The new Power sector in Mexico: The Trans-boundary Impact on U. S. and Mexican Transactions

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University of Houston
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www.reformaenergetica.gob.mx
• Impact of the Reform
• Objectives of the Reform
• New industry structure
• The new Electric Market
  • Short Term Market/Clean Energy/Clean Energy Certificates/Capacity/Long Term Auctions
• Development of new infrastructure
• The Transboundary Impact on U. S. and Mexican Transactions.
• Universal Electric Service Fund (FSUE)
Impact of the Reform
• With the Energy Reform Mexico introduced a wholesale market with retail competition.
• Mexican industrial organization in the electricity sector is moving towards the **OECD standard**.
Mexico's GDP will grow between 0.9 and 2.2% if electricity rates converge with US: IMF

Competition and lower costs:

- Improve the competitiveness of industry and commerce.
- Increase disposable income of the population in general.
- Create opportunities to export low-cost power.

### Economic Impact of a Reduction in Electricity Prices

<table>
<thead>
<tr>
<th>(In percent)</th>
<th>Lowest</th>
<th>Highest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elasticities</td>
<td>-0.11</td>
<td>-0.28</td>
</tr>
</tbody>
</table>

**Scenario 1: Substitution of fuel for natural gas**

- Increase in manufacturing output: 1.4 - 3.6
- Increase in overall GDP: 0.2 - 0.6

**Scenario 2: Convergence to U.S. Levels**

- Increase in manufacturing output: 5.5 - 14.0
- Increase in overall GDP: 0.9 - 2.2

Note: Scenario 1 assumes a reduction in electricity prices of 13 percent, consistent with fuel oil being substituted by natural gas. Scenario 2 assumes convergence of electricity prices for industrial and commercial users to U.S. levels. Source: National authorities and staff calculations.
Table 2. **Impact of the reform on the level of GDP in the medium term**
OECD estimates of the reforms that have been legislated and those expected\(^1\)
Effect after 5 years, assuming that implementation is immediate.

<table>
<thead>
<tr>
<th></th>
<th>Via productivity growth (%)</th>
<th>Via intensification of capital (%)</th>
<th>Via employment growth (%)</th>
<th>GDP growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Reforms from Pact for Mexico</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. market regulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) telecommunications</td>
<td>0.06</td>
<td></td>
<td></td>
<td>0.06</td>
</tr>
<tr>
<td>b) Electricity and Gas</td>
<td>0.32</td>
<td></td>
<td></td>
<td>0.32</td>
</tr>
<tr>
<td>c) Oil</td>
<td></td>
<td>0.45</td>
<td></td>
<td>0.45</td>
</tr>
<tr>
<td>2. Labor market reform</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment protection</td>
<td></td>
<td></td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>3. Tax structure</td>
<td></td>
<td></td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>4. Legal reform</td>
<td></td>
<td></td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>B. Additional reforms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Judicial reform</td>
<td>0.91</td>
<td>0.00</td>
<td>0.10</td>
<td>1.0</td>
</tr>
<tr>
<td>6. Labor market reform</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Reforms towards formality</td>
<td>0.42</td>
<td></td>
<td></td>
<td>0.42</td>
</tr>
<tr>
<td>b) Participation of women</td>
<td></td>
<td></td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1.82</strong></td>
<td><strong>0.51</strong></td>
<td><strong>0.13</strong></td>
<td><strong>2.0</strong></td>
</tr>
</tbody>
</table>

1. It is likely that the tax and education reforms will have significant effects on growth (the latter especially long-term), but these have not been included in the table because of the difficulty in quantifying these effects.

Source: Bourles *et al.* (2010); Bassanini *et al.* (2009); Dougherty and Escobar (2014); Thévenon *et al.* (2012); IMF-OECD-World Bank (2014); Dougherty (2014).
Reform can reduce up to 29.5% of the system costs

The areas with the greatest potential are:

• Reduction of energy losses in the network and fuel substitution and optimization.

Composition of electricity rates reduction
(% Of the current rate)

- CFE Sales revenue
- Fuel substitution by natural gas
- Fuel optimization
- Reducing non-technical losses
- Guarantee commitments in operational efficiency
- Operational efficiency
- Sales revenue reduced rates

The areas with the greatest potential are:

• Reduction of energy losses in the network and fuel substitution and optimization.
The Reform will create innovation and investment in technology

<table>
<thead>
<tr>
<th>The transparency of the market demands that the authorities invest in technology, to eliminate mistakes and improve processes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Optimization algorithms</td>
</tr>
<tr>
<td>- Databases</td>
</tr>
<tr>
<td>- Metering equipment</td>
</tr>
<tr>
<td>- Accounting systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competition will drive efficient practices:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- True costs are identified; prices and rates are set without distortions</td>
</tr>
<tr>
<td>- Inefficient business practices are eliminated under the pressure of competition</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The flexibility of the market permits the entry of new solutions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Retail products that incentivize efficient consumption</td>
</tr>
<tr>
<td>- Demand response and interaction with the consumer</td>
</tr>
<tr>
<td>- New generation technologies</td>
</tr>
<tr>
<td>- Innovative financial products</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Human capital is attracted and developed:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Foreign companies bring their knowledge to Mexico</td>
</tr>
<tr>
<td>- Local talent is developed</td>
</tr>
<tr>
<td>- New companies are born in Mexico</td>
</tr>
</tbody>
</table>
New industry structure
## Background:
### Mexican Electric System

#### Generation Capacity (MW)

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Cycle</td>
<td>23,309</td>
</tr>
<tr>
<td>Steam (Fuel Oil and Gas)</td>
<td>12,959</td>
</tr>
<tr>
<td>Coal</td>
<td>5,958</td>
</tr>
<tr>
<td>Simple Cycle</td>
<td>3,419</td>
</tr>
<tr>
<td>Internal Combustion</td>
<td>1,312</td>
</tr>
<tr>
<td>Multiple</td>
<td>1,573</td>
</tr>
<tr>
<td>Hydro</td>
<td>12,429</td>
</tr>
<tr>
<td>Wind</td>
<td>2,036</td>
</tr>
<tr>
<td>Geothermal</td>
<td>813</td>
</tr>
<tr>
<td>Solar</td>
<td>56</td>
</tr>
<tr>
<td>Nuclear</td>
<td>1,400</td>
</tr>
<tr>
<td>Biomass</td>
<td>180</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>65,452</strong></td>
</tr>
</tbody>
</table>

**Conventional**: 48,530 MW  
**Clean**: 16,921 MW

#### Networks (km-c)

<table>
<thead>
<tr>
<th>Type</th>
<th>Length (km-c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 kV</td>
<td>23,641</td>
</tr>
<tr>
<td>230 kV</td>
<td>27,543</td>
</tr>
<tr>
<td>Subtransmission (≥ 69 kV)</td>
<td>56,851</td>
</tr>
<tr>
<td>Distribution</td>
<td>683,226</td>
</tr>
</tbody>
</table>
Electric Rates Pre-Reform

Average rates, first quarter 2013 (centavos/ kWh)

- **Average rates:** 25% higher than in the US
- **Without subsidies:** difference would be 73%
- **Subsidies equal to 0.75% of GDP**

Sources: Sistema de Información Energética (Mexico), Energy Information Administration (USA)
Objectives of the Reform

Reform Objectives
- Reduce costs and rates
- More clean energy
- Spread the benefits

Reform Elements
- Industry Restructuring
- Competitive Market
- Clean Portfolio Standard
- Independent Planning

Reform Principles
- Incentives for value creation and efficient operation
- Decisions through competitive processes
- Open access and non-discrimination
- Transparency
Mexico's GDP will grow between 0.9 and 2.2% if electricity rates converge with US: IMF

Industry Structure, Pre-Reform

Public Service
- CFE
- CFE\_PIEs

Self Supply
- PEMEX
- Walmart\_México
- IBERDROLA
- Holcim\_APASCO
- EDF\_énnergies\_nouvelles

Dispatch
- CFE
- CFE
- PEMEX
- Walmart\_México
- Hylsa
- Holcim\_APASCO
New Industry Structure: investment opportunities in markets and PPPs

- Generation
  - Subsidiary “A”
  - Subsidiary “B”
  - Subsidiary “C”
  - Private Parties
  - Long Term Contracts

- System Control and Power Market
  - Spot Market
  - Auctions
  - Short Term Transactions

- Retailing
  - Unregulated Supply
  - Qualified Users
  - Basic Service Users
  - Regulated Supply

- Consumption
  - and PPP Contracts
  - CFE
  - and PPP Contracts

- Transmission
  - and PPP Contracts

- Distribution
## New Institutional Roles

### Generation
- Expansion Plan
- SENER: Generation “Modality”
- Approve Expansion Plan
- CRE: Permits
- CFE: Operation of Short and Long Term Markets
- CENACE: Requirements for Clean Energy
- SENER: Contracting Requirements
- CRE: Administer CEC’s

### Control/Dispatch
- Dispatch Rules
- Reliability Standards
- Initial Market Rules
- Reliability Standards
- Market Monitor

### Transmission
- Generator Interconnection
- Planning and Interconnection Studies
- Approve expansion plan
- Regulated Tariffs
- Supervision of Interconnection

### Distribution
- Final Rates
- Participate in Final Rates
- Minimum consumption to be Qualified User

### Marketing
- Final Rates (Basic Service)
- Participate in Final Rates
Reestructuring of CFE
**Restructuring of CFE**

**Characteristics**

**Restructuring**
- Vertical Separation (G/T/D/S)
- 5 CFE Generation Companies
- Distribution in 16 units

**Corporate Governance**
- Subsidiaries: 2 CFE, 1 SHCP, 1 SENER y 1 Independent
- CFE CEO presides boards

**Chinese Walls**
- Separate employees/spaces
- No coordination between competitive segments
- Separate marketing

**Benefits for CFE**
- Specialized supervision of each activity
- Clear information about the performance of each company
- Planning and finance coordinated among companies

**Benefits for the Market**
- Vertical separation assures open access to networks for all generators and marketers
- Horizontal separation of generation avoids market power
**CFE Terms of Strict Legal Separation**

**Horizontal Separation**
- **1 Transmission Subsidiary**
- **5 Subsidiaries / Affiliates (eventually) Own Generation**
- **1 Subsidiary to Administer PPA Contracts**
- **1 Affiliate to Administer Legacy Interconnection Contracts**

**Vertical Separation**
- **State Control**
  - **1 Transmission Subsidiary**
  - **1 Distribution Subsidiary (16 Business Units)**
  - **1 Subsidiary for Basic Retail Service**
  - **1 Affiliate for Qualified Retail**

**Chinese Walls:**
- Information can only be shared if it is made public
- No coordination of strategies between generators or generator-transmission
- Separate marketing
- Investments evaluated for their effect on the company that makes them
- Remuneration based on specific company results
Assignment of CFE Plants and PPA’s to 6 Companies

Legend

- **Type**
  - Thermal
  - Hydro
  - Wind
  - Solar
  - Geo.
  - Various
- **Size**
  - < 100 MW
  - >=100 MW & < 500 MW
  - >=500 MW & < 2,000 MW
  - >=2,000 MW
- **Company**
  - EPS I
  - EPS II
  - EPS III
  - EPS IV
  - EPS V
  - EPS VI
  - Corp.

- **Existing**
- **New Plants**
The new Electric Market
## Market Features

<table>
<thead>
<tr>
<th>Market</th>
<th>Periodicity</th>
<th>Market Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy and Ancillary Services</td>
<td>Daily, Hourly</td>
<td>Cost Based</td>
</tr>
<tr>
<td>Capacity</td>
<td>Yearly</td>
<td>Administered</td>
</tr>
<tr>
<td>Clean Energy Certificates</td>
<td>Yearly</td>
<td>Unrestricted offers</td>
</tr>
<tr>
<td>Financial Transmission Rights</td>
<td>Yearly / Monthly</td>
<td>Unrestricted offers</td>
</tr>
</tbody>
</table>

### Auctions and Long Term Contracts

- CRE will set requirements for retailers to contract forward energy and associated products.
- Basic Service Retailers may only contract forward through auctions operated by CENACE.
The market adopts global best practices

<table>
<thead>
<tr>
<th>Feature</th>
<th>Other Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nodal prices for the <strong>spot energy market</strong></td>
<td>Argentina, Chile, Ireland, Russia, Singapore, New Zealand, PJM, ERCOT, CAISO, MISO</td>
</tr>
<tr>
<td>Cost-based capacity market for new generation with reserves demand curve</td>
<td>United Kingdom, Ireland, Russia, Colombia, PJM, NYISO, MISO</td>
</tr>
<tr>
<td><strong>Clean Energy Certificates</strong> with clean portfolio requirements</td>
<td>Nordpool, Italy, CAISO, United Kingdom, Australia, Chile, India</td>
</tr>
<tr>
<td><strong>Financial Transmission Rights</strong> with periodic auctions</td>
<td>New Zealand, PJM, ERCOT, CAISO, MISO</td>
</tr>
</tbody>
</table>
Short Term Market
Short Term Market: General Characteristics

Objectives

- Efficient and reliable dispatch of the National Electric System.
- Correct signals for the location of new electric plants and the use of controllable demand.

Features

- Two-Settlement (Day Ahead and Real Time).
- Nodal prices (approximately 2000 nodes).
- Three part offers.
- Co-optimization of energy and ancillary services.
- Economic unit commitment by system operator.
- Cost based offers and market monitoring.
- Initial market based on existing CENACE software.
# Market Implementation Calendar

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Baja California</th>
<th>Interconnected System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing and Validation</td>
<td>5-22 January 2016</td>
<td>27 January 2016</td>
</tr>
<tr>
<td>Real Time Market</td>
<td>27 January 2016</td>
<td>29 January 2016</td>
</tr>
</tbody>
</table>

**Transitory Rules for Gradual Implementation**

- Real Time Market in phases (quantities, prices and dispatch)
- Longer timeframe for initial billing and payment cycle
- Simplified participant registration during an initial period
- Credit requirements suspended until first billing cycle is complete
WHAT IS THE ELECTRICITY MARKET?

Market Participation to Date

American Light & Power MX, S. A. P. I. de C. V.
Granja Generadora de Energía Solar, A. C.
Compañía Cervecería de Coahuila, S. de R.L. de C. V.

Iberdrola Generación S. A. de C. V.
Iberdrola Clientes S. A. de C. V.

Rosch Latam México, S.A. de C.V.
Energía Renovable del Istmo II, S.A. de C.V.

Frontera México Generación, S. A. de R. L. de C. V.
Energía del Valle de México, S.A.P.I. de C.V.
E2M Suministro Calificado, S.A.P.I. de C.V.
Orden Cardinal, S.A.P.I. de C.V.

Suministro Sustentable de Energía en México, S. A. P. I. de C.V.
Energía Buenavista, S. de R. L. de C.V.

Intergen Soluciones Energéticas, S. de R. L. de C.V.
B-Energy Industries, S.A. de C.V.
Renovables Valor Agregado y Resultados Suministradora, S.A.P.I. de C.V.

GPG Energía México S.A. de C.V.
Hella Automotive México, S.A. de C.V.
Ammper Energía S.A.P.I. de C.V.

With a contract

In the process of being signed

Generator
Intermediation Generator
Basic Supply
Qualified Supply

Day Ahead Market Results

* The average includes 2,130 nodes in this system

Local Marginal Price
Average Hourly from January 29th to September 23rd, 2016.

$820 a $865
$866 a $911
$912 a $957
$958 a $1,003

* The average includes 2,130 nodes in this system
FTRs

Objectives

- Allow market participants to reduce exposure to congestion prices.
- Assure that generators face correct signals to build and operate plants.
- Preserve legacy rights.
- Avoid restricting dispatch.

Features

- Allocation process for Grandfathered FTRs.
- General auctions for new FTRs.
- Special FTR mechanism linked to new construction.
- CENACE will only award FTRs up to the simultaneously feasible capacity of the network.
Clean Energy
Clean Energy Potential in Mexico

Clean Energy Goals:
35% in 2024, 40% in 2035 and 50% in 2050

<table>
<thead>
<tr>
<th>Renewable Energy Potential</th>
<th>Actual Generation Year 2013 (% of total GWh)</th>
<th>Actual Generation + Proven Resources</th>
<th>Actual Generation + Proven Resources +Probable Resource</th>
<th>Actual Generation + Proven Resources +Probable Resources +Possible Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>1,900</td>
<td>1.4%</td>
<td>5.3%</td>
<td>34.8%</td>
</tr>
<tr>
<td>Geothermal</td>
<td>823</td>
<td>2.0%</td>
<td>22.5%</td>
<td>40.0%</td>
</tr>
<tr>
<td>Solar</td>
<td>64</td>
<td>0.01%</td>
<td>0.6%</td>
<td>2,189.4%</td>
</tr>
<tr>
<td>Mini Hydro</td>
<td>419</td>
<td>0.5%</td>
<td>9.5%</td>
<td>24.4%</td>
</tr>
<tr>
<td>Total</td>
<td>3,206</td>
<td>4.0%</td>
<td>9.9%</td>
<td>37.9%</td>
</tr>
</tbody>
</table>

Installed Capacity 2° semester 2014 (MW)

Solar Resources

Wind Resources

Geothermal resources

Solar Resources

Wind Resources

Geothermal resources

Solar Resources

Wind Resources

Geothermal resources
Opening of Retailing and Distributed Generation

Before Reform
- Generation in small installations could not sell surplus.
- Credit was awarded toward consumption, but avoided rates were often lower than market values.

After Reform
- Regulated suppliers will pay a regulated price for surplus energy.
- Unregulated suppliers can buy from all users at market prices.
- Minimal regulation of on-site sales.

Distributed generation will earn a fair payment.

Specialized companies can market distributed generation.

Only users on the highest rates had incentives to install distributed generation.
Principal Increases in Capacity (MW)

- **Hydro**: 12,489 (2015) to 16,976 (2030)
- **Wind**: 2,805 (2015) to 15,101 (2030)
- **Efficient Cogeneration**: 583 (2015) to 7,627 (2030)
- **Solar**: 56 (2015) to 6,905 (2030)
- **Combined Cycle**: 24,043 (2015) to 42,643 (2030)

- **Tripled** Clean Energy
- **Increased 75%** Combined Cycle
Clean Energy Certificates
Clean Energy Certificates

Objectives

- Solve the “missing money” problem for clean generators.
- Let the market make choices over technology.
- Transparency regarding the cost of clean energy.
- Maintain flexibility in case of cost surprises.

Features

- SENER establishes requirements to use a percentage of clean energy.
- Retailers fulfill their requirements by buying Certificates.
- CENACE operates a market once a year.
- CRE verifies compliance and applies fines in case of non-compliance.
Mexico has adopted the global best practice of clean energy certificates

- Mexico’s clean energy portfolio standard of 35% in 2024 is among the most ambitious in the world
Required Income from Clean Energy Certificates

- **Proyecto en Hermosillo con costo $65**
  - Costo Proyecto: $65
  - Precio CEL: $26
  - Precio Energía: $39

- **Proyecto en Hermosillo con costo $80**
  - Costo Proyecto: $80
  - Precio CEL: $41
  - Precio Energía: $39

- **Proyecto en Mérida con costo $65**
  - Costo Proyecto: $65
  - Precio CEL: $8
  - Precio Energía: $57

- **Proyecto en Mérida con costo $80**
  - Costo Proyecto: $80
  - Precio CEL: $23
  - Precio Energía: $57
Elasticity in the CEC Market

- Without storage of CECs or deferral of obligations, the price would alternate between zero and the value of the fine.

- CEC guidelines permit storage and deferral of up to 25% of obligations.
- The Energy Transition Law establishes cases where up to 50% can be deferred.
- Elasticity guarantees price stability.
Capacity
Capacity Market: General Characteristics

**Objectives**

- Installation of sufficient capacity.
- Pay the fixed costs that aren’t recovered in the energy market.
- New investments need long term contracts, but the short term capacity market must pay the right prices.

**Features**

- Ex-post market to avoid market power concerns and incentives to over-report capacities.
- Demand curve based on the Cost of New Entry.
- Zonal capacity requirements when necessary.
Long Term Auctions
Guarantee a stable cash flow that will cover fixed costs, reducing the risk of generation investment.

<table>
<thead>
<tr>
<th>Products</th>
<th>Term</th>
<th>Time to Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>15 years</td>
<td>3 years</td>
</tr>
<tr>
<td>CECs</td>
<td>(Cap / Energy)</td>
<td>3 years (or more)</td>
</tr>
<tr>
<td>Energy</td>
<td>20 years (CEC)</td>
<td></td>
</tr>
</tbody>
</table>

Allow retailers to obtain an energy hedge prior to the short-term markets.

<table>
<thead>
<tr>
<th>Products</th>
<th>Term</th>
<th>Time to Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>3 years</td>
<td>4 months</td>
</tr>
<tr>
<td>Energy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Long-Term Auctions

### Objectives

- Advance quickly toward Mexico’s clean energy goals.
- Acquire clean energy at minimum cost for users.

### Strategies

- All technologies compete on a level playing field, recognizing the value of each one.
- Reduce risk assigned to generators, to make projects more bankable.

### Design

- Bids for each product based on the Retailer's needs.
- Sale offers by package according to each plant’s capabilities.
- Adjustments for location and time of generation.

### Outcome

“Deploying a mix of technologies can:
- Lead to more stable variable renewable energy, and
- Reduce periods of variable renewable energy excess.

Hence boosting System Value.”

*IEA: Next Generation Wind and Solar Power (Overview of Mexico Auctions), June, 2016.*
Simultaneous Auction for Clean Energy and Capacity

**Individual product/technology auctions:**

Geothermal Technology would not be competitive in Clean energy auctions, or Capacity auctions.

**Package auction:**

Geothermal technology is competitive and is a winner, based on its package price.
**Historical Context**

**Clean Energy: Solar & Wind**

**Installed Capacity: Solar & Wind**

- **Capacity since 1998 to 205**: 2,861 MW
- **1st Long-Term Auction**: 2,085 MW
- **2nd Long-Term Auction**: 2,804 MW

*Does not include hydroelectric capacity (67 mw).*

**Auctions**

The First Auction acquired solar and wind capacity equal to 73% of the amount installed in the previous 18 years.

CECs covered 1.9% of annual energy consumption.

The Second Auction acquired solar and wind capacity equal to 98% of the amount installed in the previous 18 years.

CECs covered 3.2% of annual energy consumption.
WHAT IS THE ELECTRICITY MARKET?

1st + 2nd Long-Term Auctions

Investment by State

Investment by source

Investment per State (%)

Approx. 6.6 billion dollars of total investment.

15 states with investment in new projects.
What is the Electricity Market? International Comparison

**By Country and Technology**

**Solar**
- Brazil
- France
- Germany
- India
- Jordan
- 1st Mexican Auction
- 2nd Mexican Auction
- Australia
- Brazil
- 1st Mexican Auction
- 2nd Mexican Auction
- Peru
- Saudi Arabia
- South Africa
- United Arab Emirates
- United Kingdom

**Wind**
- Australia
- Brazil
- 1st Mexican Auction
- 2nd Mexican Auction
- Peru
- South Africa
- United Kingdom

**By Capacity**

**Solar. Assigned Capacity (MW), 2016**
- 1st & 2nd Mexican Auctions: 3,483
- United Arab Emirates: 800
- Peru: 184
- India: 100

**Wind. Assigned Capacity (MW), 2016**
- 1st & 2nd Mexican Auctions: 1,406
- Australia: 200
- Peru: 162
Long Term Auctions; praised by observers around the world

Forbes

Steven Chu, Mexico’s Energy Auction Reveals True Price Of U.S. Renewables

Bloomberg

Mexico auction results in record low PV prices

Panel beaters

World politics

Key point - The design of the Mexican auction system reflects the SV of different projects depending on when and where they generate electricity.

SENER

SECRETARIA DE ENERGIA

Economist.com

Un 75% de los participantes encuestados considera que la subasta fue un éxito porque:

“Hubo una elevada participación, se asignó el 85% de las aforas de compra a precios competitivos.”
Development of new infrastructure
Strategy for the creation of a Natural Gas Market

**Information**
- Production, Transactions
- Market-based prices

**Access to Infrastructure**
- Open Seasons
- Capacity reservations

**More participation** = **Liquid Market**

- **Map of Natural Gas Infrastructure**
Gas pipelines will guarantee supply for combined cycle generation.

- The 2015-2019 Five-Year Expansion of Natural Gas Transportation System will to capitalize on our strategic position through 13 projects.

### Gas Pipeline Expansion Plan. Summary

<table>
<thead>
<tr>
<th>Projects (Number)</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (km)</td>
<td>5,159</td>
</tr>
<tr>
<td>Estimated investment (Billions of dollars)</td>
<td>9,736</td>
</tr>
</tbody>
</table>
Natural Gas Investment Opportunities

Natural Gas Balance (MMcfd)

Production: 4,467 (97%)
Consumption: 4,576
Imports: 109 (3%)


MMcfd: Million cubic feet
Gradual Market Liberalization: Gasoline and Diesel

- Transition to market prices for gasoline and diesel retail
- Pemex product offering and other suppliers

2015

Maximum prices for gasoline and diesel, adjusted according to expected inflation.*
- Magna Gasoline: $13.96/l
- Premium Gasoline: $14.81/l
- Diesel: $13.98/l

2016 onwards

Public retail: Pemex and other brands

Imports: Exclusive by Pemex

Until March 31, 2016

Free imports From April 1, 2016

2017

2018

Free prices based on market conditions

SENER HAS AUTHORIZED 95 PERMITS FOR GASOLINE AND 135 FOR DIESEL**

** Up to August 2nd, 2016.
• According to the Program for the Development of the Electricity System 2016-2030, Mexico will need to invest **131.6 Billion dollars** in the next fifteen years.

<table>
<thead>
<tr>
<th>Total Investment (Billion dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation</td>
</tr>
<tr>
<td>98.686</td>
</tr>
</tbody>
</table>

- **Generation 75%**
- **Transmission 13%**
- **Distribution 13%**
Indicative Generation Expansion Plan

- Total Clean Energy Capacity will Triple
- Clean Energy focused in Wind, Solar, and Efficient Cogeneration
- 75% growth in Combined Cycle capacity
The Transmission Network will be strengthened in the next five years.

**Strengthening** the network to interconnect the new power plants.

**Anticipating** the new infrastructure required to take advantage of **Clean Energy** resources.

- **1st HVDC Line**: 2nd semester 2016
  - Cancún-Cozumel.
  - Angostura-Tapachula.
- **2nd HVDC Line**: 1st semester 2017
  - Baja California-SIN Interconnection.
  - Back to Back asynchronous link 150 MW in Nogales, Sonora-Arizona, USA.
- **3rd HVDC Line**: 2nd semester 2017
  - Istmo de Tehuantepec - Valle de México.
  - Reinforcements.
Transmission investment will reduce congestion in the electric system.

Through investment and expansion, the transmission network will guarantee the delivery of cheap and clean resources to the regions of high demand.
Contracts for Transmission and Distribution

- Transmission and Distribution remain reserved to the State, but Associations and Contracts are permitted in order to finance, install, maintain, administer, operate and expand networks.
- SENER can determine that non-CFE lines be contracted.
- The first tender for a non-CFE transmission line was launched two months ago.

<table>
<thead>
<tr>
<th>Contract Type</th>
<th>Public Service</th>
<th>New Investment</th>
<th>Commercial Risk (Who assumes)</th>
<th>Operation and Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Privatization</td>
<td>Public</td>
<td>Private</td>
<td>Private</td>
<td>Private</td>
</tr>
<tr>
<td>Concession</td>
<td>Private</td>
<td>Private</td>
<td>Private</td>
<td>Private</td>
</tr>
<tr>
<td>Integral Management</td>
<td>Public</td>
<td>Private or Mix</td>
<td>Shared</td>
<td>Private with public supervision</td>
</tr>
<tr>
<td>Risk Sharing</td>
<td>Public</td>
<td>Private</td>
<td>Public</td>
<td>Private with public supervision</td>
</tr>
<tr>
<td>Operation and</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Private with public supervision</td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Management</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
</tbody>
</table>
Calendar: Auctions and transmission lines

1ª Subasta de Energías Limpias
- 2.6 mil millones de dólares
- 1ª Línea HVDC (Oaxaca)

2ª Subasta de Energías Limpias
- 4 mil millones de dólares
- 2ª Línea HVDC (Baja California)

Marzo 16

Nov 15

Abril 16

Sep 16

Ene 17

Marzo 17

Abril 17

3ª Subasta de Energías Limpias
- 2.6-4 mil millones de dólares
Transparency in the Planning Process

- Complete planning database published by SENER

- Base de datos de demanda horaria para PIIRCE 2016-2030.
- Base de datos de generación para PIIRCE 2016-2030.
- Base de datos de precios de combustibles para PIIRCE 2016-2030.
- Base de datos de transmisión para PIIRCE 2016-2030.
- PRODESEN Capítulo 1.
- PRODESEN Capítulo 2.
- PRODESEN Capítulo 3.
- PRODESEN Capítulo 4.
- PRODESEN Capítulo 5.
- PRODESEN Capítulo 6.
- PRODESEN Capítulo 7.
WHAT IS THE ELECTRICITY MARKET?

Transparency in the Power Market

Building on the requirements in Law, the Market Rules require the publication of a wide range of information

Public Information
- Offers and Local Marginal Prices for the Day-Ahead and Real Time Markets
- Assigned quantities in the Day-Ahead and Real Time Markets
- Real time information regarding demand, power plant performance and system conditions
- Market results for the Capacity Market, Clean Energy Certificates Market and FTR auctions
- Technical and non-technical losses assumptions used in the Wholesale Electricity Market, as well as observed data regarding such losses
- Interconnection queues
- Opportunity cost models for hydroelectric energy
- Forecasts for:
  - aggregate level electric power demand;
  - aggregate level generation;
  - generation availability
  - transmission availability

Market Participants and trusted entities
- Complete Day Ahead and Real Time Market models
- Complete models used to calculate start and stop instructions
- National Electric System topology in a format that allows its use in common software for power system simulation
- Financial Transmission Rights models
- Detailed planning models
- Complete calculation used for the National Electric System operating limits
- List of specific contingencies considered in the security evaluation of the National Electric System
- Capacity market models
- Models used in the calculation of capacity zones
- Scheduled outages
### Achievements to Date

| Constitution       | December 2013 | • Competition in generation and retail; contracts and PPP
|                    |              | • Vertical and horizontal separation
| Secondary Laws     | August 2014  | • Wholesale Electricity Market
|                    |              | • Independence of Regulators
| **CENACE**         | August 2014  | • Creation Decree
| Universal Serv.    | Sept. 2014   | • Creation of the Electrification Fund
| Clean Energy       | March 2015   | • Clean Energy Certificate Requirements
| Interconnection    | June 2015    | • Interconnection Criteria
| Planning           | August 2015  | • System Expansion Program
| Market Rules       | Sept. 2015   | • Electric Power Market Bases
| **Spot Market**    | January 2016 | • Market Start
| Associations       | January/Aug 16 | • Terms of CFE Separation / Generation Portfolios
| **Auctions**       | March/Sept 16 | • First and Second Auction Results
| Associations       | October 2016 | • Launch of competitive process for Oaxaca line
## Conclusions

**Milestones Reached**

- Independence of system operator
- Market design and start of operations
- System expansion plan and RFP for Oaxaca line
- Terms of CFE separation

**Next Steps**

- Implementation of advanced market features
- Auctions with more participants
- Implementation of CFE Restructuring
- Complete process for Oaxaca line contract

**Final Result**

- Transparent market attracts investment
- CFE adapts to compete and grow
- Expansion of transmission and clean energy
- CRE becomes the authority for the power market
The Transboundary Impact on U. S. and Mexican Transactions
Currently, Mexico-US trade occurs in two main regions: Baja California / California and Tamaulipas-Coahuila / Texas.

- 5 interconnections (1086 MW) in permanent operation.
- 8 interconnections (788 MW) for emergency backup.

In 2014, Mexico exported 1,910,238 MWh and imported 2,119,011 MWh over these interconnections.

Additional interconnections could produce annual net savings of 125 to 300 million dollars.
The PRODESEN 2015-2029 proposes a stronger interconnection from North America to Central America.

**Mexico – California:**
- Interconnection of the National System with Baja California (already interconnected to California)
  - Pinacate-Cucapáh: 200 km
  - Seis de Abril-Pinacate: 205 km
  - Interconnection of isolated systems on the Baja California Peninsula

**Mexico – Central America:**
- Expansion of connection between the Central and Southern regions of the National Interconnected System
- Back-to-back DC interconnections between Mexico and Guatemala
## Cross-Border Transactions in the Power Market

<table>
<thead>
<tr>
<th>Source</th>
<th>Sink</th>
<th>CRE Permits</th>
<th>Market Participation</th>
</tr>
</thead>
</table>
| SEN or Foreign System      | Foreign System or SEN    | No specific permit        | • In any modality  
• Transactions in competitive market                                               |
| Standalone Foreign Plant   | SEN                      | Authorization only        | • As Generator  
• Dispatch as any other plant.                                                      |
| Foreign System             | Standalone Mexican Load  | Authorization only        | • Market participation not required.                                                 |
| Standalone Mexican Plant   | Foreign System           | Generation Permit         | • Market participation not required.                                                 |
| SEN                        | Standalone Foreign Load  | Authorization only        | • In any modality  
• Transactions in competitive market                                                 |
Mexico’s GDP will grow between 0.9 and 2.2% if electricity rates converge with US: IMF

Existing Capacity
- Market rules permit cross-border capacity transactions, as long as system operators have agreed to honor the associated energy schedules.
- Systems will be able to reduce the need for investment in peaking plants, taking advantage of differences in peak load hours.

Energy and Ancillary Services
- Mexico is evaluating participation in the CAISO Imbalance Market.
- The co-optimization of dispatch in both systems will allow lower-cost resources to be used more, replacing higher-cost resources.

New Plants
- Low cost resources (geothermal and wind in Baja California, gas and wind in Texas, wind in Tamaulipas) can be exported to load in other regions.
- Regional diversity will allow higher levels of intermittent resource penetration.

SENER estimates that 6000 MW of new interconnections would produce net savings of 125 to 300 million dollars per year.
Universal Electric Service Fund (FSUE)
Mexico has a significant advance in electrification, but more than 440 thousand homes still do not have electricity.

- **98.53%** of the national population has electricity service.

- More than **1.8 million** people do not have access to electricity. Scattered throughout the national territory, in isolated and difficult to access areas, and with different degrees of poverty.

- Of a total of 192 thousand towns, 41,697 do not have electricity service (440 thousand homes).

- Nearly 31,000 villages have between one and two homes only.

Fuente: Comisión Federal de Electricidad (CFE).
The FSUE will make it possible to achieve universal coverage by addressing the 1.47%

The 1.5% coverage is a more difficult challenge than in the previous stages due to:

- Areas more distant and inaccessible.
- Unreliable information
- Irregular settlements.
- Unsafe zones.
- More expensive provision and with more uncertainty in recovery of investment and costs of supply.
- Unprofitable areas for suppliers.

Hence:

- A stronger instrument is needed in financing and more agile and flexible in spending.
- This instrument is the **FSUE**.
FSUE is the social instrument of the Electric Reform and works with the contributions of the Market.

**Universal Electric Service Fund (FSUE)**

- Created in the Law of the Electrical Industry in 2014 *

- **Solidarity contribution of the electric industry, to reduce energy poverty.**

**Fundamental objective:**

- **Electrification of rural populations and marginalized urban areas, providing lighting and electricity service.**

* Articles 113, 114, 115, 116 and 166 of the LIE regulating FSUE.
Coverage of electrification and goals are inertial. It accelerates with FSUE

**Percentage of electrified population**

**FSUE challenge:**
- Combat the inertial trend in coverage.
- **CHALLENGE:** Universal access to electricity in the next 5 years.
**FSUE strategy: Appropriate technical solutions**

<table>
<thead>
<tr>
<th>Component</th>
<th>Isolation</th>
<th>Estimated Population</th>
<th>Percentage</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expansion of the RGD</td>
<td></td>
<td>1,350,000</td>
<td>75%</td>
<td>Invitation to CFE</td>
</tr>
<tr>
<td></td>
<td>Distance to the Distribution Network</td>
<td>Minimum number of homes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up to 1 km</td>
<td>DNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 1 km up to 3 km</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 3 km up to 5 km</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolated systems*</td>
<td>Others</td>
<td>450,000</td>
<td>25%</td>
<td>Call for Qualified Executors</td>
</tr>
</tbody>
</table>

* Initially photovoltaic panels will be financed to electrify homes and eventually photovoltaic panels with Micro networks and other technological solutions will be used.