	-	-	-	-	*314 631*	-	-	-
Geothermal	-	-	*3 996 890*	*25*	*198 764*	*198 764*	-	-	-
Combined cycle	-	-	-	*850*	-	-	-	-	-
Turbogas	-	-	-	-	-	-	*500*	-	-

Source: Authors' compilation based on information from CENACE

6. Disaggregated detail of the three auctions with the companies awarded, their associated technologies and the volumes of products delivered is included in Appendix C: Projects awarded in the three auctions

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6.1. Current project situation

Of the 66 wind and solar generation projects (Proyectos México, CENACE, February 2020) tendered through the three auctions between 2015 and 2017, the current status is as follows: 34 projects (51 per cent) are in commercial operation – 11 from the first auction, 22 from the second auction, 1 from the third auction; 8 projects (12 per cent) have entered the testing phase; 14 projects (21 per cent) are in the construction stage; and 10 projects (16 per cent) are in administrative processes.

The projects currently in the testing phases are scheduled to commence commercial operation no later than January 2021. The projects in the construction stages are expected to meet their scheduled COD, while those under the administrative processes are in the process of negotiating an extension due to delays associated with obtaining permits and land acquisition.

7. Lessons learned and recommendations

7.1. Auction implementation

A well-developed legal and regulatory framework shaped the design and execution of three successful auctions. This was achieved by building on the capabilities of Mexican institutions such as SENER, CRE and CENACE, and their integration as a working group seeking benefits for the electricity system at the lowest costs.

Two key characteristics of the process were important: participants' trust in CENACE's capacity and integrity, which was critical in providing accurate requirements and rules for the bidding process; and the transparency of the process, which was supported by the appointed social witness.

As a result, all the awarded projects achieved financial closure and obtained some of the lowest prices worldwide. Nevertheless, some projects are still facing environmental or social issues that need to be addressed, including in future auctions.

However, due to the current political views of the new government, the auction processes for new clean energy tenders have been halted and may face significant changes in accordance with strengthening CFE's position as the core actor in Mexico's power sector. Many of these new policies are being legally challenged.

The situation has been perceived as a negative signal to the market and to investors. Nevertheless, for the time being the new policy still maintains the goals and commitments of adopting clean energy and mitigating climate change, complying with the legal and regulatory framework, and maintaining CENACE as an independent system and market operator.

7.2. Auction design

After three auctions, building upon the recently established overall sector reform, Mexico was able to meet the targets established for CELs at some of the lowest and most competitive prices worldwide at the time. As of 2020, the CEL obligations had been fulfilled by all the obligated participants.

However, the rollback of the sector reform, the social and environmental issues associated with infrastructure projects, and the technical complexities of electricity systems present challenges in terms of auction design that need to be addressed through long-term planning.

The four areas identified for the design of future auctions being considered in Mexico are discussed next.

7.2.1. PLANNING

Harmonise inconsistencies between market operating provisions, grid code and other instruments

The issuing of many technical documents is a challenge in terms of harmonising and standardising their contents. A systematic and detailed review of the various regulatory and technical codes is thus needed. This review will help to identify aspects where the main actors – led by SENER – should intervene to establish priorities when the objectives are mutually

exclusive (for example, the modernisation of the infrastructure required by the Network Code, and the requests of individuals to relax its application to avoid excessive costs).

Further integration of methodologies for grid expansion

The National Transmission Network and the General Distribution Grid planning continues to be reactive, considering only those projects that have already requested studies or paid the corresponding guarantees. The recommendation is for the adoption of methodologies which involve generators and infrastructure developers from the beginning in the identification of the clean energy zones to be developed.

Better define and integrate markets for energy storage

Take a transversal approach to incorporate storage beyond a project-level focus, and thus give way to a more comprehensive evaluation where it is deployed strategically based on the added value to the system. To achieve this, the relevant authorities need to identify and match the services that storage offers with the operational needs of the network, and then correctly classify it within or outside the market based on the services offered at a particular time and location. The payment received will then be a function of the services offered versus the operating regime, and if necessary, compensating the difference in prices between both through a 'Guarantees of Sufficiency of Income' (compensatory payments, also called 'uplifts'). Likewise, the hybrid nature and the diversity of services that storage can offer allow it to be conceived more as a collection of assets than as a technology, which opens the possibility of its inclusion as a complement in current auctions, or in other specific auctions for system reliability.

Accelerate transmission projects

Speed up the implementation of transmission projects by agreeing on the criteria and technical analysis used in the planning framework, including whether these projects are to be built by the private or public sector.

7.2.2. AUCTION

Provide greater complementarity between generation options for better flexibility of the electricity grid

While the optimisation carried out in the auctions ignores the related services demanded during the operation of the selected power plants, the optimisation carried out in the planning considers SENER's Reliability Policy as an operational restriction, but not its associated costs. Most importantly, none of these optimisation exercises differentiates between dispatchable firm, non-dispatchable firm, dispatchable intermittent and non-dispatchable intermittent generation, as classified by the Market Participant Registration and Accreditation Manual or the associated benchmarks. The result is that the selected generation projects do not complement each other in practice and incur higher operating costs by satisfying the same demand.

It is possible to incorporate the complementarity of the various technologies within the auctions process since CENACE has all the technical elements to do so. Each price zone, load zone and regional control management must seek the greatest possible complementarity between the power plants in its territory, to increase their response flexibility, improve coordination between balance areas, reduce the power demand and ultimately minimise the frequency of the auctions for reliability.

Further define and address environmental and social requirements in the bidding rules

Several winning projects from the first auction are at risk of not being carried out due to social or environmental reasons. It is proposed to apply specific mechanisms to mitigate the additional risk in the event of not having completed the environmental and social studies at the time of participating in an auction. This could be done by requiring an additional guarantee (or an increase to the current one) that is proportional to the type of EvIS applied to the project and its degree of progress. The amount of this guarantee could then be progressively reduced as certain milestones are reached in the implementation of the project.

Provide greater flexibility in contracts for greater auction participation

In its current design, the auction rules oblige all buyers to purchase the same products, in the same proportion to the energy, power and CEL portfolio acquired by the basic service supplier(s), which is called the 'buyer's proportional allocation factor'. This rigidity has caused important market players to remain outside the auctions, considering that their needs can be better served through bilateral contracts or private auctions. The recommendation is to open the auction portfolio options to the requirements of the buyers. This could increase the number of potential participants and thus improve the economic conditions of the auctions.

7.2.3. CONSTRUCTION

Consider options of several technologies to provide greater flexibility and enough delivery times

According to the auction rules, the awarded projects must come online in 36 months following the contract signature. Considering 12 months of the 'pre-investment' stage of any project, only solar and wind technologies are capable of delivering clean energy in time. This situation excludes other clean technologies from participating in the auctions. This has been a cause for concern among some generator associations and the implication is that if these deadlines continue to be used, the auctions are not to be considered technology neutral.

The recommendation is that technological neutrality should start by recognising the intrinsic differences of each technology and adjusting the deadlines to allow them to compete on equal footing. By annualising the financial flows of each technology according to its different maturity periods, the profitability of the different projects could be equitably compared. This modification would also make it possible to diversify the energy mix and achieve better complementarity between technologies.

8. Conclusion

Power sector reforms take at least a decade to consolidate, and the benefits are not immediately clear to consumers. Energy auctions are designed within the local legal, regulatory, institutional, policy, strategic, market and economic framework of the country. As a result, the following issues are identified:

- Political timeframe considerations, such as elections and change of government, are important in the development of regulation and policies. Consistency is critical, regardless of the previous or current government policy or vision for the sector.
- It is critical to deliver a message to the population of the expected benefits and improvements from the auction, such as pricing, grid stability, energy availability and other socio-economic and environmental aspects.
- Auction design should incorporate social aspects associated with local and indigenous communities affected by the projects, including land, access and participation.
- There is a need to consider alternative auction design options to meet specific objectives, such as carrying out local/regional auctions and auctions for energy storage.

Even though the change of government in Mexico has presented new challenges to the electricity industry, the momentum gained from the sector reform and results of the energy auctions provide the framework for future decisions. The overall objectives are still to provide low-cost, reliable and clean energy to the Mexican population.

9. Appendix A: Key objectives of PRODESEN

Following is a list of the key objectives included on the 2019 PRODESEN:

1. Sovereignty, national energy security and sustainability.
2. SENER carries out the planning of the National Electric System and the preparation of PRODESEN as required by law.
3. SENER directs the planning of the National Electric System, integrating generation, transmission, distribution, commercialisation and energy transition, in accordance with the requirements of national development.
4. Guarantee the supply of electricity in accordance with the economic growth of the country in conditions of quality and the best price for the consumer.
5. Apply all the same regulations to CFE and the private power producers to ensure competition, fairness and equality of conditions.
6. Assure the required electricity transmission and distribution capacity.
7. Considering that electricity is a necessity, CFE is considered a public service company.
8. Ensure the profitability and return of capital on investments made in companies participating in the electricity market.
9. Establish transparency and best industrial practices for all participants in the National Electric System.
10. Increase electricity generation with clean and renewable energies and comply with international commitments regarding climate change and emissions reduction.
11. Electricity is a necessary public service which must meet the criteria of efficiency, quality, reliability, continuity, safety and sustainability of the electrical system.
12. The coordination between SENER and CRE must incorporate in its guidelines for authorisations and permits the criteria put in place based on the established energy policy.
13. Establish a responsible balance in the electricity tariffs in relation to the costs, including transmission and distribution, as well as generation support including fuel prices. This will require coordination of the design of methodologies and electricity rates which allow for the profitability and sustainable development of the electricity industry as a whole, as well as a quality electric service at an adequate price for users, and competitive for the national economy.
14. Make optimal use of the CFE generation infrastructure, especially to supply the basic supply.
15. Distribution to guarantee open access within the current limits of accommodation capacity, determined for medium- and low-voltage distribution circuits.
16. Consider that the reinforcements to the distribution network necessary for the interconnection of distributed generation power plants, whose maximum generation capacity exceeds its limits, will be charged to the applicant.
17. Guarantee access to universal, efficient, quality and reliable electrical service to all Mexicans.
18. Make rational and sustainable use of all available energy resources and technologies for national development and integrate clean and renewable energies in an orderly, sustainable and reliable manner into the national energy matrix, thereby promoting the generation and use of clean energies which contribute to the reduction of greenhouse gas emissions and the recovery of ecological systems.
19. Optimise science, technology, engineering and national industries of services, equipment and capital goods, and take advantage of the technological transfer that reaches the country.

20. A plan is provided to address the demand for electricity and its complement of distributed photovoltaic generation that will require the charging of electric vehicle batteries in the country in the future, for the medium and long term.
21. Recognise the contribution of CFE to the national generation of electricity with clean energy, so that they apply the same administrative and financial criteria as other private producers.
22. Respect the condition of fairness and fair competition between private companies and CFE in the participation of the electricity market.
23. Based on the autonomy and independence of each company participating in the electricity market, the regulations that subject other participants in the National Electric System to the subsidy or cost charge on CFE are modified by CRE to take into account the customer subsidy allocated considering all the elements associated with the wholesale electricity market, transmission and distribution.
24. Intermittent renewable generation must meet the criteria of not affecting the reliability of the National Electric System.

10. Appendix B: Definition of clean energies

Following is a list of the clean energies considered in the Mexico Regulatory Framework (Electric Industry Law):

- Wind power;
- Solar radiation in any form;
- Ocean energy in any of its forms: tidal, wave, marine currents and the salt concentration gradient;
- Heat from geothermal well;
- Bioenergetics as specified in the Law for the Promotion and Development of Bioenergetics;
- Energy generated from the heat power of methane and other gases from waste disposal sites, livestock farms and wastewater treatment plants, among others;
- Energy generated from hydrogen through combustion or use in fuel cells, whenever complying with a minimum threshold of efficiency established by CRE and the criteria from the Environmental and Natural Resources Secretariat on the life cycle of the fuel cells;
- Energy from hydroelectric power plants (up to 20 MW and to a limit of 10 W/m^2 – e.g., 100 MW with no flooded area greater than 10 000 000 m^2);
- Nuclear power;
- Energy generated with the products of the processing of agricultural waste or urban solid waste (such as gasification), when said processing does not generate dioxins and furans or other emissions that may affect health or the environment and complies with official regulations issued for this purpose by the Environmental and Natural Resources Secretariat;
- Energy generated by efficient cogeneration plants in terms of the efficiency criteria issued by CRE and emissions established by the Environmental and Natural Resources Secretariat;
- Energy generated by sugar mills that meet the efficiency criteria established by CRE and emissions established by the Environmental and Natural Resources Secretariat;
- Energy generated by thermal power plants with geological capture and storage processes or bio sequestration of carbon dioxide that have an efficiency equal to or greater in terms of kWh generated per ton of equivalent carbon dioxide emitted into the atmosphere at the minimum efficiency established by CRE and the emission criteria established by the Environmental and Natural Resources Secretariat;
- Technologies considered as low carbon emissions according to international standards; and
- Other technologies determined by the Energy Secretariat and Environmental and Natural Resources Secretariat, based on parameters and standards of energy and water efficiency, emissions to the atmosphere and generation of waste, directly, indirectly or in the life cycle.

11. Appendix C: Projects awarded in the three auctions

The table shows the companies, technologies and products awarded in the three auctions.

No.	Company	Technology	Power (MW)	Energy (MWh)	CEL (#)
		First auction			
1	Aldesa Energias Renovables, S.L.U	Wind	-	113 199	113 199
2	Aldesa Energias Renovables, S.L.U	Wind	-	117 689	117 689
3	Consorcio Energía Limpia 2010	Wind	-	291 900	291 900
4	Energía Renovable de la Península, S.A.P.I. de C.V	Wind	-	275 502	275 502
5	ENERGIA RENOVABLE DEL ISTMO II	Wind	-	585 731	-
6	ENERGIA RENOVABLE DEL ISTMO II	Wind	-	-	585 731
7	Enel Green Power México S. de R.L. de C.V	Solar	-	972 915	972 915
8	Enel Green Power México S. de R.L. de C.V	Solar	-	737 998	737 998
9	Enel Green Power México S. de R.L. de C.V	Solar	-	539 034	539 034
10	Jinkosolar Investment Pte. Ltd	Solar	-	277 490	277 490
11	Jinkosolar Investment Pte. Ltd	Solar	-	176 475	176 475
12	Jinkosolar Investment Pte. Ltd	Solar	-	48 748	48 748
13	Photoemeris Sustentable S.A. de C.V	Solar	-	54 975	53 477
14	Recurrent Energy Mexico Development, S. de R.L. de C.V	Solar	-	140 970	140 970
15	Sol de Insurgentes S. de R.L. de C.V	Solar	-	60 965	60 518
16	SunPower Systems México, S. de R.L. de C.V	Solar	-	269 155	263 815
17	Vega Solar 1, S.A.P.I. de C.V	Solar	-	493 303	483 515
18	Vega Solar 1, S.A.P.I. de C.V	Solar	-	246 832	241 935
		Second auction			
1	Comision Federal de Electricidad	Combined cycle	374.98	-	-
2	FRONTERA MÉXICO GENERACIÓN S DE RL DE CV	Combined cycle	119.98	-	-
3	FRONTERA MÉXICO GENERACIÓN S DE RL DE CV	Combined cycle	34.99	-	-
4	FRONTERA MÉXICO GENERACIÓN S DE RL DE CV	Combined cycle	99.99	-	-
5	FRONTERA MÉXICO GENERACIÓN S DE RL DE CV	Combined cycle	99.99	-	-
6	FRONTERA MÉXICO GENERACIÓN S DE RL DE CV	Combined cycle	119.98	-	-
7	Enel Green Power México S. de R.L. de C.V.	Wind	-	399 129.86	399 129
8	Energía Renovable de la Península, S.A.P.I. de C.V.	Wind	14	-	-
9	Energía Renovable de la Península, S.A.P.I. de C.V.	Wind	16	-	-

10	Eolica de Oaxaca S.A.P.I. de C.V.	Wind	-	818 264.52	818 264
11	Parque Eólico El Mezquite S.A.P.I. de C.V.	Wind	-	820 635.81	-
12	Parque Eólico El Mezquite S.A.P.I. de C.V.	Wind	-	-	774 938
13	Parque Eólico El Mezquite S.A.P.I. de C.V.	Wind	76.74	-	-
14	Parque Eólico Reynosa III, S.A.P.I. de C.V.	Wind	-	-	1 613 416
15	Parque Eólico Reynosa III, S.A.P.I. de C.V.	Wind	-	1 613 416.80	-
16	TRACTEBEL ENERGIA DE ALTAMIRA, S. DE R.L. DE C.V.	Wind	21.62	223 010.76	223 010
17	Comisión Federal de Electricidad	Geothermal	25	198 764.40	198 764
18	GENERADORA FENIX SAPI DE CV	Hydroelectric	-	-	75 546
19	GENERADORA FENIX SAPI DE CV	Hydroelectric	-	-	75 546
20	GENERADORA FENIX SAPI DE CV	Hydroelectric	-	-	64 386
21	GENERADORA FENIX SAPI DE CV	Hydroelectric	-	-	33 051
22	GENERADORA FENIX SAPI DE CV	Hydroelectric	-	-	33 051
23	GENERADORA FENIX SAPI DE CV	Hydroelectric	-	-	33 051
24	Alten Energías Renovables México Cuatro, S.A. de C.V.	Solar	38.59	-	-
25	Alten Energías Renovables México Cuatro, S.A. de C.V.	Solar	-	348 466.84	-
26	Alten Energías Renovables México Cuatro, S.A. de C.V.	Solar	-	373 576.95	-
27	Alten Energías Renovables México Cuatro, S.A. de C.V.	Solar	-	-	420 335
28	Alten Energías Renovables México Cuatro, S.A. de C.V.	Solar	-	-	392 082
29	Alten Energías Renovables México Cuatro, S.A. de C.V.	Solar	36	-	-
30	AT Solar	Solar	29	-	-
31	AT Solar	Solar	-	478 260.96	
32	AT Solar	Solar	-	-	478 260
33	Bluemex Power 1 S.A. de C.V.	Solar	-	249 982.32	249 982
34	Consorcio ENGIE Solar Trompezon	Solar	-	342 629.62	338 851
35	Consorcio Fotowatio	Solar	-	779 161.60	-
36	Consorcio Fotowatio	Solar	-	-	779 161
37	Consorcio Guanajuato	Solar	12	146 957.76	146 957
38	Consorcio SMX	Solar	-	278 357.76	-
39	Consorcio SMX	Solar	-	-	285 606
40	Consorcio SMX	Solar	10	-	-
41	ENERGIA SIERRA JUAREZ HOLDING S DE RL DE CV	Solar	-	114 115.90	-
42	ENERGIA SIERRA JUAREZ HOLDING S DE RL DE CV	Solar	-	-	117 064
43	GREEN HUB S DE RL DE CV	Solar	10	72 919.11	72 919
44	HQ Mexico Holdings, S. de R.L. de C.V.	Solar	18.3	-	-
45	HQ Mexico Holdings, S. de R.L. de C.V.	Solar	-	252 444.87	-
46	HQ Mexico Holdings, S. de R.L. de C.V.	Solar	-	-	252 444
47	Kamet Energía México, S.A.P.I. de C.V.	Solar	-	-	353 466
48	Kamet Energía México, S.A.P.I. de C.V.	Solar	-	353 466.00	-

49	OPDE	Solar	-	-	213 655
50	OPDE	Solar	-	-	75 853
51	OPDE	Solar	-	213 655.15	-
52	OPDE	Solar	-	75 853.95	-
53	Quetzal Energía México S.A.P.I. de C.V.	Solar	-	-	393 611
54	Quetzal Energía México S.A.P.I. de C.V.	Solar	-	393 611.32	-
55	X-Elio Energy, S.L.	Solar	16	193 771.20	193 771
56	X-Elio Energy, S.L.	Solar	14	169 365.84	169 365
		Third auction			
1	X-ELIO ENERGY, S.L.	Solar	10	435 354	483 727
2	NEOEN INTERNATIONAL S.A.S.	Solar	0	616 692	770 864
3	COMPAÑÍA DE ELECTRICIDAD LOS RAMONES S.A.P.I de C.V.	Turbogas	499.95	-	-
4	Canadian Solar Energy Mexico, S. de R.L. de C.V.	Solar	0	235 640	265 095
5	Canadian Solar Energy Mexico, S. de R.L. de C.V.	Solar	0	206 017	247 220
6	Canadian Solar Energy Mexico, S. de R.L. de C.V.	Solar	0	210 426	252 511
7	Consorcio Engie Wind	Wind	30.62	362 935	391 805
8	Consorcio Engie Solar 1	Solar	0	280 055	302 332
9	Consorcio Engie Solar 1	Solar	0	486 313	524 997
10	Consorcio Engie Solar 4	Solar	0	379 603	434 486
11	ENEL RINNOVABILE S.A. DE C.V.	Wind	0	373 017	373 016
12	ENEL RINNOVABILE S.A. DE C.V.	Wind	0	357 032	357 031
13	ENEL RINNOVABILE S.A. DE C.V.	Wind	0	510 680	510 680
14	ENEL RINNOVABILE S.A. DE C.V.	Wind	0	848 883	848 883
15	Consorcio integrado por MITSUI & CO., LTD y Trina Solar (Netherlands) Holdings B.V.	Solar	0	189 928	189 928
16	ENERGIA RENOVABLE DEL ISTMO II S.A. DE C.V.	Wind	52.04	-	-

Source: Authors' compilation with information from CENACE

12. Select bibliography

Asociación Mexicana de Unidades de Verificación de Instalaciones Eléctricas (AMUVIE). Subsidio Eléctrico Pendiente del Gobierno Mexicano. https://www.amuvie.mx/noticias-rss/142-subsidio-electrico-pendiente-del-gobierno-mexicano

Banco de México. Sistema de Información Económica, Tipos de cambio diarios. https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?&sector=6&accion=consultarDirectorioCuadros&locale=es

Cámara de Diputados. Ley de la Industria Eléctrica (LIE), Diario Oficial de la Federación, 11 August 2014, México.

Central Intelligence Agency (CIA). The World Factbook, North America – Mexico. https://www.cia.gov/library/publications/the-world-factbook/geos/mx.html

Centro Nacional de Control de Energía (CENACE). Bases de Licitación de la Subasta de Largo Plazo no 1 de 2018, 28 March 2018, México.

https://www.cenace.gob.mx/Docs/MercadoOperacion/Subastas/2018/01%20Convocatoria%20SLP2018%20v15%2003%202018.pdf

Centro Nacional de Control de Energía (CENACE). Cámara de Compensación de la Subasta de Largo Plazo, June 2017, México.

https://www.cenace.gob.mx/Paginas/SIM/CamaraCompensacionSLP.aspx

Del Rio, P. (2017). Auctions for renewable support in Mexico: Instruments and lessons learnt. Report D4.4-MX, AURES-EU Horizon 2020 Program.

Expansión. Datos Macro.com, PIB de México 2019. https://datosmacro.expansion.com/pib/mexico?anio=2019

Gobierno de México. Datos abiertos – Porcentaje de la población con servicio eléctrico. https://base.energia.gob.mx/dgaic/DA/P/DGPlaneacionInformacionEnergeticas/PorcentajePoblacionServicioElectrico/SENER_05_PorcentajePoblacionConServicioElectrico.csv

Gobierno de México. Plan Nacional de Desarrollo 2019–2014, 12 July 2019, México.

Index Mundi. Market capitalization of listed domestic companies (current US$) – Country ranking. https://www.indexmundi.com/facts/indicators/CM.MKT.LCAP.CD/rankings

Instituto Nacional de Estadística, Geografía e Informática (INEGI). Índice Nacional de Precios al Consumidor, Índice general, Período Enero 1969 a Mayo 2020. https://www.inegi.org.mx/app/indicesdeprecios/CalculadoraInflacion.aspx

Proyectos México, Información de CENACE, Contratos de largo plazo de cobertura eléctrica para la compraventa de potencia, energía eléctrica acumulable y certificados de energías limpias, 2020. https://www.proyectosmexico.gob.mx/

Secretaría de Energía (SENER). Disposiciones Administrativas de Carácter General sobre la Evaluación de Impacto Social en el Sector Energético, 1 June 2018, México.

Secretaría de Energía (SENER). Programa de Desarrollo del Sistema Eléctrico Nacional (PRODESEN), 14 June 2019, México.