cooperación alemana
DEUTSCHE ZUSAMMENARBEIT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

New investment opportunities:

Solar Energy Investment in Mexico

Context, perspectives and trends

Published by:
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Agencia de la GIZ en México
Torre Hemicor, PH
Av. Insurgentes Sur No. 826
Col. Del Valle
03100 CDMX, México
T +52 55 55 36 23 44
E giz-mexiko@giz.de
I www.giz.de/mexico

Version
Draft versión, June 2018

Programme
Energy Efficiency and Renewable Energy – Large Scale Solar Energy in Mexico (DKTI Solar)

Author
Ernst & Young

Supervision
Arno van den Bos, Joscha Rosenbusch (GIZ)

Design
Radical Testa SC

GIZ is responsible for the content of this publication.
On behalf of German Federal Ministry for Economic Cooperation and Development (BMZ)

TABLE OF CONTENT

ACRONYMS

AC	Alternating Current- Corriente Alterna
AMESCO	Asociación Mexicana de Empresas ESCO/Mexican Enterprises Association
ANES	Asociación Nacional de Energía Solar/National Solar Energy Association
APF	Administración Pública Federal/Federal Public Administration
ASOLMEX	Asociación Mexicana de Energía Solar Fotovoltaica/Mexican Solar Photovoltaic Energy Association
AZEL	Atlas Nacional de Zonas con Alto Potencial de Energías Limpias/National Atlas of Areas with Clean Energies High Potential
BANCOMEXT	Banco Nacional de Comercio Exterior/National Foreign Trade Bank
BANOBRAS	Banco Nacional de Obras y Servicios Públicos/National Infrastructure and Public Services Bank
BCA	Sistema Interconectado Baja California/Baja California Interconnected System
BCS	Sistema Interconectado Baja California Sur/Baja California Sur Interconnected System
BID	Banco Interamericano de Desarrollo/Inter-american Development Bank
BNEF	Bloomberg New Energy Finance
BSS	Basic Service Supplier
CAPEX	Capital Expenditures
CEC	Clean Energies Certificates
CEE	Cumulative energy
CEGAM	Centro de Especialistas en Gestión Ambiental/Environment Management Specialists Center
CENACE	Centro Nacional de Control de Energía/National Energy Control Center
CFE	Comisión Federal de Electricidad/Federal Electricity Commision
CONAGUA	Comisión Nacional del Agua/National Water Commission
CONUEE	Comisión Nacional para el Uso Eficiente de la Energía/National Commission for the Efficient Use of Energy
CRE	Comisión Reguladora de Energía/Energy Regulatory Commission
CSA	Calentadores Solares de Agua/Solar Boilers
DAC	Tarifa Doméstica de Alto Consumo/High Consumption Domestic Tariff
DAM	Day Ahead Market
DC	Direct Current
DEG	Distributed Electricity Generation
DG	Distributed Generation
DHI	Difuse Horizontal Irradiation
DOF	Diario Oficial de la Federación/Federal Official Gazzette
ENCC	Estrategia Nacional de Cambio Climático/National Climate Change Strategy
EP	Energy Performance
ESCO	Energy Service Companies- Empresas de Servicios Energéticos
ESM	Energy Surplus Meter
FATERGED	Financiamiento para Acceder a Tecnologías de Energías Renovables de Generación Eléctrica Distribuida/Financing to Access Distributed Electricity Generation Renewable Energies TechnologyFideicomiso para el Ahorro de Energía Eléctrica/Electricity EnergySa
FIDE	ving Trust

ACRONYMS

FIRCO	Fideicomiso de Riesgo Compartido/Shared Risk Trust
FOTEASE	Fondo para la Transición Energética y el Aprovechamiento Sustentable de la Energía/Energy Transition and Energy Sustainable Utilization Fund
FSE	Fondo de Sustentabilidad Energética/Energy Sustainability Fund
FSUE	Fondo de Servicio Universal Eléctrico/Electric Universal Service Fund
FTR	Financial Transmission Rights
GDN	General Distribution Network
GED	Generación Eléctrica Distribuida
GM	Generation Meter
GWh	Gigawatt-hour
GHI	Global Horizontal Irradiance
HAM	Hour Ahead Market
ICM	Iniciativa Climática de México/Mexico's Climate Initiative
IEA	International Energy Agency
IEC	International Electro-technical Commission
IFC	International Financial Commission
INAH	Instituto Nacional de Antropología e Historia/National Anthropology and History Institute
INECC	Instituto Nacional de Ecología y Cambio Climático/National Ecology and Clean Energies Institute
INEEL	Instituto Nacional de Electricidad y Energías Limpias/National Electricity and Clean Energies Institute
INEL	Inventario Nacional de Energías Limpias/National Clean Energies Inventory
INERE	Inventario Nacional de Energías Renovables/National Renewable Energies Inventory
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency - Agencia Internacional de Energías Renovables
IRR	Internal Return Rate
JBIC	Japan Bank for International Cooperation - Banco de Cooperación Internacional de Japón
KfW	Banco de Desarrollo Alemán/German Development Bank
kW	Kilowatt
kWh	Kilowatt-hora/Kilowatt-hour
kWp	Kilowatt ponderado/Weighted Kilowatt
LCTH	Load Center Titleholder
LGCC	Ley General de Cambio Climático/General Law on Climate Change
LIE	Ley de la Industria Eléctrica/Electricity Industry Act
LMP	Locational Marginal Price
LORCM	Ley de Órganos Reguladores Coordinados en Materia Energética/Coordinated regulatory Bodies or Energy Law
LRSS	Last Resource Service Supplier
LTA	Long Term Auctions
LTE	Ley de Transición Energética /Energy Transition Act
MIA-P	Manifestación de Impacto Ambiental del Proyecto/Project Environmental Impact Statement
MTA	Medium Term Auctions
MW	Megawatt
MWh	Megawatt-hora/Megawatt-hour
Nafin	Nacional Financiera/National Financial Entity
DNI	Direct Normal IrradianceNorma Oficial Mexicana

ACRONYMS

NMX	Normas Mexicanas/Mexican Standards
NOM	Norma Oficial Mexicana/Mexican Official Standards
NREL	Nacional Renewable Energy Laboratory
NTN	National Transmission Network
OPEX	Operating Expense
PECC	Programa Especial de Cambio Climático/Climate Change Special Program
PETE	Programa Especial de la Transición Energética /Energy Transition Special Program
PG	Private Grid
PPA	Power Purchase Agreement (o Contrato Bilateral)
PPP	Public-Private Partnership
PR	Performance Ratio
PRESEM	Proyecto de Eficiencia y Sustentabilidad Energética en Municipios /Municipal Energy Sustainability and Efficiency Project
PRODESEN	Programa de Desarrollo del Sistema Eléctrico Nacional /National Electricity System Development Program
PRONASE	Programa Nacional para el Aprovechamiento Sustentable de la Energía /National Program for the Sustainable Use of Energy
PSIE	Proyecto Servicios Integrales de Energía /Comprehensive Energy Service Project
QMPU	Qualified Market Participant User
QSS	Qualified Service Supplier
RTM	Real Time Market
SAGARPA	Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación/ Ministry of Agriculture, Farming, Rural Development, Fishing and Food
SCT	Secretaria de Comunicación y Transportes/Ministry of Communication and Transportation
SEIA	Solar Energy Industries Association
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales /Ministry of Environment and Natural Resources
SEN	National Electricity System
SENER	Secretaría de Energía/Ministry of Energy
SHCP	Secretaría de Hacienda y Crédito Público/Ministry of Finance and Public Credit
SIE	Social Impact Evaluation
SIE	Sistema de Información Energética /Energy Information System
SIN	National Interconnected System
TWh	Terawatt-hour
WEM	Wholesale Electricity Market

EXECUTIVE SUMMARY

This report provides a general overview of the electricity market in Mexico since the comprehensive Energy Reform, and describes opportunities for investors in the solar sector, by describing recent developments in the Mexican solar PV market, business models allowed under the new law, and general considerations for entering this fast-growing market.

The Energy Reform has created important opportunities, positioning Mexico as one of the most attractive markets for foreign investment among other emerging markets[1]. The photovoltaic sector in particular has generated high investment expectations, reflected in the results of the Long Term Auctions (LTA), in which solar energy projects had the largest participation in awarded contracts at very competitive prices. Solar projects awarded in the first three long-term auctions will require investments estimated at around USD $ 6.2 billion[2] for the next three years.

The new market structure includes a competitive wholesale electricity market (WEM), and opens the market to new business models where energy and associated products can be traded. The most relevant business models identified and described in this report include: the long and medium-term auctions, Power Purchase Agreements (PPAs) with both public and private entities (including the Energy Service Companies (ESCO), models for Distributed Generation (DG) and on-site generation), the sale of energy and associated products in the Short-Term Market and the Clean Energy Certificates (CEC) market. Each of these models has different advantages, disadvantages and risks that should be considered by investors when defining their market entry strategy.

The trading of Clean Energy Certificates (CEC) represents an additional opportunity for generators of solar energy to get additional revenue streams from their projects. The Ministry of Energy (SENER) establishes that suppliers and direct WEM participants must acquire a percentage of their total consumption in CEC.

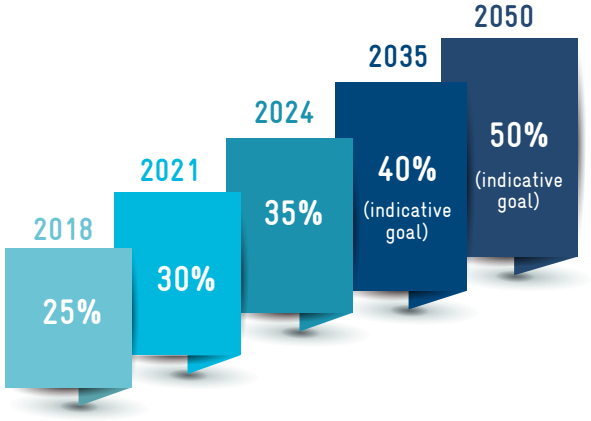
Though distributed solar generation (DG) is still in it´s infancy in Mexico, the global rapid growth of the solar sector, and the related reduction in PV system costs have contributed to a fast growth in this sector in Mexico as well. This growth is expected to continue unabated, driven by net-metering and net-billing schemes that are particularly attractive in unsubsidized tariff consumers from the residential, commercial and industrial sectors.

Acknowledgements: Special thanks to the Ministry of Energy, the Energy Regulatory Commission, National Energy Control Center, to Germany Trade and Investment, to the Germany-Mexican Chamber of Commerce and Industry (CAMEXA), ASOLMEX and other private sector players, for their support in contributing information for the elaboration of this report.

1 Bloomberg (2018) These Are 2018's Most (And Least) Attractive Emerging Markets.
2 SENER (2018) Blog: 2018, año de arranque de enormes transformaciones en el sector energético

SOLAR SECTOR KEY POINTS

The opening of the electricity market has resulted in an increase in clean energy investment as demonstrated in the outcomes of the auctions described in Section 1 of this report. Also, ambitious goals[3] have been defined for clean energy generation:



CLEAN ENERGY GOALS

Over a short period of time, the WEM was created and different mechanisms for selling clean energy were defined. One of the main mechanisms used are long-term auctions (LTA) where solar energy projects have taken a crucial role.

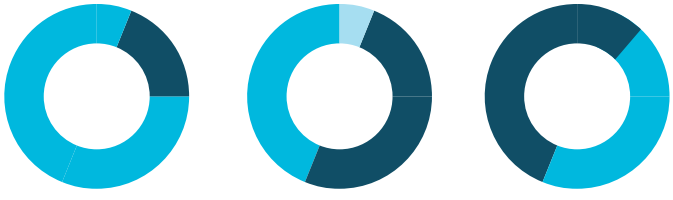
ENERGY ALLOCATED IN AWARDED CONTRACTS FROM THE LTA

(% by generation source)

1st Power Auction 2015
- Wind 25%
- Solar 74.4%

2nd Power Auction 2016
- Wind 43.5%
- Solar 54.5%
- Geothermal 2.2%

3rd Power Auction 2017
- Wind 45%
- Solar 55%



Source: Prepared by EY with information from CENACE (2017), Fallo de las Ofertas de Venta de la primera, segunda y tercera SLP

Power Purchase Agreements (PPAs) represent another important energy trading mechanism, with advantages for participants:

BUYER
Prices are fixed according to energy consumption while the supply is ensured

SELLER
Income is guaranteed as long as the contract has validity

Moreover, the growth of Distributed Generation (DG) is considered one of the main trends in the solar sector,. Since 2014, capacity has significantly increased[4]:

Installed Capacity in DG in Mexico

3 DOF (2015) LTE, tercero transitorio; y SENER (2017) Reporte de Avance de Energías Limpias, primer semestre 2017

4 ANES 2018

SECTION 1: CURRENT MARKET SITUATION AND SOLAR SECTOR TRENDS

1.1 MARKET VOLUME AND PROJECTIONS

Utility-scale Photovoltaic Power Plants

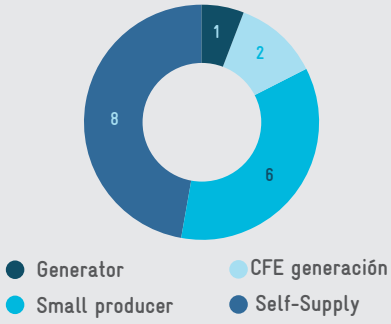
According to the Programa de Desarrollo del Sistema Eléctrico Nacional (PRODESEN 2018 – 2032), 23 large-scale photovoltaic power plants were in operation by the end of 2017, representing about 0.28% of the total installed capacity and 0.105% of power generation during 2017.

LARGE SCALE SOLAR ENERGY

PHOTOVOLTAIC PLANTS

23

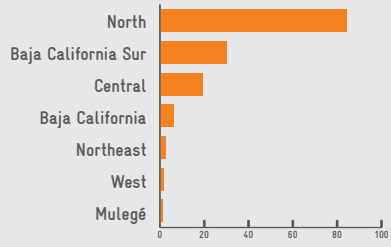
Number of photovoltaic plants by type of generation permit



INSTALLED CAPACITY

214MW

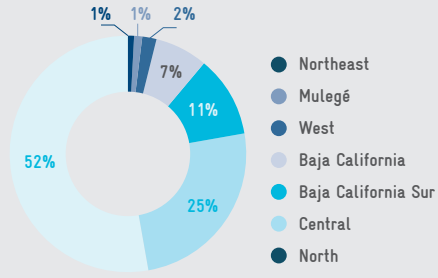
Installed capacity by region



POWER GENERATED

344GWh

Power Gross Generation* by region



Fuente: Elaborado por EY con información de PRODESEN 2017 – 2031

Additionally, 57 permits for photovoltaic plants were granted during 2017 according to the Comisión Reguladora de Energía (CRE)[5].

DISTRIBUTED GENERATION (< 500 KW)

According to the Electricity Industry Law - Ley de la Industria Eléctrica (LIE)- Distributed Generation (DG) shoul meet the following conditions[6]:

- It is carried out by an exempted generators (no generation permit required), who have an installed capacity below 0.5MW.
- It is carried out by a generation system that is connected to a private network (behind the meter) with high concentration of load centers.

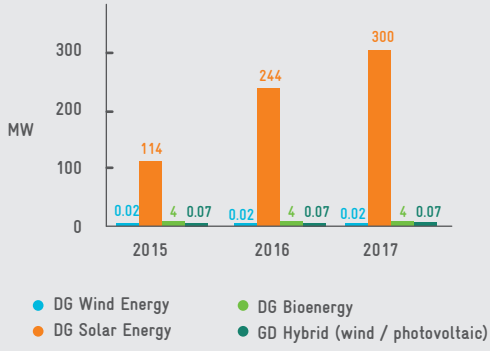
Notes: The 23 power stations should have generation permits from the CRE since the installed capacity is higher or equal to 0.5 MW. Source: DOF (2014), LIE. This number does not include the installed capacity in DG.
*Power Gross Generation: corresponds to the power generation reported by those power stations during the testing phase.
5 CRE (2017). http://organodegobierno.cre.gob.mx/permisose.aspx
6 DOF (2014) LIE

INSTALLED CAPACITY AND POWER GENERATED THROUGH DG

INSTALLED CAPACITY

TOTAL-MIND-2017
304 MW

DG installes capacity by technology type (June 2017)

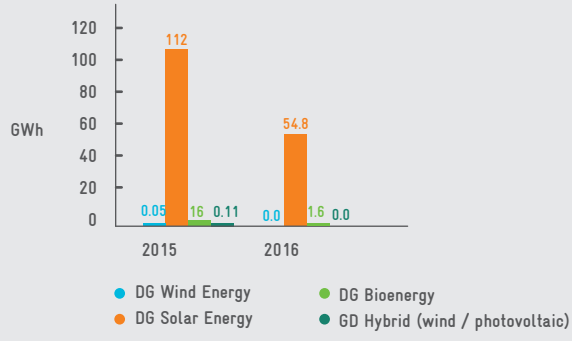


Source: Prepared by EY with information from CRE (2017)
Contratos de inteconexión en pequeña y mediana escala. Estadísticas 2017

POWER GENERATED THROUGH DG

TOTAL - 2016
56.4 GWh

Power ganerated through DG by technology type (2016)



Source: Prepared by EY with information from PRODESEN 2017-2031

INTERCONNECTION CONTRACTS FOR SMALL AND MEDIUM SCALE

NUMBER OF INTERCONNECTION CONTRACTS FOR SMALL AND MEDIUM SCALE

These contracts allow the interconnection between the National Grid - Sistema Eléctrico Nacional (SEN) and the renewable power system, or with medium-scale cogeneration systems. Small and medium scales are defined as follows:

Small scale projects: **up to 30 kW**
Medium scale projects: **up to 500 kW**

In any case[7] a power generation permit is not required.

7 CRE (2017) Contratos de interconexión en pequeña y mediana escala: Estadísticas ejercicio a Junio de 2017

SELF-SUPPLY (LEGACY PERMITS)

Previous to the Energy Reform, under the former Ley del Servicio Público de Energía Eléctrica (LSPEE), SENER granted permits for self-supply[8] (Autoabasto). These permits remain valid under the new law (LIE) until the end of 2018 while no new such permits are issued. Although these legacy permits remain valid until the end of 2018, the project capacity cannot be changed. New permits for self-supply are granted under the new law under the new self-supply scheme – called ´Auto-abasto´ – described below.

The reform establishes that this legacy figure of self-supply disappears for new projects and the LIE states that to generate power › 0.5 MW a Generation permit is needed and the generator should participate directly in the wholesale electricity market (WEM), regardless of the type of project. Projects with a capacity lower than 0.5 MW fall under the Distributed Generation legislation and do not require any permit.

Also, under the LIE, it is possible to transition to the new scheme through the CRE and without any cost. One benefit of this transition is the possibility that, once a permit was transitioned under the new regulation, it can return to the original contract terms (under the LSPEE) during the first five years[9]. Nonetheless, the contract´s length cannot be extended.

Additionally, the LIE creates the figure of legacy contracts which helps the transition in a more organized way[10]. This mechanism works specifically when the power generation is stablished in a free market.

According to LIE, it is determined that the Basic Service Supplier (BSS) may sign contracts with the legacy power stations[11] and the external legacy power stations[12] according to the price of its contracts and costs.

The following diagram includes the market volume for self-supply as of 2016 (considering the former regime). The main information reflects the number of self-supply photovoltaic plants (8), which represents 47% of solar stations currently operating in Mexico (17).

8 DOF(2012) Ley del Servicio Público de Energía Eléctrica – Artículo 36
9 CRE (s.f), http://www.cre.gob.mx/documento/faq-regulacion-electricos.pdf
10 SENER (s.f), Nota explicativa – Contratos legados para el suministro básico https://www.gob.mx/cms/uploads/attachment/file/258356/Nota_explicativa_contratos_legados.pdf
11 The legacy power stations are part of the State and in consequence participate in the federal budget. Source: SENER (s.f), Nota explicativa – Contratos legados para el suministro básico
12 The external legacy power stations have permits as an Independent Energy Producer and may be included in the federal budget as conditioned investment. Source: SENER (s.f), Nota explicativa – Contratos legados para el suministro básico

SELF-SUPPLY

IT IS THE ENERGY SUPPLY REQUIREMENT THROUGH A SELF-OWNED GENERATION PLANT.

NÚMERO DE CENTRALES DE AUTOABASTECIMIENTO

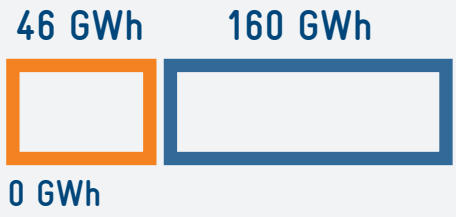
ALL TECNOLOGIES **376**

SOLAR PHOTOVOLTAIC **8**

PHOTOVOLTAIC INSTALLED CAPACITY (MW) - 2016

- Self-sufficiency photovoltaic installed capacity
- Total photovoltaic installed capacity

PHOTOVOLTAIC GENERATION*1 (GWH) - 2016



- Self-supply photovoltaic gross generation
- Total photovoltaic gross generation

SELF-SUPPLY PERMITS GRANTED BY THE CRE (JUNE 2016)

546	Total of self-supply permits granted by the CRE*2
65	Total of self-supply permits for photovoltaic technologies granted by CRE*3

Source: Prepared by EY with information from PRODESEN 2017 – 2031 and CRE (2016)

*1 Gross Generation, includes the generation reported by the power stations during testing stage.
*2 Considers: permits in building stage, in operation, or about to start the construction stage, including all types of technology.
*3 Considers: permits in building stage, in operation, or about to start the construction stage, including only photovoltaic technology.

Self-supply represents 30.3% of photovoltaic installed capacity. 28% of the photovoltaic gross generation corresponds to self-supply. CRE has granted 546 self-supply permits (including operating stations, in construction and those about to start the construction stage), from which 65 corresponds to photovoltaic technology.

From the 65 self-supply permits granted by the CRE, 17 are under construction, 40 are about to start the construction stage and 8 are in operation[13].

SOLAR POTENTIAL BY GEOGRAPHIC REGIONS

Mexico has some of the world´s most attractive solar irradiation profiles, which contribute to bringing down levelized costs of electricity.

The solar resource in a particular location is typically defined using one of the following three concepts:

IDN

Direct Normal Irradiance: Is the amount of solar radiation received per unit area by a surface that come in a straight line from the direction of the sun at its current position. DNI is of particular interest to concentrating solar thermal installations and installations that track the position of the sun.

IHD

Diffuse Horizontal Irradiance: Is the amount of radiation received per unit area by a surface that does not arrive on a direct path from the sun, scattered by molecules and particles in the atmosphere.

IGH

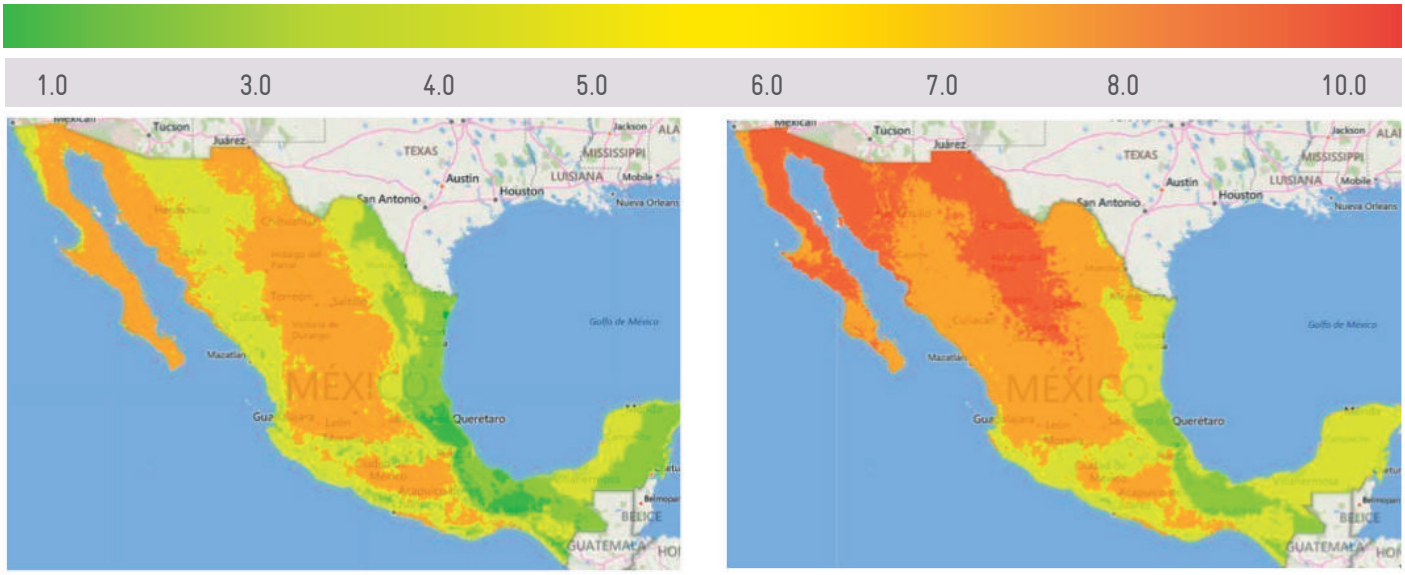
Global Horizontal Irradiance: Is the total amount of shortwave radiation received from above by a surface horizontal to the ground.

The National Clean Energies Inventory (INEL, former INERE) and the National Atlas of Areas with High Potential of (AZEL) are the instruments that the Mexican government has created for statistical and geographical information regarding clean energies. The following maps show the solar potential, considering the DNI and the GHI Mexico receives during one year.

13 Includes the reported generation by the power stations in testing stage. Source: SENER (2017), PRODESEN (2017-2031)

SOLAR POTENTIAL IN MEXICO

(kWh/m²/día) *4



MEDIDA	IGH
ANNUAL AVERAGE	5 kWh/m² per day
HIGHEST	6.12 kWh/m² per year
LOWEST	4.43 kWh/m² per year

MEDIDA	IDN
ANNUAL AVERAGE	6.2 kWh/m² per day
HIGHEST	NOT AVAILABLE
LOWEST	NOT AVAILABLE

Note: *4
To calculate the highest values, heat maps from INERE in the month with highest irradiation were identified, as well as the area with highest irradiation within the territory. In order to find the lowest values, the solar irradiation maps from INERE in the month with lowest irradiation were identified, as well as the lowest irradiation within the territory.

95% of the Mexican territory has a GHI annual average higher than 5 kWh/m2 per day. Areas with the highest solar resource are in the northeastern region. The highest GHI occurs during May, where a GHI of 6.12 kWh/m2 /year is registered. The lowest GHI is around 4.43 kWh/m2/year, during October.

Regarding DNI, Mexico has an annual average of 6.2 kWh/m2 per day[14], which is more than double the irradiation received in Germany.

INSTALLED CAPACITY POTENTIAL AND SOLAR GENERATION POTENTIAL (GWH/YEAR)-JUNE 2015

INEL hast also calculated the power generation potential of solar energy, as shown in the table below.

RESOURCES	INSTALLES CAPACITY POTENTIAL (MW)	SOLAR GENERATION POTENTIAL (GWh/año)
PROVED	11,648.74 MW	25,052 GWh/year
POSSIBLE	NOT AVAILABLE	6,500,000 GWh/year

Source: INERE

14 SENER (2017) Recursos renovables para la producción de electricidad en México https://dgel.energia.gob.mx/documentos/Renovables_Mexico.swf

TECHNICAL POTENTIAL

Below are four scenarios with solar generation potential identified by AZEL[15]. These scenarios were classified according to the distance between potential areas and the National Transmission Network (NTN). Potential installed capacity by type of technology (fixed and solar tracking[16]) are presented for each scenario

SOLAR GENERATION POTENTIAL

SCENARIO 1

Areas without considering NTN distance*[5]

POTENTIAL		
SYSTEM	INSTALLED CAPACITY POTENTIAL (GW)	SOLAR GENERATION POTENTIAL (TWh/year)
FIXED	1,171.8	2,121.8
SOLAR TRACKING	837.5	2,077.9

Map 3 - Solar photovoltaic potential (fixed)

Map 4 - Solar photovoltaic potential (solar tracking)

SCENARIO 2

Areas located at a distance equal or shorter to 20 Km from NTN.

POTENTIAL		
SYSTEM	INSTALLED CAPACITY POTENTIAL (GW)	SOLAR GENERATION POTENTIAL (TWh/year)
FIXED	639.4	1,156.2
SOLAR TRACKING	450.6	1,115.8

Map 5 - Solar photovoltaic potential (fixed)

Map 6 - Solar photovoltaic potential (solar tracking)

Source: AZEL and SENER (2016) Prospectiva de energías renovables 2016 – 2030

According with the heat map analysis, scenario 1 reflects a higher solar photovoltaic potential than the other three scenarios, mainly due to the lack of restrictions in terms of distance from the NTN.

On the other hand, scenario 3 considers areas with a distance shorter to 2 km from the NTN. In this scenario, the installed capacity potential (solar fixed: 139 GW, solar tracking: 97.6 GW) and the solar generation potential (solar fixed: 252.5 TWh/year, solar tracking: 242.6 TWh/year) are lower than the other scenarios.

Finally, even when scenario 2 considers a distance equal or shorter to 20 Km and scenario 4 a distance of more than 20 Km from the network; scenario 2 is the closest to real conditions since it considers the distance restrictions from the network and has an installed capacity potential and a solar generation potential higher than scenarios 3 and 4.

SCENARIO 3
Areas with a distance shorter or equal to 2 Km from the national grid.

POTENCIAL APROVECHABLE

SYSTEM	INSTALLED CAPACITY POTENTIAL (GW)	SOLAR GENERATION POTENTIAL (TWh/year)
SOLAR FIJO	139	252.5
SOLAR SEGUIMIENTO	97.6	242.6

Map 7 – Solar photovoltaic potential (solar fixed)

Map 8 – Solar photovoltaic potential (solar tracking)

SCENARIO 4
Areas with a distance longer to 20 Km from the national grid.

POTENCIAL APROVECHABLE

SYSTEM	INSTALLED CAPACITY POTENTIAL (GW)	SOLAR GENERATION POTENTIAL (TWh/year)
SOLAR FIJO	462.2	837.5
SOLAR SEGUIMIENTO	334.1	836

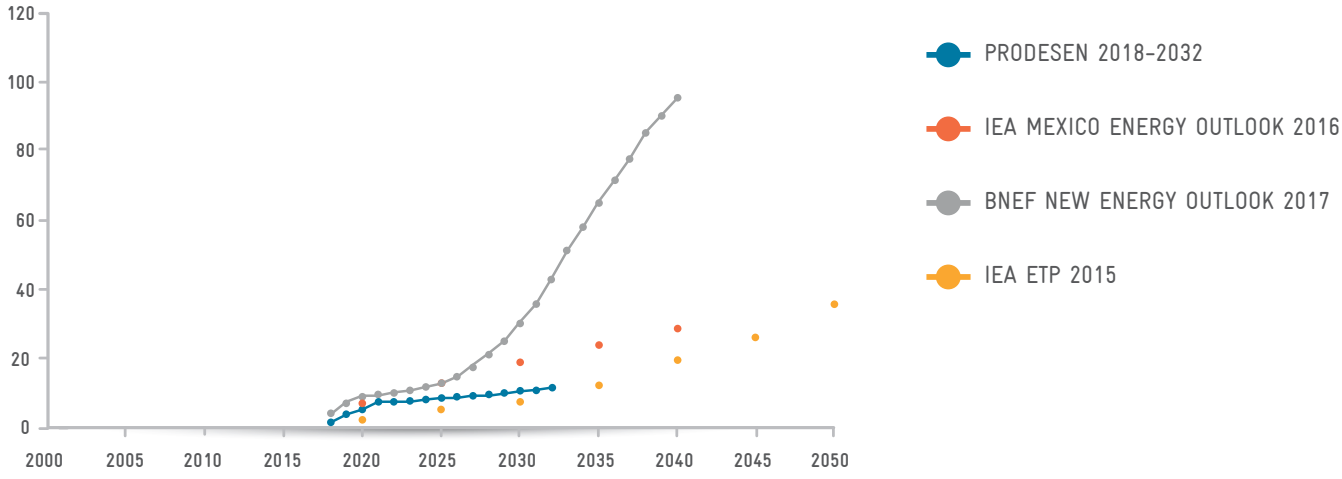
Map 9 – Solar photovoltaic potential (solar fixed)

Map 10 – Solar photovoltaic potential (solar tracking)

Source: AZEL y SENER (2016) Prospectiva de energías renovables 2016 – 2030

From the four proposed scenarios, it can be observed that even the installed capacity is lower in the tracking systems than in the fixed one, the solar generation potential in each scenario is similar. This results from a higher energy production from the tracking systems considering its perpendicular direction to the sun[17].

Below the projections for PV installed capacity until 2050 are shown from several sources. The information sources are: PRODESEN 2018-2032, the International Energy Agency (IEA)[18] [19] and Bloomberg New Energy Finance´s New Energy Outlook 2017. Although the forecasts differ in their assumptions of price developments and adoption rates, they all expect a large growth in both utility-scale as well as distributed generation solar power. show a growing trend for both installed capacity.



The differences between PRODESEN and the IEA are mainly due to the methodologies used. In the case of PRODESEN, they forecast first the power energy demand from 2018-2032. With these results, the Programa Indicativo para la Instalación y Retiro de Centrales Eléctricas (PIIRCE) uses an optimization model that allows to understand the type, size and location of the power stations that must be installed, the operating timeframe and the capacity withdrawal programs. [20].

In the other hand, the methodology used by the IEA is based in a New Policies Scenario, which takes into account the national policies and the guidelines from the Energy Reform. The data used in the forecast up to 2014 came from IEA statistics and the growth rates are calculated based on the annual growth rate baseline.

Note: *5 According with AZEL methodology, scenario 1 identifies the regions with high potential for power generation projects base don clean energies without considering the distance to the NTN. This has the objective of identigying the regions with highest potential without considering the distance to the NTN.

15 This evaluation is driven at a country scale and is focused mainly in the possible potential category (technical potential), since it considers the restrictions in the use of the territory. Also, it stablishes the requirements for energy production performance for each technology. Source: AZEL (2016), https://dgel.energia.gob.mx/AZEL/
16 Solar fixed: refers to solar panels without a tracking system to find the perpendicular orientation of the Sun. They are fixed in an optimal position to obtain the highest amount of energy through the year. Solar tracking: refers to solar panels that rotate in one or two axes, following the Sun's movement. Source: Universidad Pública de Navarra (2014) Estudio comparativo de la eficiencia energética en seguidores solares http://academica-e.unavarra.es/bitstream/handle/2454/11844/TFGTurrillasSalobreEduardo2014.pdf?sequence=1
17 Tecnointeligente (2018), http://www.tecnoligente.com/incrementando-potencial-los-paneles-solares-en-mexico-seguidor-solar-diseno-mexicano/
18 Data published by the IEA are given at 5-year intervals (2015, 2020, 2025, 2030 y 2035).
19 IEA (2016) Mexico Energy Outlook
20 SENER (2017) PRODESEN 2017-2031

In the other hand, the methodology used by the IEA is based in a New Policies Scenario, which takes into account the national policies and the guidelines from the Energy Reform. The data used in the forecast up to 2014 came from IEA statistics and the growth rates are calculated based on the annual growth rate baseline.

Based on the explanation above, the IEA forecasts are more optimistic due to the following reasons:

IEA considers a lineal annual growth rate.

PRODESEN optimize the type of technology, the size and the location of the power stations, with the aim of achieving the efficiency of the installed capacity and the power generation considering the clean energy goals.

The following graphic shows the evolution of the gross consumption in the three scenarios defined by PRODESEN 2017 – 2031: low, planning and high. These scenarios show a grow trend from 2017 to 2031, due to higher gross consumption:

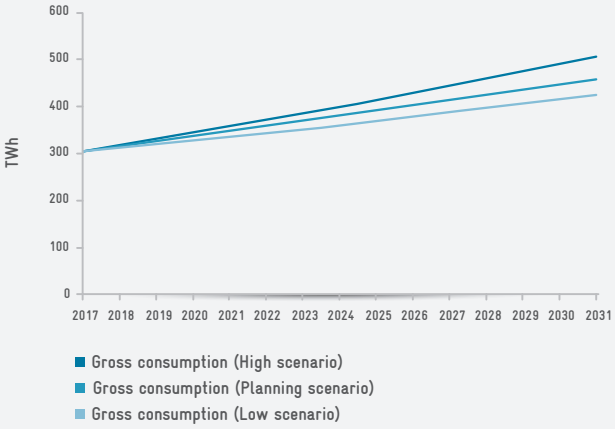
By analyzing the power consumption needs that may be covered in year 2031, the following scenarios resulted in:

LOW SCENARIO	PLANNING SCENARIO	HIGH SCENARIO
122.86 TWh	151.33 TWh	198.02 TWh

LOW SCENARIO	PLANNING SCENARIO	HIGH SCENARIO
3.14%	2.93%	2.64%

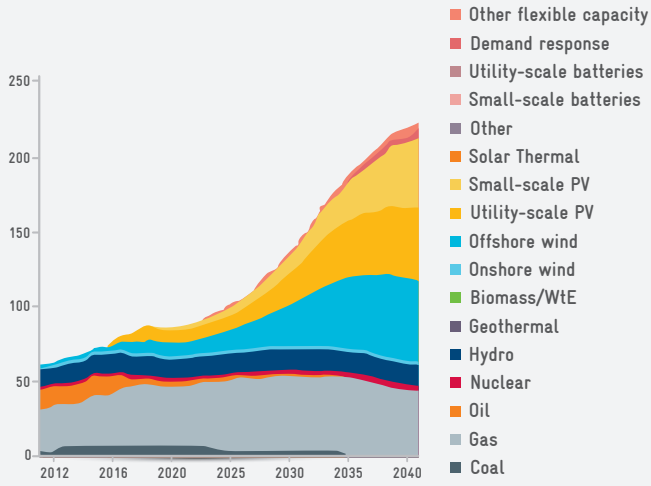
Also, the cumulative installed capacity by technology type (2012 – 2040) shows that the photovoltaic installed capacity between 2025 and 2040 grows from 8.7 GW to 40 GW[21]. Additionally, gas, wind and solar are the main energy sources in the Mexican market uo to 2030.

Gross energy consumption evolution (2017 – 2031)



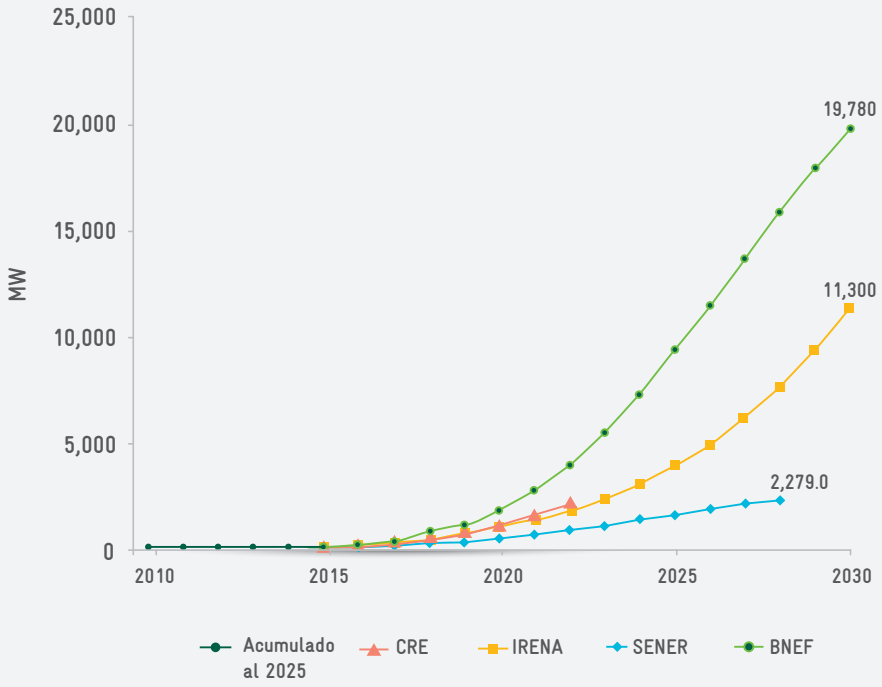
Source: Prepared by EY with inforation from PRODESEN 2017 – 2031

Cumulative installed capacity by technology (2012-2040)



Source: BNEF (2017)

DG Projections in Mexico (2010-2030)



Source: SENER, Prospectiva de Energías Renovables (2016 – 2030)

21 BNEF (2017) bases de datos de BNEF

According to SENER (about DG estimates in Mexico for 2030), it is expected that DG may reach an installed capacity close to 2.2 GW by year2022[22].

In the case of the International Renewable Energy Agency (IRENA), their forecast for 2030 demonstrate that an installed capacity of 11,300 MW may be reached in Mexico, while Bloomberg New Energy Finance (BNEF) estimates an installed capacity of 19,780 MW.

PRICES AND TARIFFS

In November 2017, through the agreement A/058/2017 22, the CRE approved the calculation and methodology of the Final Tariffs for Basic Supplier to be used during December 2017 and December 2018. The objective was to determine the value of the final tariffs that will be applied to all users that are not classified as Qualified Users.

This new calculation and methodology is based in two objectives: I) recover the CFE efficient costs, and II) reflect the temporal variations of the power cost service throughout the year in order to reach an efficient market and an efficient consumption.

On the other hand, the Final Tariffs for Basic Supplier include:

1. The charges associated to Regulated Tariffs such as:

- Transmission
- Distribution
- CENACE Operation
- Operation Tariffs of the BSS
- Ancillary services not included in the WEM

2. The energy cost, power and CEL needed to attend the Basic Service Users demand

SENER, CRE and the Ministry of Finance and Public Credit (SHCP), participated in the development of this methodology:

• **SENER:** defines the legacy contracts from which most of the generation cost is obtained.

• **Secretaría de Hacienda y Crédito Público (SHCP):** determines the application of the different tariffs established by the CRE for specific groups of users (these tariffs consider subsidies application, for example: domestic and low demand users).

• **CRE:** establishes regulated tariffs for transmission, distribution, CENACE operation, BSS operation and all ancillary services not included in the WEM.

Likewise, CFE BSS is in charge of applying the tariffs based on the corresponding methodology. CRE will apply and publish, in a monthly basis, the methodology and calculations for the final tariffs for the Basic Supply.

22 SENER (2016) Prospectiva de Energías Renovables 2016 - 2030

TARIFF CATEGORIES DEFINED BY CRE - 2017

TARIFF	TARIFF CATEGORY	DESCRIPTION	PREVIOUS CATEGORY FROM CFE
DOMESTIC AND LOW DEMAND	DB1	Domestic low voltage demand, consuming up to 150 kWh-month	1, 1A, 1B, 1C, 1D, 1E, 1F
	DB2	Domestic low voltage demand, consuming more than 150 kWh-month	1, 1A, 1B, 1C, 1D, 1E, 1F, DAC
	PDBT	Low demand (up to 25 kW-month) with low voltage	2, 6
AGRICULTURE IRRIGATION	RABT	Agriculture irrigation - low voltage	9, 9CU, 9N
	RAMT	Agriculture irrigation - medium voltage	9M, 9CU, 9N
PUBLIC LIGHTING	APBT	Public Lighting - low voltage	5, 5A
	APMT	Public Lighting - medium voltage	5, 5A
HIGH DEMAND	GDBT	High demand (higher than 25 kW-month) - low voltage	3, 6
	GDMTH	High demand (higher than 25 kW-month) - hour medium voltage	HM, HMC, 6
	GDMTO	High demand (Higher than 25 kW-month) in ordinary medium voltage	OM, 6
INDUSTRIAL DEMAND	DIST	Industrial demand – sub-transmission	HS, HSL
	DIT	Industrial demand - transmission	HT, HTL

Source: Prepared by EY with information from the CRE Acuerdo Núm. A/058/2017
Note: kW-month refers to the máximum capacity demand during an established month

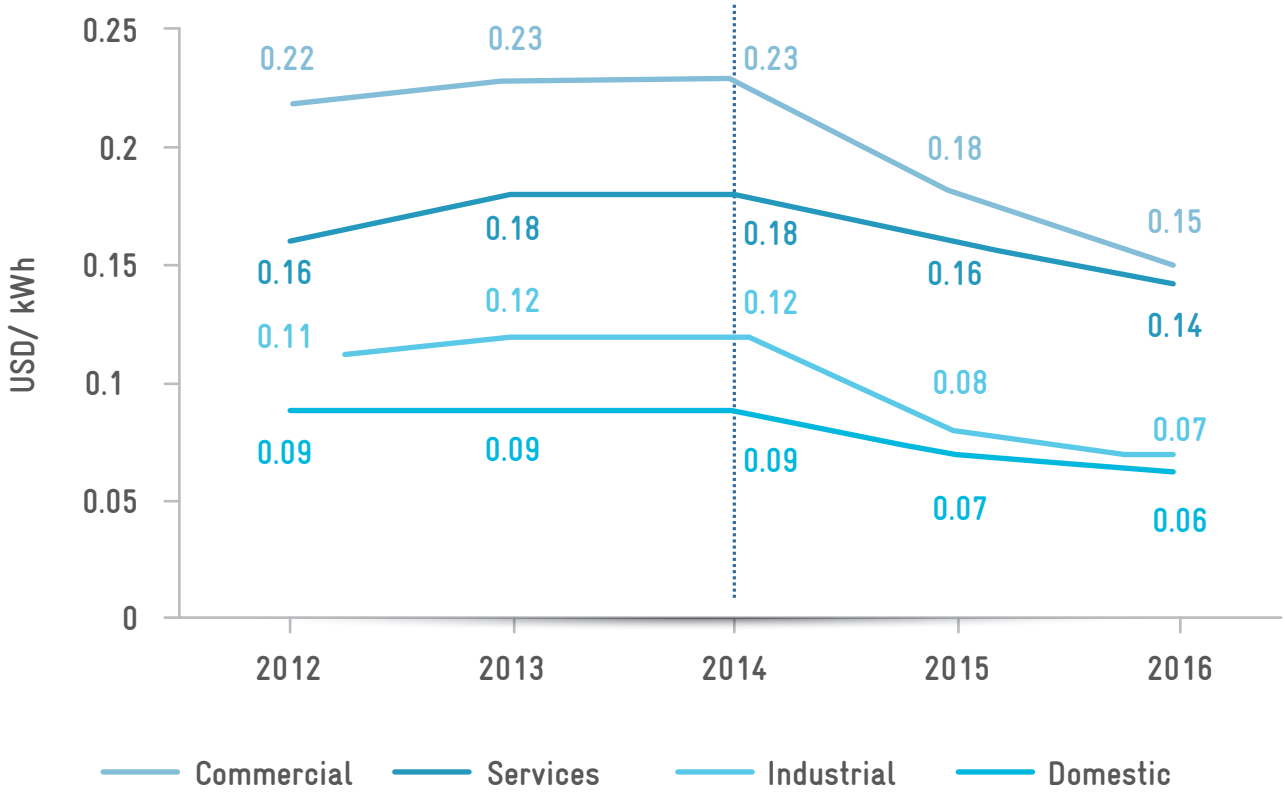
In November 2017, through the Federal Official Gazette (DOF) the agreement A/123/2017[23] was published. This agreement established that SHCP is accountable for determining a fixed mechanism for final energy tariffs in basic supply for domestic users different from that established by CRE[24]. The following chart shows the tariffs defined by the SHCP (for further reference, in the Exhibits the new tariff categories defined by the SHCP are detailed).

As mentioned before, the tariffs are defined by the SHCP in a monthly basis, however, updating formulas differ depending on the segment. For example, some residential tariffs with low consumption and agriculture tariffs are protected tariffs and their increase has been usually lower than the inflation rate.

The tariffs for other segments are adjusted on a monthly basis considering the inflation rate increase and the fuel costs[25].

In the chart below, it is observed that tariffs (average from different areas) have been dropping since the implementation of the Energy Reform.

Tariff evolution by segment (2012 – 2016)



Source: Prepared by EY with information from CFE and the Sistema de Información Energética (SIE)

23 DOF (2017) Acuerdo Núm . A/123/2017
24 DOF (2017) Acuerdo Núm. A/058/2017
25 CFE (2016) Principales elementos del plan de negocios 2017 – 2021

SUBSIDIES AND PROGRAMS

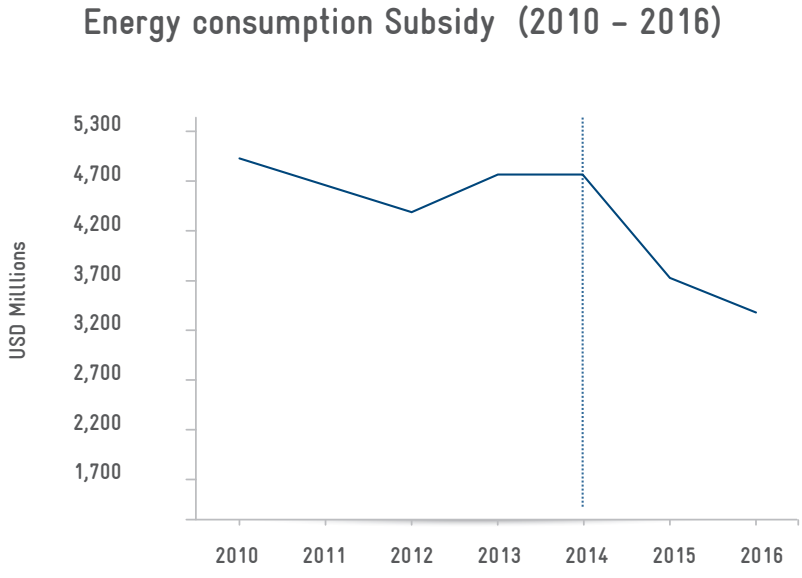
According to article 116 of the LIE, "The SENER will establish the policies and strategies to provide rural communities and urban areas with electricity under the lowest cost possible for the country".

Additionally, it is determined that "the SHCP, the SENER and Sedesol will evaluate the convenience and, if applicable, will carry out specific support programs with the purpose of helping on the supply of adequate and cost-effective electricity, under affordable prices, particularly in rural and urban areas for Basic Supply Users in vulnerable economic conditions."

CFE subsidy applies to domestic users. This subsidy varies depending on the tariff category in which the consumer is determine based on the consumption amount in kWh and the seasonality (summer or winter). This subsidy has a consumption limit within each tariff category, and, when surpassed, the user does not receive the subsidy and has to pay a higher consumption residential tariff (High Consumption Domestic Tariff/ DAC)[26].

Considering the eight tariffs for domestic use, seven of them (01, 1A, 1B, 1C, 1D, 1E and 1F, (refer to the Exhibit) have a subsidy. This subsidy is based in a crossed tariff scheme, for which the industrial sector pays according to its volume of consumption in order to be able to give the subsidy to the low consumption domestic electricity sector.

Also, the government provides support to other users. The graphic below presents the energy consumption subsidy that CFE receives from the government. After the Energy Reform, subsidies maintain a decrease tendency for approximately USD $1.8 M between 2014 and 2016.



Source: Prepared by EY with information from CFE (2017)

25 Tecnointeligente (2017) http://www.tecnoligente.com/que-importancia-tiene-el-subsidio-de-la-cfe-en-mexico/

Considering that the subsidy is the difference between the real cost and the selling price, the decrease on the subsidy shown in the graphic may be the result of the dropp in the electricity tariffs, which have been decreasing due to the substitution of diesel and oil for other energy sources that are cheaper and environmentally friendly, such as natural gas and renewable energies[27].

In the case of the agriculture sector there is "an special tariff for farmers", with the purpose of allowing any producer with agricultural activities, who requires energy for water pumping and re-pumping (tariff 9) and has registered as beneficiary, may access the incentive tariff that represents savings for almost 80% in the kWh cost in tariff 9CU and 95% in tariff 9N[28] to promote competitiveness.

27 CFE (2015), Informe anual
28 SAGARPA (2016) Ofrece SAGARPA tarifa especial de energía eléctrica a agricultores http://www.sagarpa.gob.mx/Delegaciones/yucatan/Boletines/Paginas/201606B066.aspx

1.2 MAIN BUSINESS MODELS FOR SOLAR ENERGY

WHOLESALE ELECTRICITY MARKET

It is a market operated by CENACE in which the participants may sell and buy the following products: energy, capacity, CEC, ancillary services and Financial Transmission Rights (FTR).

Regarding solar energy, only some of these products are relevant for trading. As solar energy plants have a variable capacity, there are products and services that solar generators may not provide or, they would represent a small income for them.

The most important product for solar plants is the power they produce, as it represents most of their income. The low marginal costs of energy generation for this kind of plants suppose an advantage against other technologies.

CEC are another income source for solar energy plants, as all suppliers are obliged to credit with CEC a certain percentage of their consumption. This chapter will explain CEC in further detail.

In the document "Mexico's New Energy Era Growing Investment Opportunities – From Framework Fundamentals to Electricity Sector Focus" each one of the products mentioned in the following chart are described in detail:

Source: CRE (s.f.) http://www.cre.gob.mx/documento/faq-regulacion-electricos.pdf.
DOF (2016) Manual del Mercado para el Balance de Potencia.
DOF (2015) Bases del Mercado Eléctrico

POWER

Electricity produced by each power station.

CEC

Documents verifying that the source of power **generation** is a **clean source.** This product will be described in detail in this section.

CAPACITY

Defined as the **commitment to maintain a certain amount of** installed capacity available for power generation during a given period of time.

FTR

Mechanism to **hedge exposure to the price differences** that may exist between two nodes due to **congestion** in the transmission network.

ANCILLARY SERVICES

Services needed to guarantee the quality, reliability, continuity and security of the SEN. The following are considered ancillary services: **reserves** (operating and spinning), **regulation** (frequency, voltage and reactive frequency), **emergency start-up, island mode operation and dead bus connection.**

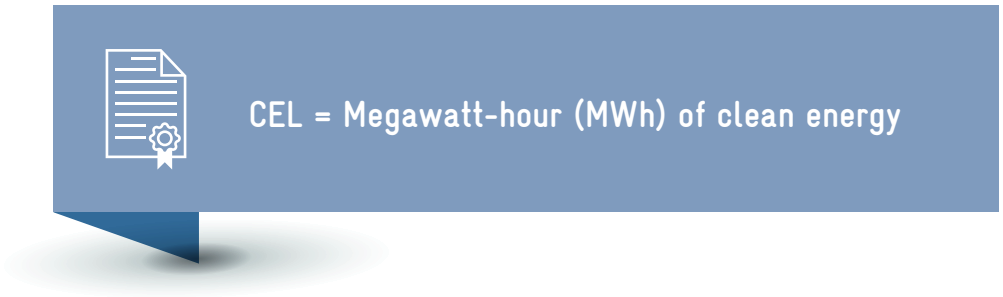
CLEAN ENERGY CERTIFICATES

WHAT IS A CEC?

CEC: are titles that certify a given source of power generation as being a celan source (must be sources of energy whose emissions do not exceed the thresholds established in the regulatory requirements). The generators committed to generate and/or sell CEC for a period of 20 years. Once issued, CEC are valid for one year[29].

CEC BACKGROUND

One of the objectives of the Energy Reform and its secondary laws is to stimulate investment in clean energies. Therefore, this Reform includes escalating clean energy goals and CEC requirements. The latter must be complied with by the Impacted participants.



CEC REQUIREMENTS

Impacted participants must certify that they hold an amount of CEC corresponding to a given percentage of the total power they consume. This percentage is based on the CEC requirements established by the SENER for each year. If they fail to meet their CEC obligations, impacted participants will be required to pay a fine.

The following are impacted participants:

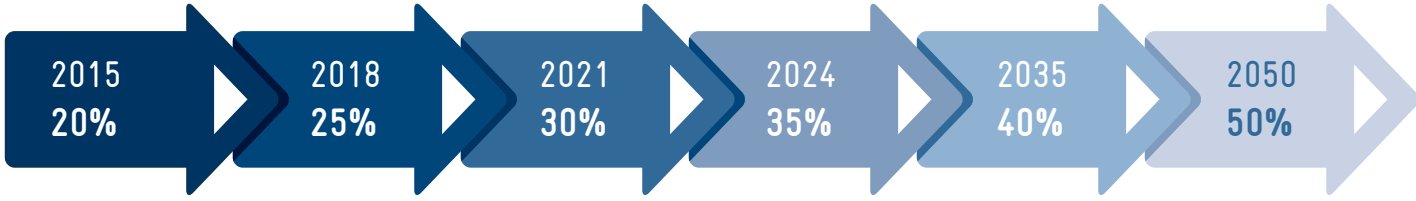
- Suppliers: BSS, Qualified Service Supplier (QSS).
- Qualified Market Participant Users (QMPU).
- End users supplied through Isolated Supply.
- Holders of Legacy Interconnection contracts (including load centers or charging points in which the total of their energy is nor provided bya clean power station source)

29 DOF (2014) LIE

FUENTE: SENER

CLEAN ENERGY GOALS

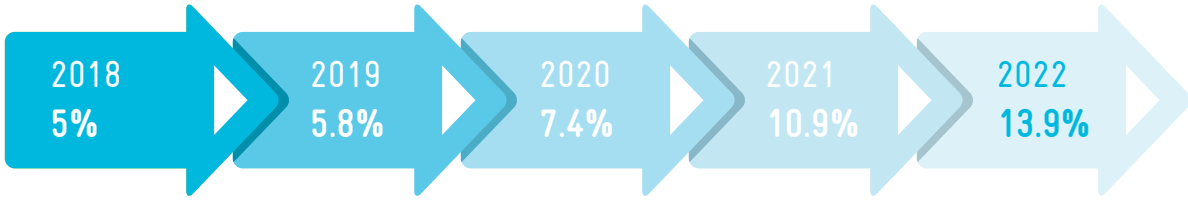
Mexico´s national policy includes clean energy goals. The ultimate aim of these goals is to increase the proliferation of clean energies as a percentage of Mexico's total electricity generation. The figure below shows the clean energy generation goals for future years:



Source: CRE (s.f.) http://www.cre.gob.mx/documento/faq-regulacion-electricos.pdf

CEC REQUIREMENTS

Impacted participants must certify the possession of a given percentage of CEC compared to their total power consumption. The figure below shows the CEC requirements for future years:



Source: DOF (2015, 2016 y 2017) Adquisición de CEL en 2018, 2019, 2020, 2021 y 2022

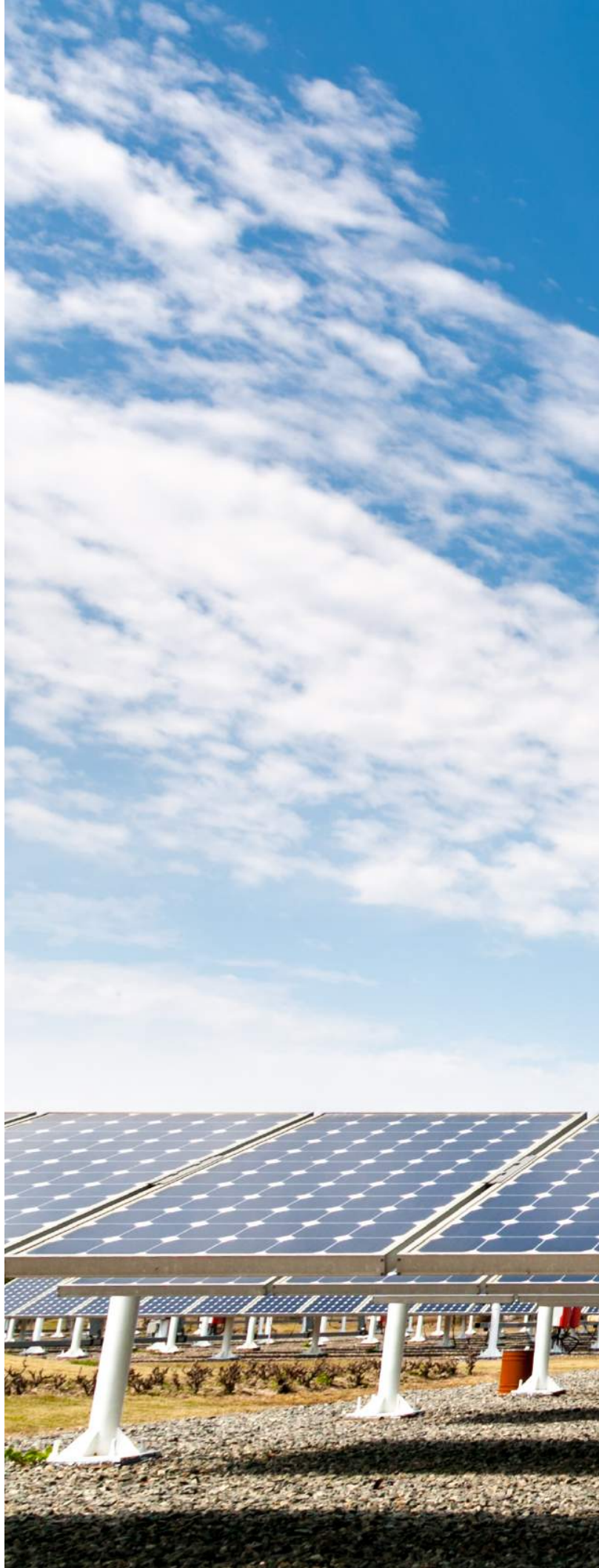
Capacity and ancillary services, are not relevant products for solar power generators mainly because solar energy plants have a variable capacity. As far as large scale solar facilities typically place greater demands on the transmission system, FTR revenues are not expected to be a likely source of compensation to them.

The amount of capacity that may be sold by a power station in Mexico is determined by its electricity generation during the 100 critical hours, that is, in the hours of highest power demand in the previous year. Because of its variable nature, solar energy does not offer certainty in generation availability during critical hours to the operator of the network, as opposed to power plants with firm capacity (such as combined cycle, natural gas, etc.), therefore, solar energy plants usually do not sell this product. However, the opportunity exists to couple the resources with storage technologies to facilitate a greater level of control over energy output, by storing energy and discharging it into the transmission network during higher demand periods or when called upon by CENACE according to dispatch instructions. There have been some capacity selling offers from solar plants awarded in the auctions executed in the Mexican market during 2017, but this brings uncertainty regarding weather these plants will be able to provide the committed capacity in critical periods.

Ancillary services are necessary to maintain continuity and reliability of the SEN operation, and they are usually provided by firm capacity plants, therefore, they do not represent an income for solar generators.

However, the evolution and price decrease of storage technology might enable solar power stations to provide some ancillary services, such as reserves.

Finally, variable energies usually demand more transmission capacity, because they must use the transmission system in the moment in which the solar resource is available, limiting its adaptation to less congested periods. Therefore, it is difficult to obtain economic benefits through FTR for Solar energy power stations. During the LTA, the energy power stations have been benefit by the hourly adjustment factors at the nodes with high congestion. These adjustment factors will be detailed later in this document.



WEM PARTICIPANTS

The trading of products and services in the WEM take place between Generation and trading activities, and there are different Market Participants in such activities[30]. Also, there are different types of users depending on consumption dimension.

GENERATOR	SUPPLIERS AND MARKETERS	USER
GENERATOR	QSS	QMPU
EXEMPT GENERATOR	BSS	QUALIFIED USERS
	SUPPLIER OF LAST RESORT (SOLR)	BASICS USERS
	ENERGY MARKETER	

● WEM DIRECT PARTICIPANTS

GENERATORS

Holders of a generation permit for power stations with a capacity of 0.5 MW or more, or hold a WEM participant agreement to represent these power stations in the WEM. Their purpose is to sell electricity in the WEM, that is, through the Short-term Market, through energy Auctions or through contracts with Qualified Users and QSS.

EXEMPT GENERATORS:

Exempt generators own power stations with a capacity below 0.5 MW, and do not require a generation permit. They are allowed to sell power and related products to BSS under the tariffs determined by the CRE. To participate in the WEM, they need a QSS.

QUALIFIED SERVICE SUPPLIER (QSS):

These suppliers purchase energy in the WEM in order to provide it to Qualified Users. To obtain a permit, they must specify their operating zone, end users and expected sales.

BASIC SERVICE SUPPLIER (BSS):

This type of supply is provided under a **regulated tariff** to any non-Qualified User requesting the service. In addition, BSSs **subscribe electric coverage contracts** exclusively **through auctions.**

SUPPLIER OF LAST RESORT (SOLR):

These suppliers represent Qualified Users for a limited time in order to maintain service continuity when a Qualified Supplier suspends its power supply; in other words, **SOLR offer a backup service.**

ENERGY MARKETERS:

Are Market Participants who trade energy without providing supply services. These players act as intermediaries with no physical assets and simply need to be registered with the CRE as "Energy Marketers" (Comercializador no Suministrador).

QUALIFIED USERS:

They must hold a permit issued by CRE and have a load center with a capacity of more than 1 MW; they are supplied by QSS.

QUALIFIED MARKET PARTICIPANT USER (QMPU):

They must meet the minimum demand (>5 MW) and consumption (20 GWh per year) requirements and sign an interconnection contract with CENACE.

BASIC USER:

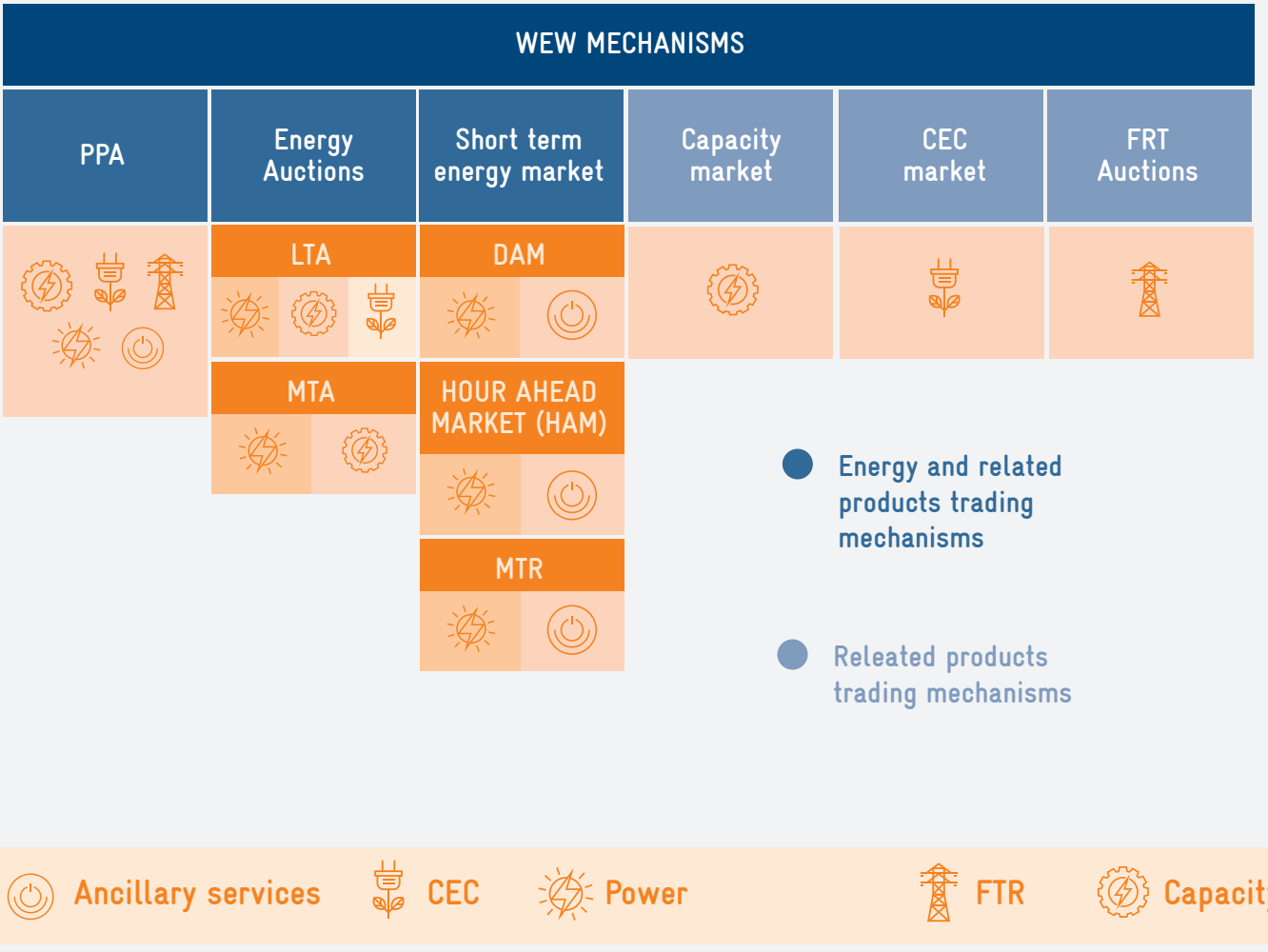
Basic User: They acquire electricity from the Basic Service Suppliers at a **regulated price.**

Source: CRE (s.f.) http://www.cre.gob.mx/documento/aq-regulacion-electricos.pdf.
DOF (2014) LIE. CRE http://www.cre.gob.mx/documento/PFUsuarios.pdf

30 DOF (2015) Bases del Mercado Eléctrico

WEM MECHANISMS

The WEM works through different trading mechanisms. The following diagram shows the mechanisms in which energy and related products and services may be sold or purchased (capacity, CEC, FTR and ancillary services). Dark blue boxes indicate mechanisms through which products can be traded in groups, that is, energy together with any related product. Light blue boxes mark mechanisms through which related products may only be sold individually[31].



Source: Prepared by EY with information from Bases del Mercado

31 DOF (2015) Bases del Mercado Eléctrico

CLEARING HOUSE

Generally speaking, the previously mentioned Clearing House facilitates the sellers' and buyers' compliance with contractual obligations. Its functions include:

- **Acting as an intermediary that facilitates the clearance of products and payments.** The **contracts** for the auctions performed **after the creation of the Clearing House will be adapted to include the Clearing House.** The Clearing House will sign as the buyer the contracts with the sellers and as the seller the contracts with the buyers.
- Administer the **Compliance Guarantees.**
- Administrar las **Garantías de Cumplimiento.**
- Play a **risk management role;** that is, if there is a payment default (and the guarantees are insufficient to cover for it) the default will be **absorbed by all of the sellers** ratably. If there are losses tied to product shortfalls (and the guarantees are insufficient to cover it and the seller cannot be held responsible), the product shortfalls will be **absorbed by all of the buyers.**

The Clearing House for the LTA started its operations in 2017 during the 3rd LTA[32]. For MTA, it will be established too, during 2018.

The operating principles of the Mexican Clearing House are based on the operation of some of the US Clearing Houses and Independent System Operators, being closest to the Pennsylvania New Jersey Maryland Interconnection (PJM). However, one of the main differences is that in the United States there is a different clearing house for each interconnected system, while in Mexico there is only one (considering that there is only one market).
In the European market, the European Commodity Clearing, as a subsidiary of the European Energy Exchange, is focused on ensuring a proper clearing and settlement of trading transactions among more than 30 countries. An important difference with the Mexican market is that in Europe usually no financial mechanisms are used to hedge

32 DOF (2017) Guía Operativa de la Cámara de Compensación para contratos asignados a través de LTA

BUSINESS MODEL 1: SOLAR ENERGY TRADING IN THE SHORT TERM ENERGY MARKET

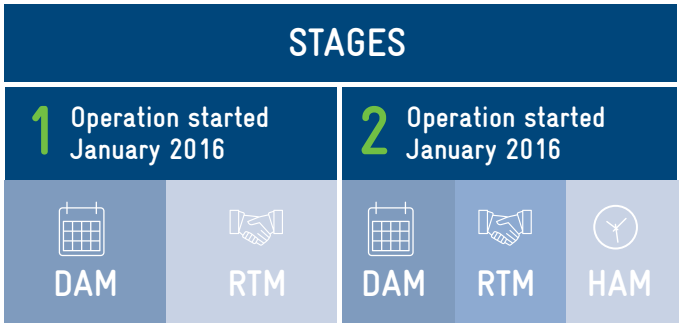
This market operates in three modalities: Day Ahead Market (DAM), Real Time Market (RTM) and Hour Ahead Market (HAM). The implementation of the market comprises two stages: the first stage, which has been already implemented, considers the DAM and the RTM; the second stage, to be implemented during 2018, also includes the HAM.

In this market, power **Generators** sell energy and ancillary products to **Qualified Suppliers** and **QMPU**. The **CENACE** issues **dispatch instructions** to create a balance between supply and demand. Short-term market transactions are based on **Locational Marginal Pricing (LMP)** for energy and **zonal pricing** for ancillary services. Further detail on LMP is described in the next subsection.

IMPLEMENTATION MODALITIES AND STAGES FOR THE SHORT TERM ENERGY MARKET

SHORT TERM ENERGY MARKET

DAM	Buying and selling offers are presented for next day dispatch
RTM	Energy is bought and sold for its immediate dispatch
HAM	Buying and selling offers are presented for next hour dispatch



SHORT TERM MARKET RISKS:

OFFTAKER:

energy dispatch will be carried out under the Merit Order model, where node demand will be covered first with energy coming from sources with the lowest marginal prices and the price received by the generators is the marginal cost of the last plant dispatched. The marginal costs of solar energy are low and therefore the risk of not being included in the curve is very low.

CASH FLOW VOLATILITY:

Due to the Merit Order model, the sales volume of the project will depend on the existing supply in the system, therefore, modeling must consider the construction of new plants in the future. Moreover, the price variation is an important risk for the project cashflow due to the uncertainty that exists over future projections of LMPs

DEVELOPMENT COSTS AND ADMINISTRATIVE REQUIREMENTS:

there is a moderated risk over costs and administrative requirements since the participant must be registered before the CRE and handle administrative matters related to market transactions. This risk is applicable to all modalities in the WEM.

Fuente: Elaborado por EY con información del DOF (2016) Manual de Mercado de Energía de Corto Plazo

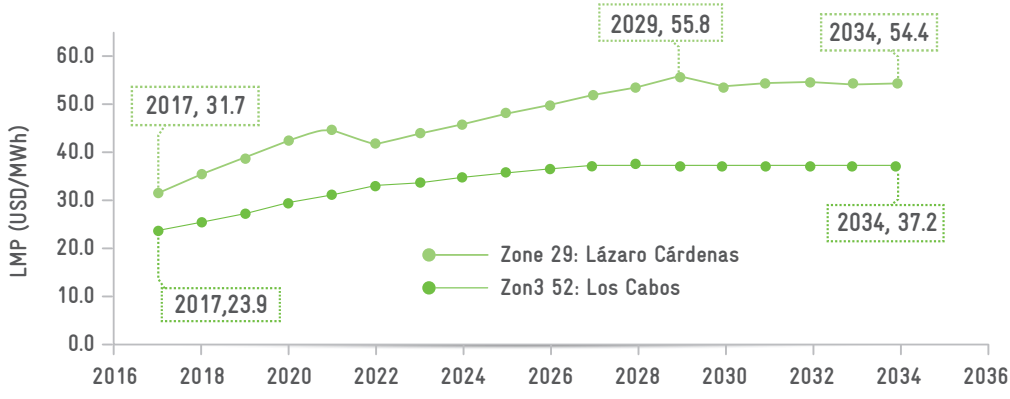
LOCAL MARGINAL PRICES (LMP)

Prices in the WEM are Nodal Prices. In other words, they are calculated in each node of the system based on three basic components: marginal energy generation cost in the node, congestion cost and energy loss. Energy dispatch is carried out in a centralized way according to the dispatch curve, which is related to the marginal energy cost component[33]. This mechanism is known as Merit Order and represents an advantage for solar generators because they will usually have the lowest marginal costs in the system.

LMP estimations involve complex mathematical modelling, since LMPs vary on each hour of each day of each year, and for each one of the 53 regions. In the graph "Average LMP Tendencies" shows the trend of the average LMP published by PRODESEN, comparing the two regions in which the maximal and minimal LMP are found in the SEN (Lázaro Cárdenas region and Los Cabos region, respectively).

According to the SEN "Catálogo NodosP", there are 2,384 nodos; that are distributed in the following way: 104 in the Baja California Interconnected System (BCA), 27 in the Baja California Sur Electric System (BCS) and 2,253 in the National Interconnected System (SIN).

AVERAGE LMP TENDENCIES



Source: Prepared by EY with PRODESEN 2017-2031 information

As shown in this graph, LMPs tend to increase. In 2017 there is a minimum of 23.85 USD/MWh and a maximum of 31.69 USD/MWh; however 17 years later, the estimation is a minimal LMP of 37.24 USD/MWh and a maximal of 54.41 USD/MWh. This accounts for a compound annual growth rate of 2.66% for Lazaro Cardenas region and of 3.23% for Los Cabos region. In order to illustrate the price variations by month and hour of the day, the following chart shows the LMP distribution for Hermosillo region in 2018, according to PRODESEN estimations58. In the chart, the highest prices are highlighted in red and the lowest in green and they are expressed in USD/ MWh. In this example, the highest prices are concentrated in the summer evenings and nights. This price distribution is illustrative and may vary in the different areas and in different years.

33 CRE (s.f.) http://www.cre.gob.mx/documento/faq-regulacion-electricos.pdf

LMP VARIATIONS FOR HERMOSILLO REGION IN 2018

HOURS	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
0	29.5	29.7	30.3	31.1	32.3	34.2	33.5	33.0	32.4	31.8	31.1	30.7
1	29.3	29.6	30.2	31.0	32.2	34.1	33.5	32.9	32.2	31.7	31.1	30.7
2	29.2	29.5	30.0	31.0	32.1	34.0	33.4	32.9	32.1	31.7	31.0	30.5
3	29.2	29.4	29.9	30.9	31.9	33.9	33.4	32.8	32.0	31.7	31.0	30.4
4	29.2	29.4	29.9	30.8	31.8	33.7	33.2	32.8	32.0	31.7	31.0	30.4
5	29.2	29.4	29.9	30.7	31.7	33.6	33.0	32.7	32.0	31.6	31.0	30.4
6	29.3	29.5	30.0	30.8	31.6	33.5	32.9	32.7	31.9	31.6	31.0	30.5
7	29.4	29.6	30.1	30.8	31.5	33.1	32.6	32.5	31.9	31.5	31.0	30.5
8	29.4	29.7	30.1	30.7	31.4	32.9	32.3	32.2	31.8	31.4	31.0	30.5
9	29.4	29.7	30.2	30.8	31.5	33.1	32.5	32.2	31.7	31.3	31.0	30.5
10	29.4	29.7	30.3	30.9	31.7	33.4	32.7	32.3	31.8	31.4	31.0	30.5
11	29.4	29.7	30.3	30.9	31.8	33.5	32.9	32.4	31.8	31.4	30.9	30.5
12	29.5	29.7	30.4	30.9	31.9	33.6	33.1	32.5	31.8	31.5	30.9	30.5
13	29.5	29.7	30.4	31.0	32.0	33.8	33.2	32.6	31.9	31.6	31.0	30.4
14	29.5	29.7	30.4	31.0	32.1	33.9	33.3	32.6	31.9	31.6	31.0	30.4
15	29.5	29.7	30.4	31.0	32.1	34.0	33.4	32.7	32.1	31.7	31.0	30.5
16	29.5	29.7	30.4	31.0	32.2	34.1	33.4	32.8	32.3	31.7	31.0	30.6
17	29.5	29.8	30.4	31.0	32.2	34.1	33.5	32.9	32.4	31.7	31.1	30.6
18	29.5	29.8	30.5	31.1	32.2	34.2	33.5	33.0	32.4	31.8	31.1	30.8
19	29.6	29.8	30.5	31.1	32.2	34.1	33.4	32.8	32.3	31.7	31.1	30.8
20	29.6	29.9	30.6	31.1	32.1	34.0	33.4	32.8	32.3	31.8	31.1	30.8
21	29.6	29.8	30.6	31.1	32.2	34.1	33.4	33.0	32.4	31.8	31.1	30.8
22	29.6	29.8	30.5	31.1	32.2	34.2	33.5	33.2	32.5	31.8	31.1	30.8
23	29.5	29.8	30.5	31.1	32.2	34.2	33.5	33.2	32.5	31.8	31.1	30.8

Source: Prepared by EY with information from PRODESEN 2017-2031

BUSINESS MODEL 2: CEC AND ENERGY TRADING IN THE AUCTIONS

LONG TERM AUCTIONS (LTA)

The purpose of LTAs is to subscribe electric coverage contracts for trading of: capacity, power (both during a 15 year period) and CEC (with a 20-year validity). In this trading model, the amount paid will be calculated multiplying the price established in the offer times the amounts of the different products included in the selected package (amount of energy, amount of capacity, and amount of CEC). There are two adjustment factors that should be considered: Hourly Adjustment Factor and the Expected Differences.

The Hourly Adjustment Factors are established by the CENACE in a specific auction in order to calculate the energy produced in the delivery hours. For each MWh of energy produced by a clean variable energy seller, and adjustment on the payment or charge will be executed.

This means that, in addition to the payment in accordance to the awarded offer, the generator with clean variable sources will receive a monthly payment or charge -in case the adjustment results in negative numbers- equal to the Hourly Adjustment factor multiplied by the MWh of energy produced each hour.

FACTORES DE AJUSTE DE HORARIOS

$$\text{PML PRONOSTICADO} - \frac{\text{PML PRONOSTICADO}}{12\ (\text{MESES}) * 24\ (\text{HORAS})}$$

The selling offers associated to generators with firm capacity (e.g., cogeneration) may offer power; however, this will be considered as a constant amount in each hour of the year and will not receive monthly adjustment payments.

In the case of the Expected Differences Adjustment, it is important to take into account that the node prices are not the same, neither those in each zone. This adjustment calculates the expected difference between the LMP average in the SEN with the LMP in the zone

RIESGOS DE LAS SUBASTAS DE LARGO Y MEDIANO PLAZO

OFFTAKER
Existe el riesgo de que el Offtaker no sea capaz de cumplir con la obligación de compra definida en los contratos adjudicados en las SLP; sin embargo, a partir de la tercera SLP, la cámara de compensación ayudará a distribuir este riesgo entre los participantes.

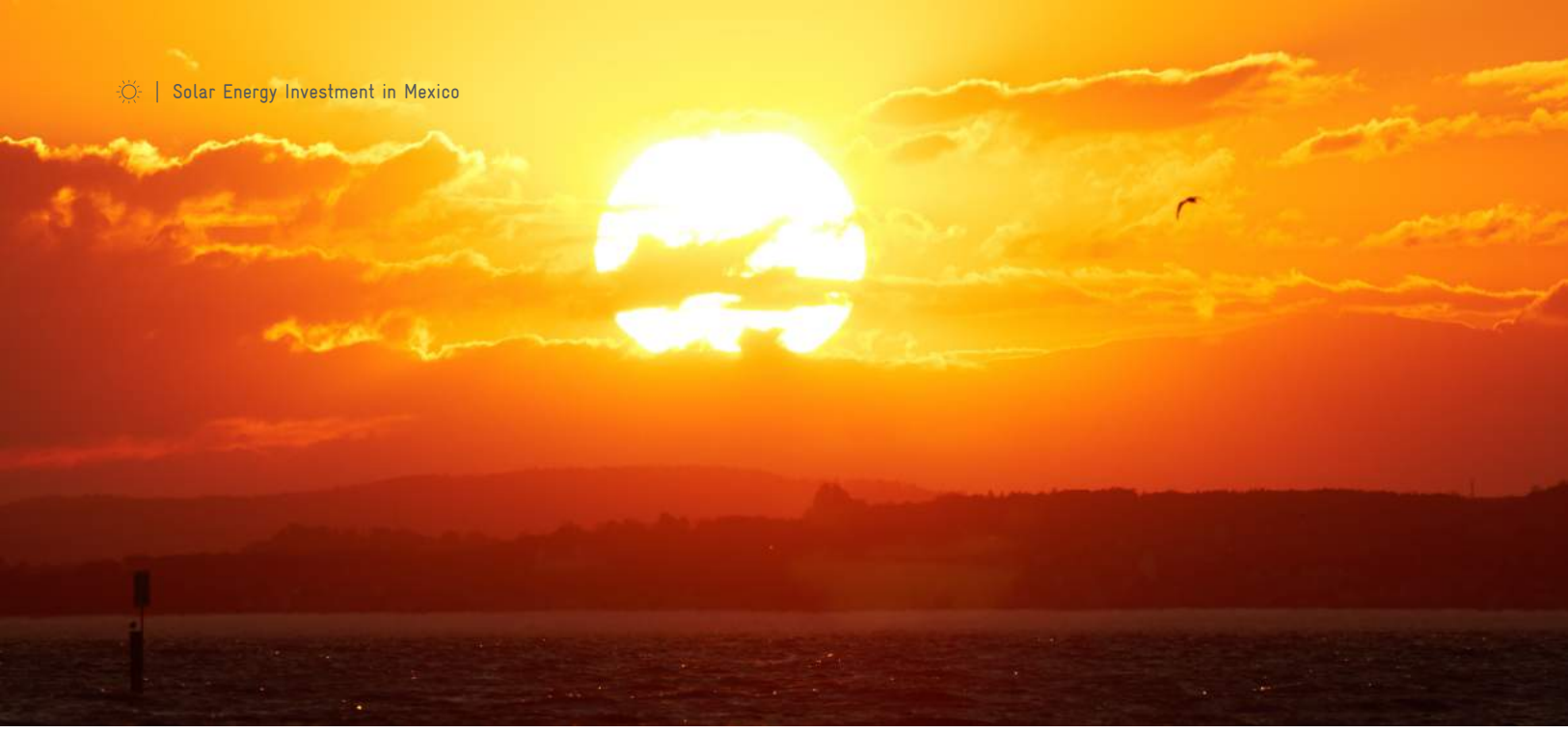
VOLATILIDAD DEL FLUJO DE CAJA
El precio obtenido por la energía comercializada será fijado de acuerdo a la oferta ganadora de la SLP; sin embargo, en el caso de las energías de fuentes limpias variables, habrá un pago o cargo adicional llamado Factor de Ajuste Horario. Los precios contratados en las SLP tendrán una vigencia de 15 años para energía y 20 para CEL, los contratados en las SMP tendrán una vigencia de 3 años para energía, minimizando la incertidumbre sobre los flujos de efectivo del proyecto.

RIESGO REGULATORIO
Algunas de las reglas de las subastas aún se están definiendo. A partir de la cuarta SLP, la CRE será la organizadora de las SLP. Además, aun no se ha ejecutado ninguna SMP, lo cual crea algo de incertidumbre sobre las reglas.

RIESGO DEL TIPO DE CAMBIO
Los precios de las ofertas pueden ser fijados en pesos o en dólares. Para las subastas cuyo precio está indexado a dólares, existe el riesgo cambiario, ya que los precios se ajustarán de acuerdo al tipo de cambio.

RIESGO DE GARANTIAS
La inversión para la participación en las subastas es significativa debido a los costos de participación y las garantías requeridas. En caso de no poder entregar la energía y Productos Asociados contratados, el generador deberá ir al mercado a comprar el faltante y así cumplir con sus obligaciones contractuales, asumiendo los costos que esto conlleve.

COSTOS DE PARTICIPACIÓN
Para los participantes de las subastas, existe el riesgo de no ser seleccionado como ganador de Oferta de Compra o de venta; en ese caso deben asumir los costos de participación.



during the term of the auction. Those differences are considered in order to determine the energy value in the price zone where the energy will be delivered and define the auction winners. The awarded contracts will have the real price, without the adjustment.

FACTORES DE AJUSTE DIFERENCIAS ESPERADAS

Valor nivelado de los PML en la Zona de Precios
-
Valor nivelado del promedio del PML en el SEN

Lastly, regarding compensation of the products subscribed in contracts from the LTAs, it is relevant to highlight that at the end of the year there will be a payment or charge to balance any surplus or deficit of delivered energy over the amount contracted. This balance will be paid or charged according to the LMP of the RTM.

MEDIUM TERM AUCTIONS (MTA)

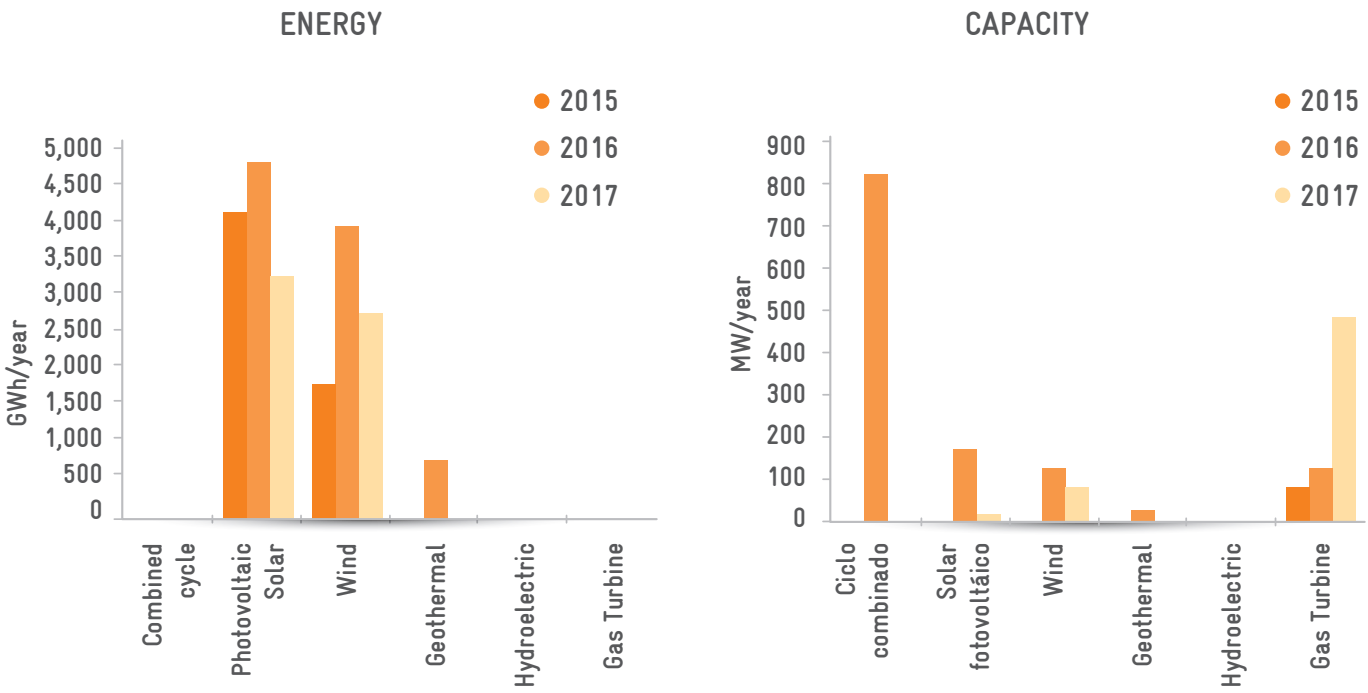
The MTAs' purpose is to subscribe electric coverage contracts in a competition regime in order to satisfy capacity and energy requirements while reducing or eliminating exposure to price variability.
An important difference between LTAs and MTAs, besides contract duration, is that CEC cannot be traded through MTAs, only energy and capacity. MTA contracts' are subscribed for a period of three years[34].
A further explanation of the LTA and the MTA operation can be found in the document "Mexico's New Energy Era Growing Investment Opportunities – From Framework Fundamentals to Electricity Sector Focus".

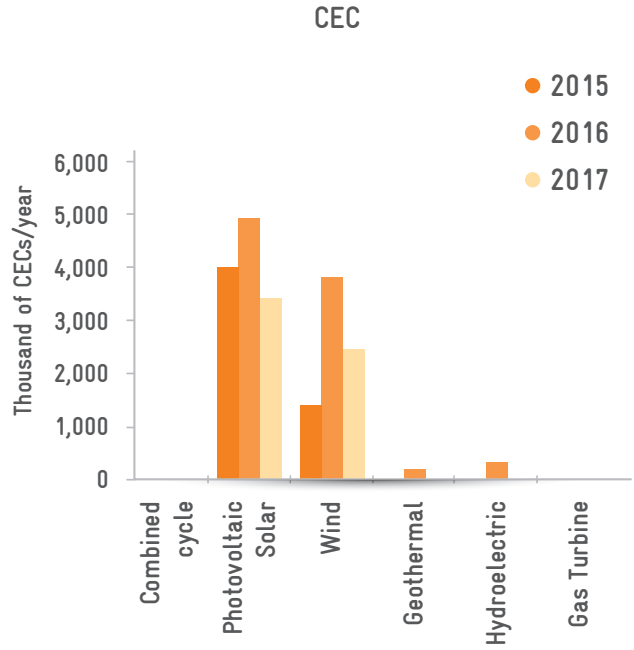
LTA RESULTS

Up to the first quarter of 2018, three LTAs have been executed, one in 2015, one in 2016 and one in 2017. In the first auction there were 18 awarded selling offers from 11 companies and the products sold were: power and CEC. In the second auction there were 56 awarded selling offers from 23 companies and the products sold were: power, capacity and CEC. In the third auction there were 16 awarded selling offers from 10 companies[35] and the products sold were: power, capacity a CEC.

34 DOF (2017) Manual de SMP
35 SENER (2017) Nueva Industria Energética en México

AUCTIONS RESULTS BY PRODUCT AND GENERATION SOURCE

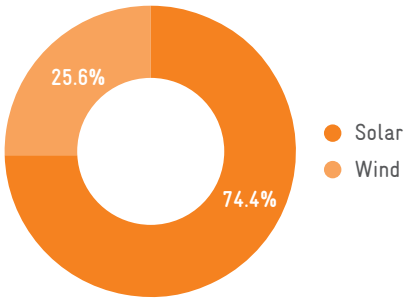




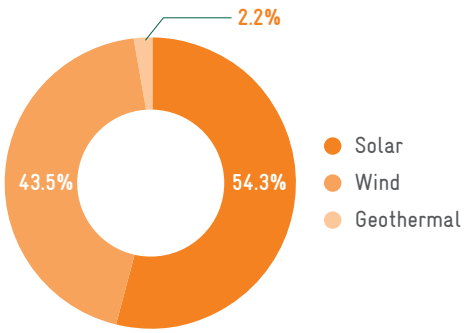
Source: Prepared by EY with information from CENACE,
Fallo de las Ofertas de Venta de la primera, segunda y tercera SLP

GENERATION SOURCE AND AVERAGE PRICE OF AWARDED OFFERS

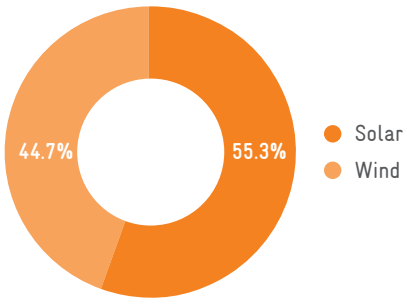
In the first and third auctions, awarded projects were wind and solar plants. In the second auction, besides wind and solar, contracts were also subscribed with geothermal power stations.



Average price: 47.78 USD per package (MWh+CEC)



Average price: 33.47 USD per package (MWh+CEC)



Average price: 20.57 USD per package (MWh+CEC)

Source: Prepared by EY with information from SENER

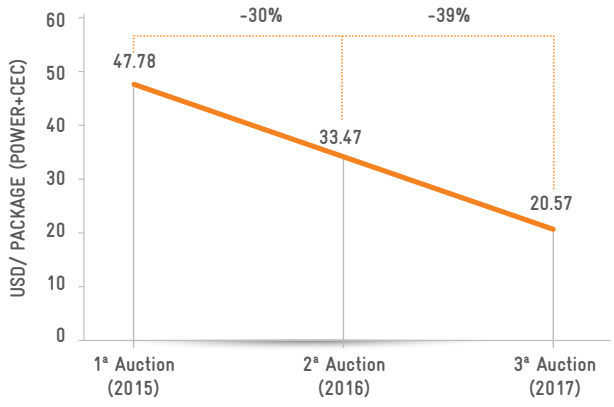
The information is presented in USD, the annual average of the daily exchange rate FIX published by Mexico´s Central Bank is: 2015 (15.88 MXN/USD), 2016 (18.69 MXN/USD), 2017 (18.89 MXN/USD)

AVERAGE PRICE

The average price of each MWh of power and CEC decreased 30% from the first to the second auction. From the second to the third auction, the average price decreased 39%. However, since the offers were presented in Mexican pesos (MXN), in order to have an accurate comparison for each auction, the variations on the exchange rate were considered. In the first auction, the exchange rate was $ 17.32 MXN / USD, while for the second auction was $ 19.152 MXN / USD.

Even after considering the exchange rate adjustment, the price per package presents a significant variation. The following reasons may explain the decrease in the price:

- The expected differences in the second LTA had a shorter range of values in comparison with the first auction where costly projects were awarded.
- The experience from the first auction and the lower costs that were expected from wind and solar power generators, resulted in lower selling offers. The same effect happened in the third LTA.
- CFE SB paid a higher price for capacity in the second and third auction, allowing generators to have an additional source of revenues which help reducing the price of MWh + CEC.



Source: Prepared by EY with information from CENACE

REFERENCES

AMESCO www.amesco.org.mx

ANES (2015) http://www.anes.org/cms/index.php

ESCO Asociación Mexicana de Empresas - www.amesco.org.mx

ASOLMEX (s.f.) https://www.asolmex.org/

AZEL (2016) https://dgel.energia.gob.mx/AZEL/

BNEF (2017) bases de datos de BNEF

CENACE Fallo de las SLP http://www.cenace.gob.mx/paginas/publicas/MercadoOperacion/SubastasLP.aspx

CFE (2015) Informe anual

CFE (2016) Principales elementos del plan de negocios 2017 – 2021

CONUEE (2016) CONUEE (2016) Contratos de desempeño energético en las dependencias y entidades de la Administración Pública Federal: evolución y perspectiva. https://www.gob.mx/cms/uploads/attachment/file/108977/cuadernosConuee_3.pdf

CONUEE https://www.gob.mx/conuee/que-hacemos

CRE (2017) Contratos de interconexión en pequeña y mediana escala. Estadísticas ejercicio 2017 (1er semestre)

CRE (2017) Contratos de interconexión en pequeña y mediana escala: Estadísticas ejercicio a Junio de 2017

CRE (2017) http://organodegobierno.cre.gob.mx/permisose.aspx

CRE (2017) RESOLUCIÓN Núm. RES/142/2017

CRE (s.f.) http://www.cre.gob.mx/documento/faq-regulacion-electricos.pdf

CRE (s.f.) http://www.cre.gob.mx/documento/faq-regulacion-electricos.pdf

DOF (2013) Ley del Impuesto sobre la Renta http://www.diputados.gob.mx/LeyesBiblio/pdf/LISR_301116.pdf

DOF (2014) LIE

DOF (2015) Bases del Mercado Eléctrico

DOF (2015) LTE

DOF (2015) LTE, tercero transitorio; y SENER (2017) Reporte de Avance de Energías Limpias, primer semestre 2017

DOF (2017) Acuerdo Núm . A/123/2017

DOF (2017) ACUERDO Núm. A/049/2017

DOF (2017) ACUERDO Núm. A/049/2017

DOF (2017) Acuerdo Núm. A/058/2017

DOF (2017) Guía Operativa de la Cámara de Compensación para contratos asignados a través de LTA

DOF (2017) Manual de SMP

DOF (2017) Manual de Transacciones Bilaterales y Registro de Contratos de Cobertura Eléctrica

DOF (2017) RESOLUCIÓN Núm. RES/142/2017

DOF (2012) Ley del Servicio Público de Energía Eléctrica – Artículo 36

FOTEASE (2017) Informe Uno

FOTEASE (2017) Informe uno del Fondo para la Transición Energética y el Aprovechamiento sustentable de la energía. https://www.gob.mx/cms/uploads/attachment/file/241356/Informe_Uno_del_FOTEASE_2017.pdf

FOTEASE (2017) Reglas de operación. https://www.gob.mx/cms/uploads/attachment/file/249307/Reglas_de_Operaci_n.pd

FSUE (2017) Convocatoria para el Concurso Público Nacional http://fsueconvocatoriaaislados.fide.org.mx/PRIMERA_CONVOCATORIA_FSUE_31mayo2017.pdf

Green MA, ... **Hishikawa Y, Warta W,et al. (2017)** Solar cell efficiency tables (version 50). Prog Photovolt Res Appl. 2017;25:668–676. https://doi.org/10.1002/pip.290

GTM Research **(2017)** Latin America PV Playbook

IEA (2016) Mexico Energy Outlook

INECC (2016) Estudios de Cadenas de Valor de Tecnologías Seleccionadas Para Apoyar la Toma de Decisiones en Materia de Mitigación en el Sector de Generación Eléctrica y Contribuir al Desarrollo de Tecnologías

INTENDED ... **NATIONALLY DETERMINED CONTRIBUTION, Mexico,** https://www.gob.mx/cms/uploads/attachment/file/162973/2015_indc_ing.pdf

INTENDED ... **NATIONALLY DETERMINED CONTRIBUTION, Mexico,** https://www.gob.mx/cms/uploads/attachment/file/162973/2015_indc_ing.pdf, p.10 y 11.

NREL Nacional Renewable Energy Laboratory - (Deline Chris, DiOrio Nick, Jordan Dick) (2016). Progress & Frontiers in PV Performance

SAGARPA (2016) Ofrece SAGARPA tarifa especial de energía eléctrica a agricultores http://www.sagarpa.gob.mx/Delegaciones/yucatan/Boletines/Paginas/201606B066.aspx

SEMARNAT(s.f.) https://www.gob.mx/semarnat/que-hacemos

SENER (2016) Estrategia de Transición para promover el uso de tecnologías y combustibles más limpios, p.80, https://www.gob.mx/cms/uploads/attachment/file/182202/20161110_1300h_Estrategia_CCTE-1.pdf

SENER (2016) Prospectiva de Energías Renovables 2016 - 2030

SENER (2017) https://www.gob.mx/sener/articulos/subasta-electricidad?idiom=es

SENER (2017) Nueva Industria Energética en México

SENER (2017) PRODESEN 2017-2031

SENER (2017) Recursos renovables para la producción de electricidad en México https://dgel.energia.gob.mx/documentos/Renovables_Mexico.swf

SENER (2018) https://www.gob.mx/sener/prensa/99-por-ciento-de-cobertura-electrica-nacional-en-2018-pjc?state=published

SENER (s.f) Nota explicativa – Contratos legados para el suministro básico https://www.gob.mx/cms/uploads/attachment/file/258356/Nota_explicativa_contratos_legados.pdf

Solar Energy ... **Industries Association (2017)** Model Leases and PPAs. https://www.seia.org/research-resources/model-leases-and-ppas

Tecnointeligente **(2017)** https://www.gob.mx/cms/uploads/attachment/file/249307/Reglas_de_Operaci_n.pd

Tecnointeligente **(2018),** http://www.tecnoligente.com/incrementando-potencial-los-paneles-solares-en-mexico-seguidor-solar-diseno-mexicano/

Universidad **Pública de Navarra (2014)** Estudio comparativo de la eficiencia energética en seguidores solares http://academica-e.unavarra.es/bitstream/handle/2454/11844/TFGTurrillasSalobreEduardo2014.pdf?sequence=1