Energy Storage in Mexico

Storage Challenges and Opportunities

12 – 13 April, 2018

UNIVERSITY OF BIRMINGHAM

INSTITUTO NACIONAL DE ELECTRICIDAD Y ENERGÍAS LIMPIAS

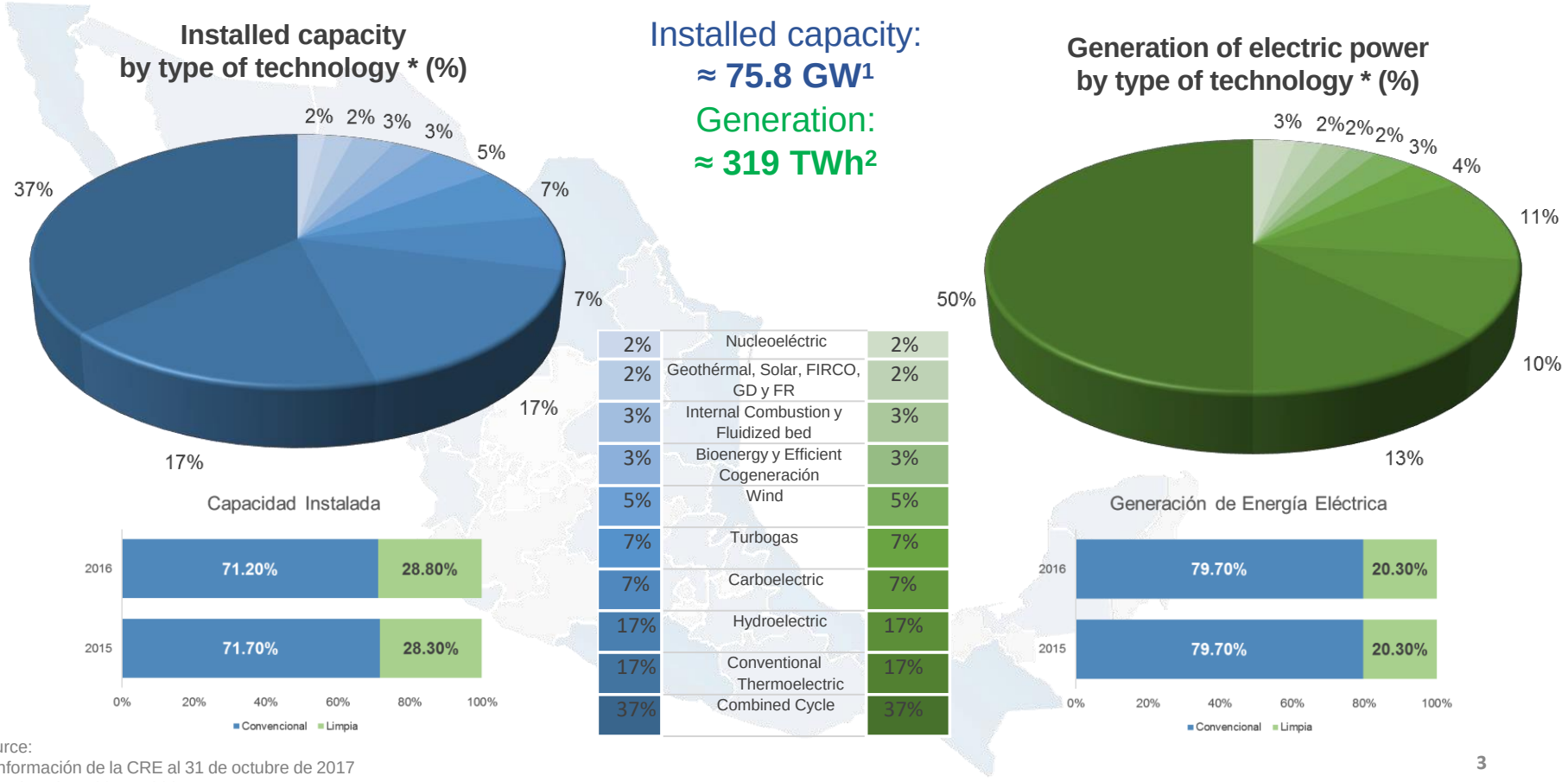
ineel.mx

National Electric System
Actual state

- Installed capacity, **75.8 GW**[1]
- Generation, **319 TWh**[2]
- Peak demand, **43 GW**[3]
- Population, **124 millones**[4]
- Transmission Lines, **102 391 km****
- Distribution Lines, **831 087 km****

Source:
1. Información de la CRE al 31 de octubre de 2017
2. PRODESEN 2017 – 2031
3.Información Preliminar Proporcionada por CFE
4.Proyección CONAPO 2018

National Electric System
Installed Capacity and Electric Power Generation



Source:
1. Información de la CRE al 31 de octubre de 2017
2. PRODESEN 2017 – 2031

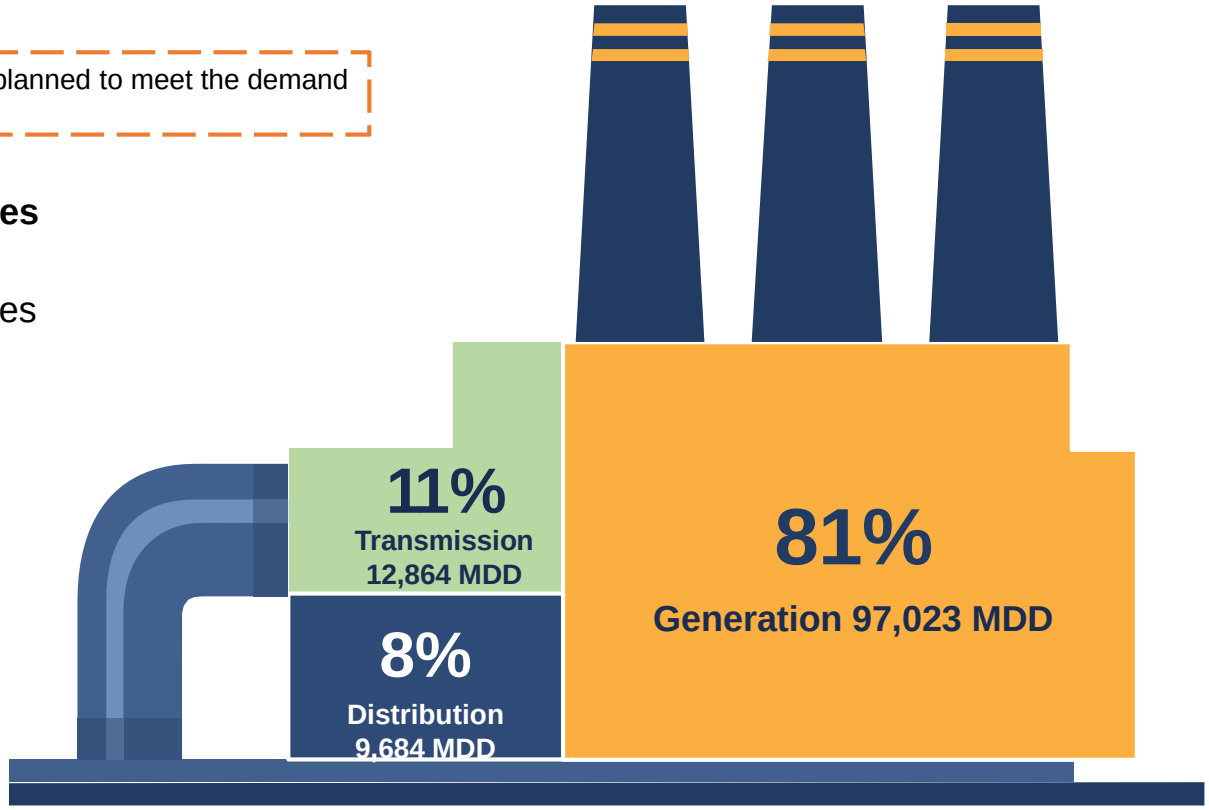
Program of Development of the National Electric System (PRODESEN) 2017-2031: the planning in electrical matter is key to detonate the competitiveness of the country

There are 55,840 MW of additional capacity planned to meet the demand for electricity in the period 2017-2031 1[1]

63% Clean technologies

37% Fossil technologies

119.5
One billion dollars in the next 15 years

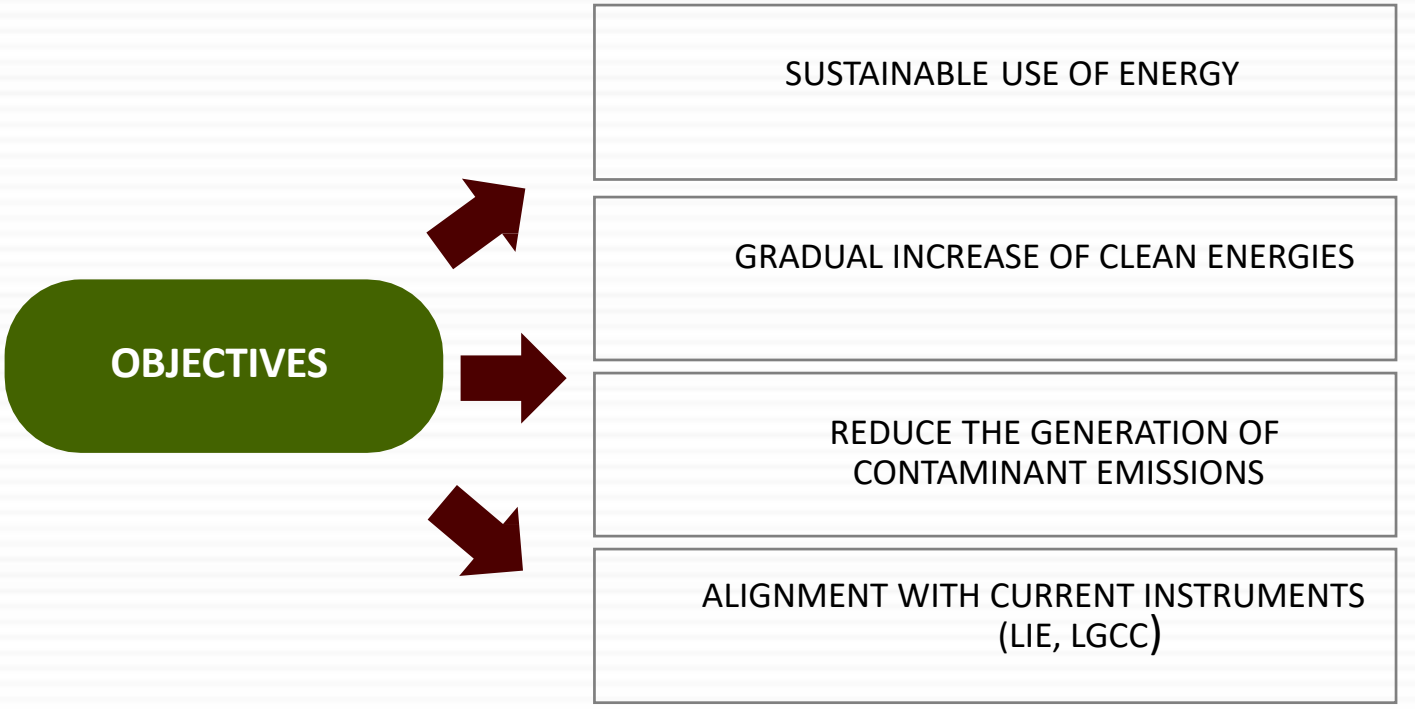


1/ Programa de Desarrollo del Sistema Eléctrico Nacional (PRODESEN) 2017-2031

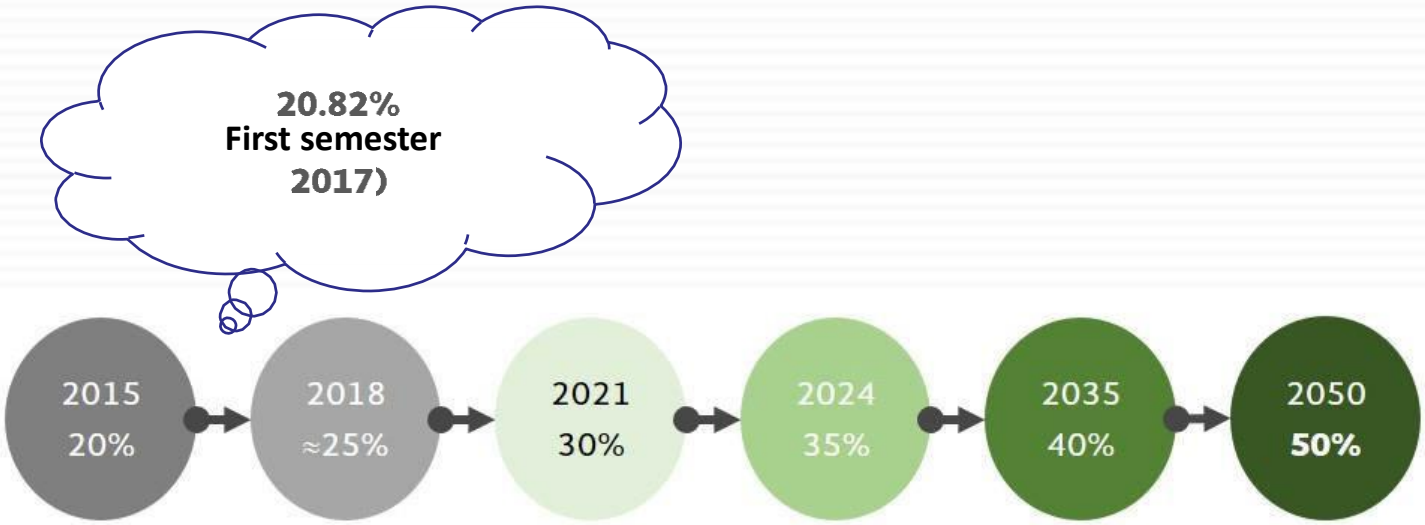
ENERGETIC REFORM

ENERGY REFORM: ENERGY TRANSITION LAW

Create a conducive business environment for the development and implementation of projects by private investors.



POLICIES DERIVED FROM THE ENERGETIC REFORM



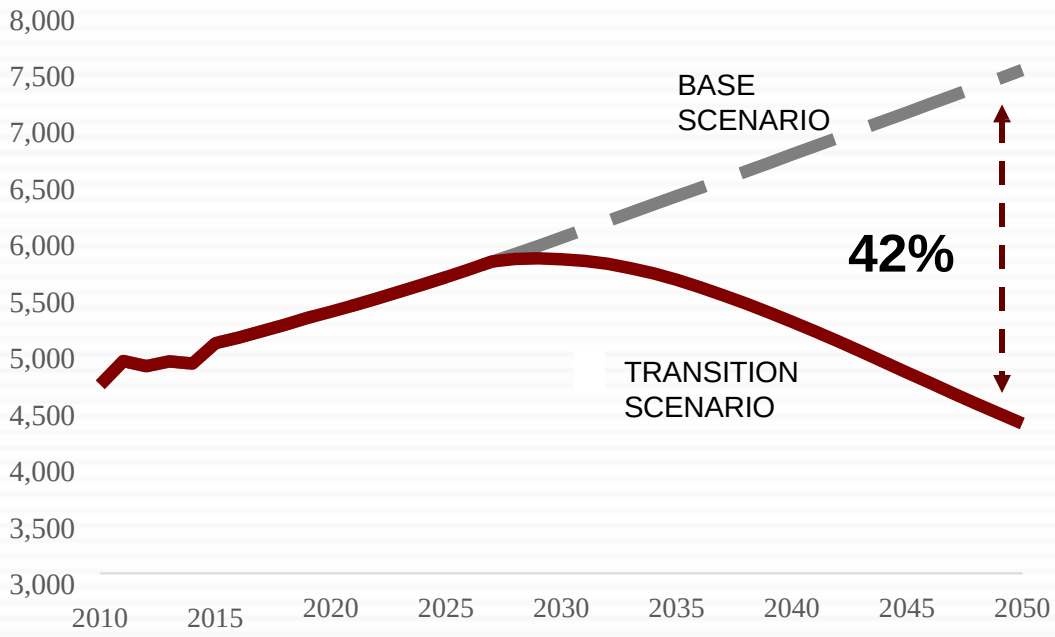
Transition strategy to promote the use of cleaner technologies and fuels

Derived from the Energy Reform, the **Energy Transition Law** was approved, in which clean energy goals are established in the generation of electrical energy.

TRANSITING TOWARDS A LOW CARBON ECONOMY

PROSPECTIVE AND MEDIUM AND LONG-TERM GOALS

FINAL ENERGY CONSUMPTION (PJ)



42% POTENTIAL REDUCTION BY APPLYING ENERGY EFFICIENCY ACTIONS

ENERGY TRANSITION SCENARIO

ANNUAL AVERAGE REDUCTION OF FINAL CONSUMPTION INTENSITY

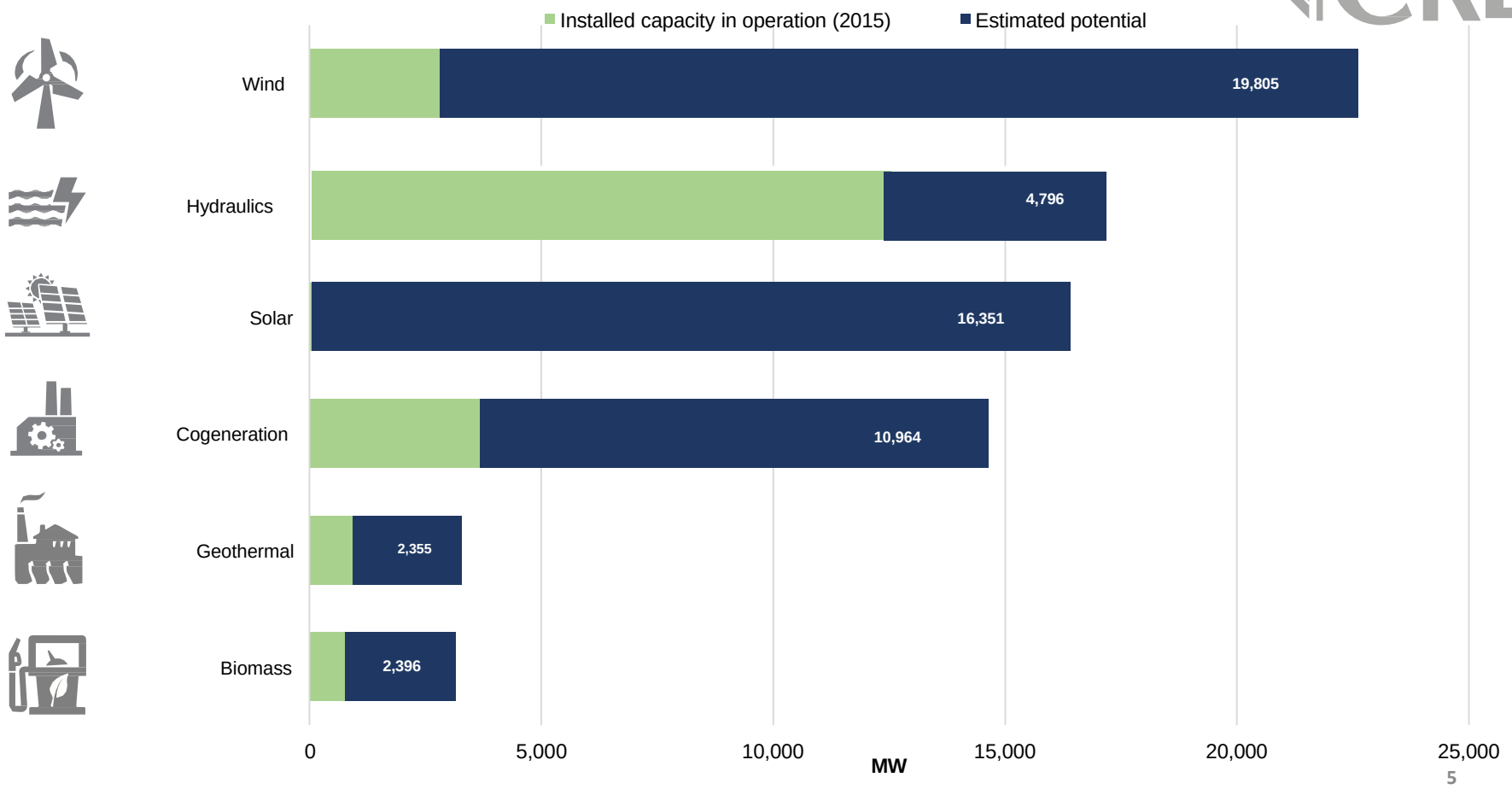
1.9% → 3.7%

2016-2030 **2031-2050**

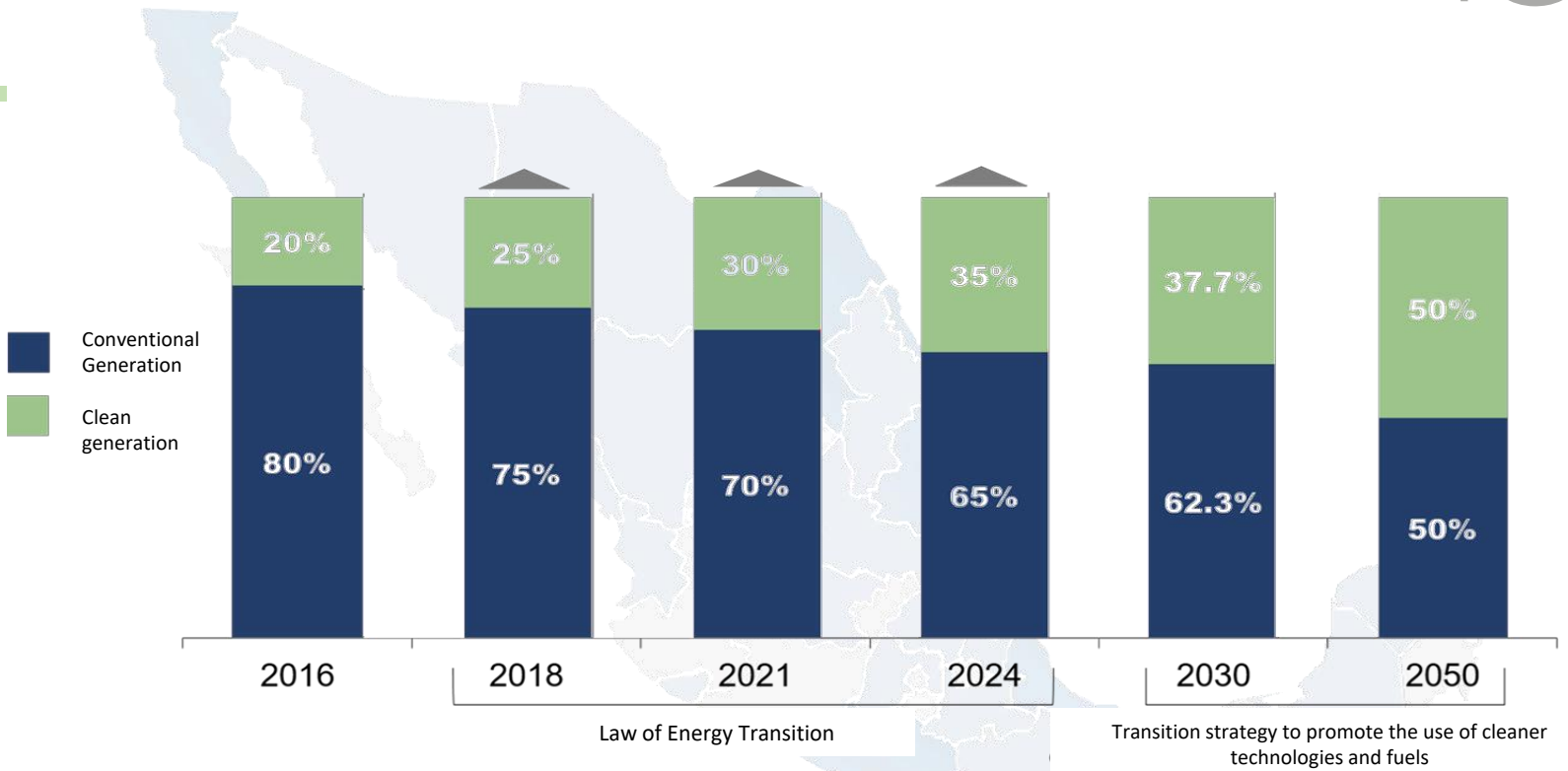
2.9%

2016-2050

Potential of renewable resources in Mexico



Goals of Electric Power Generation from clean sources



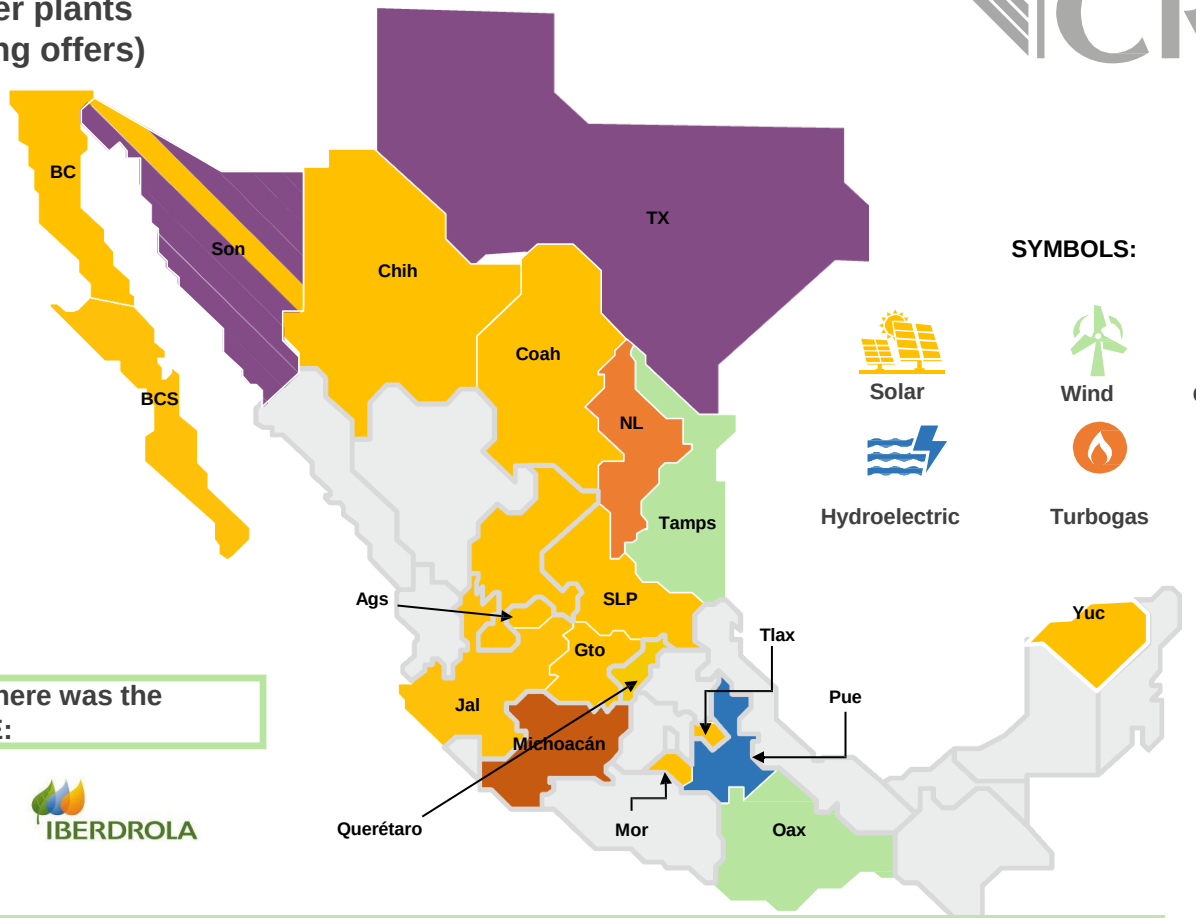
"In the Renewable Energy Country Attractiveness Index (Ernst & Young), Mexico has gone from 24th place in 2014, to 9th place in 2017, out of a total of 40 economies; while in the Climatescope study (Bloomberg New Energy Finance), we went from place 9 in 2016, to place 4 in 2017 of the 71 nations analyzed

Long-term auctions

Development of 70 new power plants (corresponding to 76 winning offers)

9,000 MDD **of investment**

Increase of 7.6 GW to the current generation capacity in Mexico



In the third auction, for the first time, there was the presence of buyers other than the CFE:

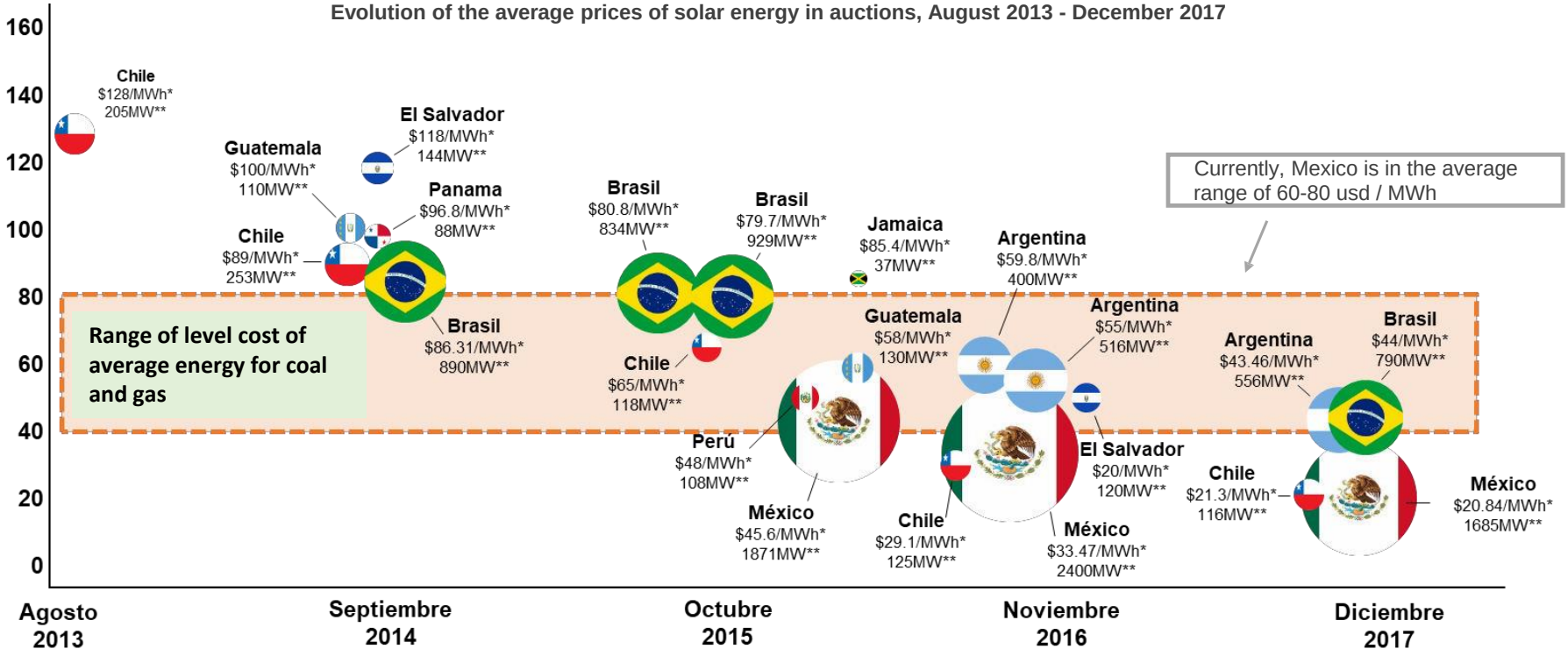
CFE Comisión Federal de Electricidad · CEMEX · IBERDROLA

In the third auction an average price of Clean Energy (Energy + CEL) of 20.57 dollars / MWh was achieved, 38% lower than the Second Auction and one of the lowest prices observed worldwide.

Long-term auctions

Mexico has been the author of the three auctions with greater capacity in Latin America, achieving lower costs each time, which has allowed solar energy to be more competitive than natural gas and coal..

Evolution of the average prices of solar energy in auctions, August 2013 - December 2017

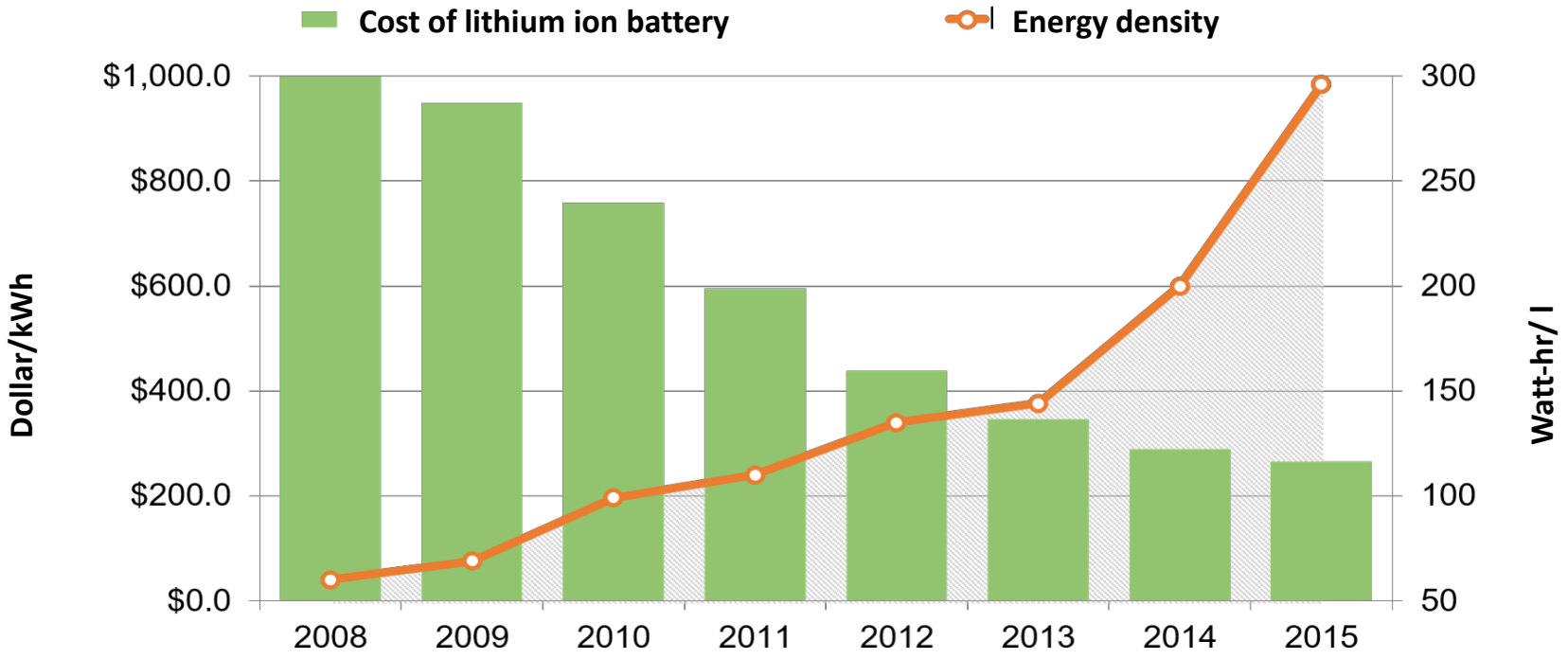


* Dólares for Megawatt-hora

** Megawatts. The size of the circles in the graph is associated with the capacity of each country

Recovered from: https://www.greentechmedia.com/articles/read/mexico-record-solar-prices-are-below-the-cost-of-gas-and-coal#gs.nYP_QjA

In recent years, the cost of batteries has been reduced, while they have become more efficient



Source: U.S. Department of Energy, 2016.

Storage Challenges and Opportunities

Baja California Sur Electrical System

Installed capacity

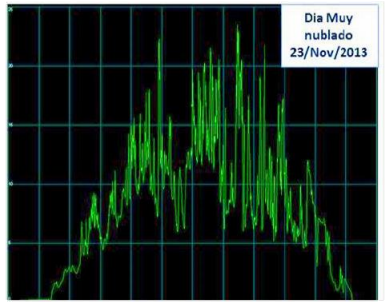
Total:	1,017 MW
Photovoltaic generation :	31 MW
Distributed generation:	5.9 MW

Demand

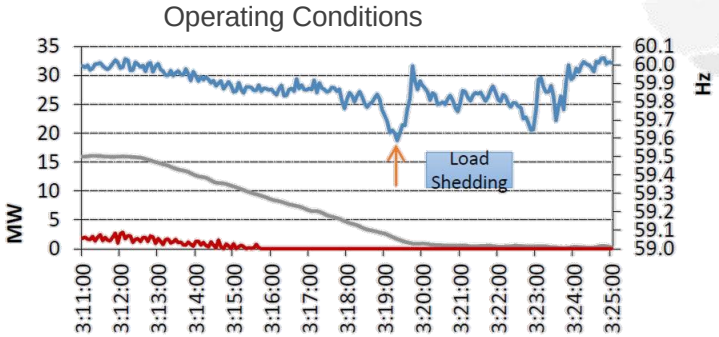
59 < 435 MW

Integration limits

Large scale:	50 MW
Distributed generation:	18 MW



Generation Profile of a
30 MW photovoltaic central



Installation of a 20 MW storage system

- Investment of 16.4 MDD
- Support for the integration of an additional 50 MW, from renewable sources.
- Contributes to maintain the reliability of the System

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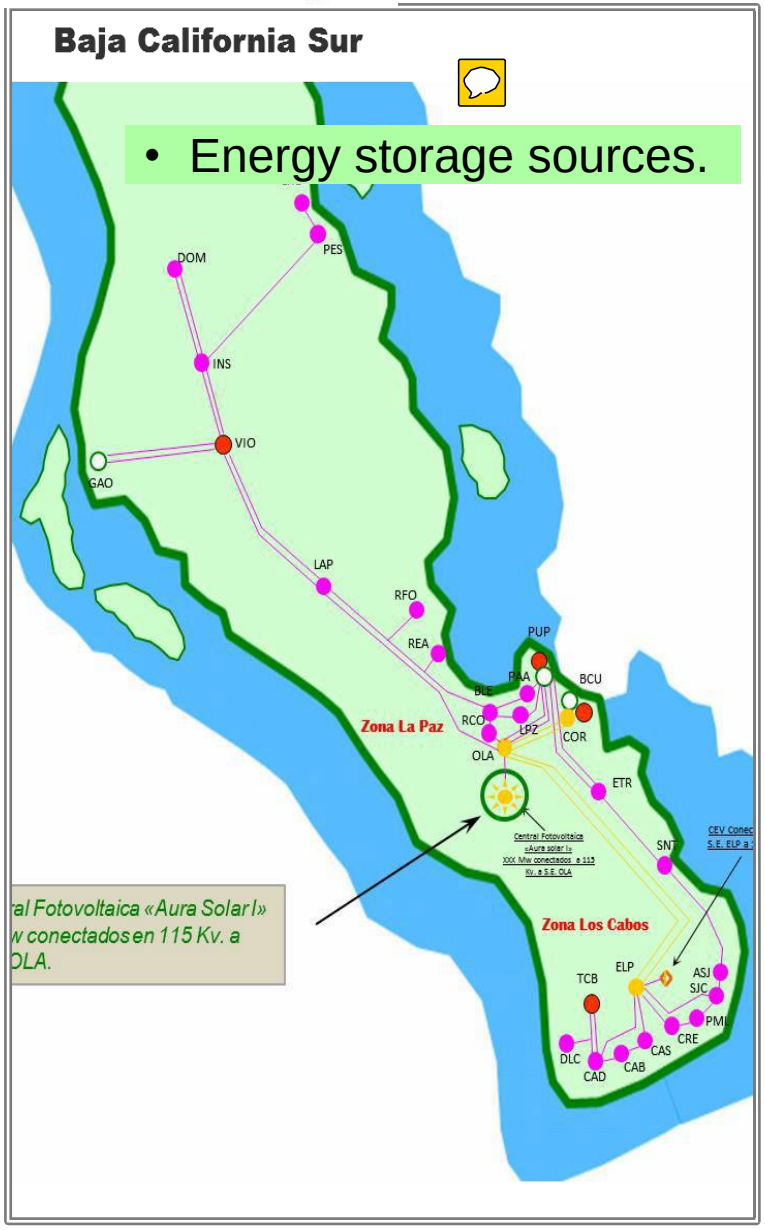
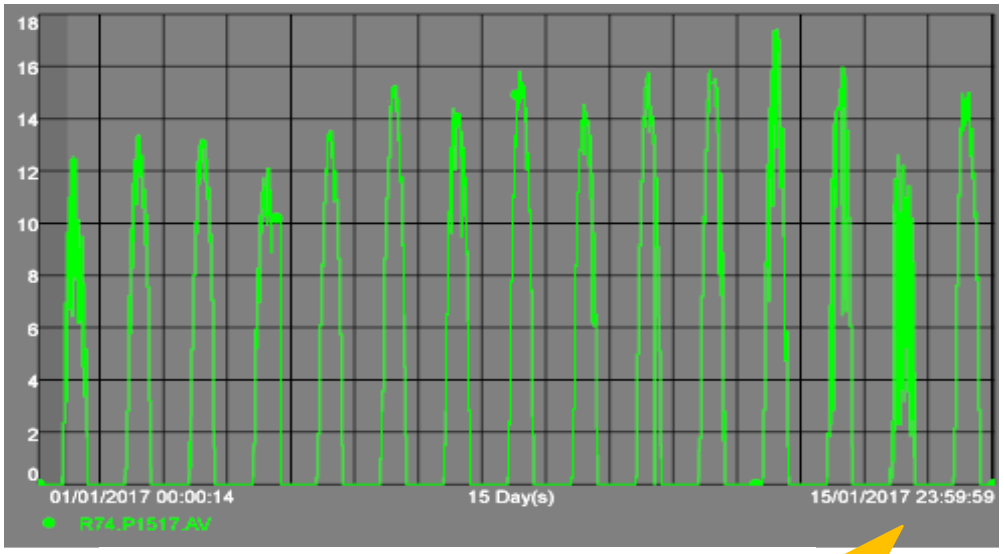
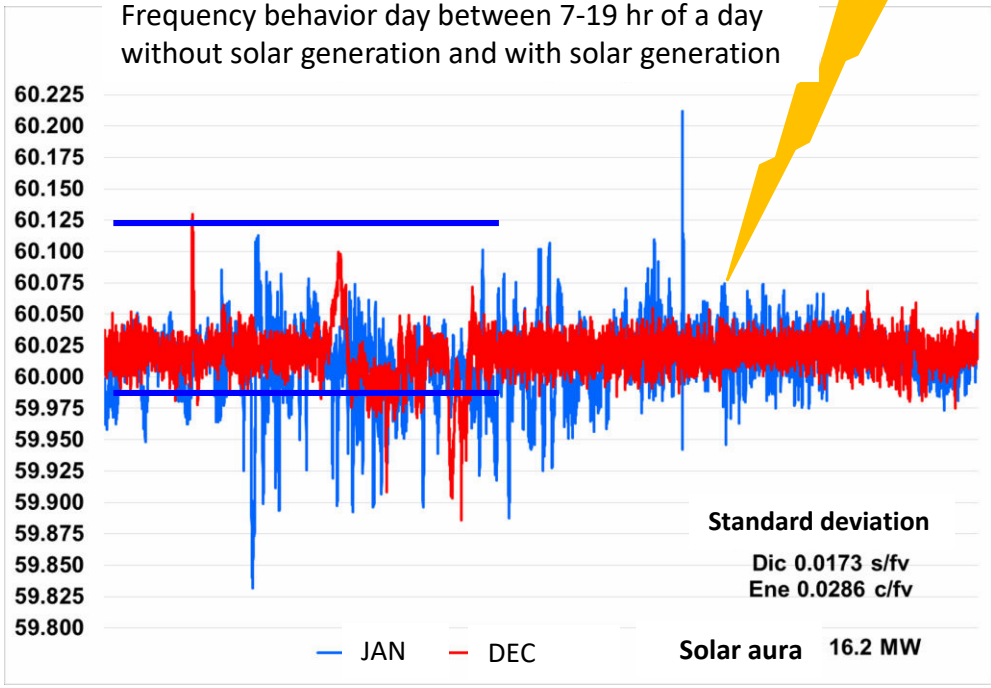
CENTRO NACIONAL DE CONTROL DE ENERGÍA

Impact of the variability of the solar generation on the reliability and quality of the frequency





Frequency behavior day between 7-19 hr of a day without solar generation and with solar generation



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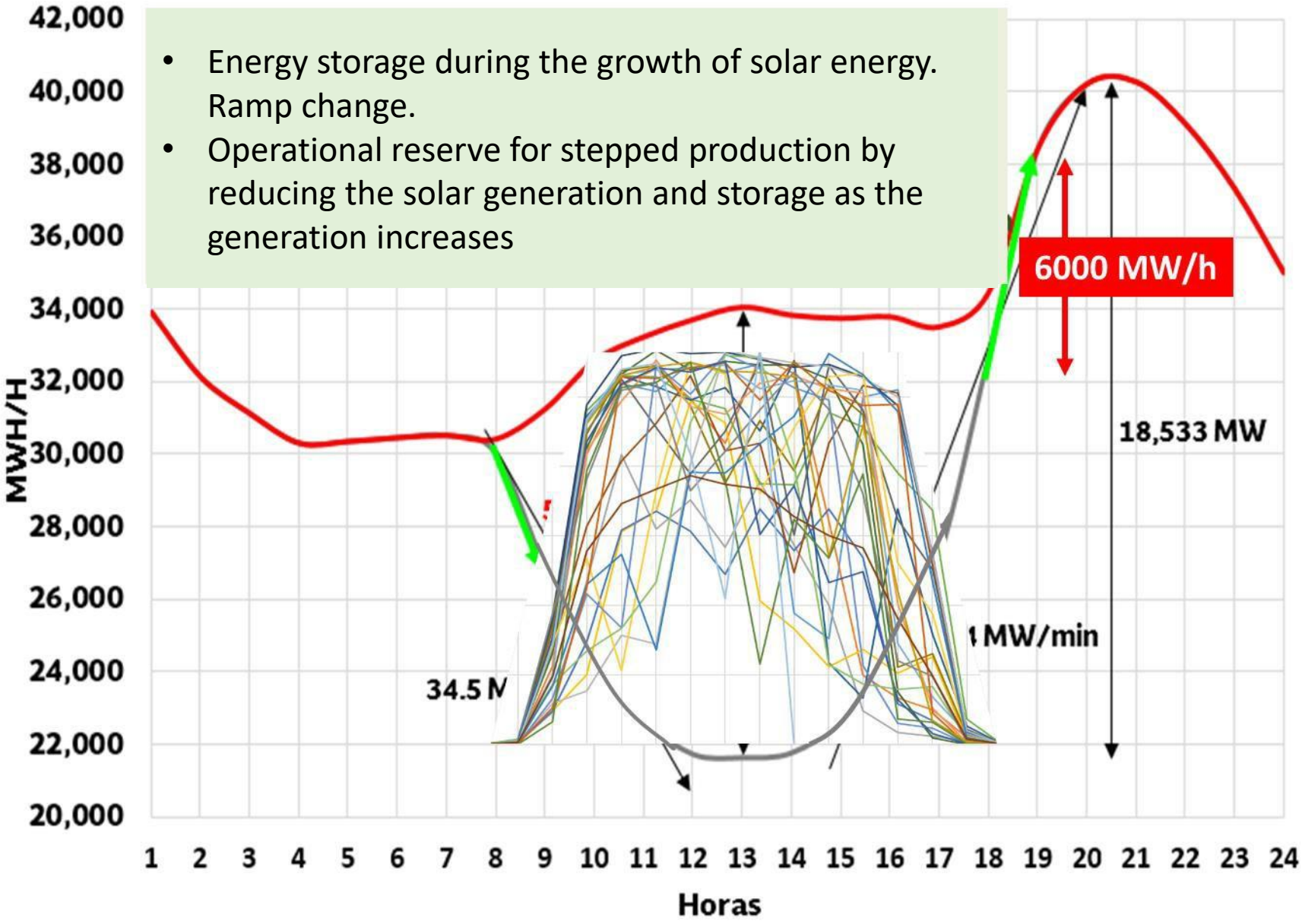
Potential application of sources in the ramp of the predicted demand for 2024.

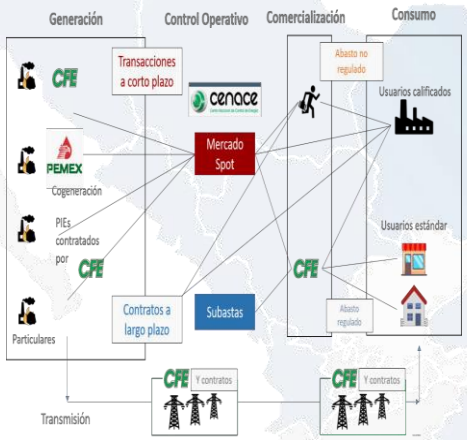
- Energy storage during the growth of solar energy. Ramp change.
- Operational reserve for stepped production by reducing the solar generation and storage as the generation increases



Storage Challenges and Opportunities

National Electric System

Remove barriers so that storage can monetize the regulated services provided



Recognize storage as an asset of generation, loading, transmission and distribution.

Develop the instruments through which it is recognized that storage can provide service as regulated as market. (Contract outline)

Develop a methodology to recognize products and services outside the market offered by storage