Integrated solar energy supply concepts for climate-neutral buildings and communities for the "City of the Future"

Industry Workshop No 1 Solar Energy Buildings worldwide

Perspectives on Energy Efficiency and Solar Energy Buildings projects & regulations in Mexico

Dra. Norma A. Rodríguez-Muñoz
CONACYT – Centro de Investigación en Materiales Avanzados, S. C.
INDEX

• Energy consumption and renewables
• Buildings in Mexico
• Programs on energy efficiency & renewables
• Summary
IEA Key energy statistics, 2020: Mexico

- **Total primary energy supply**: 175.34 Mtoe, up 41.76% from 1990
- **Electricity final consumption**: 307.48 TWh, up 209.09% from 1990
- **Total CO2 emissions**: 381 Mt of CO2, up 48.27% from 1990

https://www.iea.org/countries/mexico
Renewable share & electricity generation

Renewable share (modern renewables) in final energy consumption (SDG 7.2), Mexico 1990-2018
Renewable electricity generation by source (non-combustible), Mexico 1990-2020
Buildings in Mexico

- The building sector accounts for 17% of energy consumption

- The residential sector is the fastest growing subsector
  - 33 million houses
  - 45 m² to 60 m² (46%) and larger than 60m² (41%)

- 15 million of houses by 2030 (600 million m²)

- Growth in non-residential and commercial buildings also expected
  - Built area of 155 million m²
Buildings in Mexico

Köppen-Geiger climate classification map for Mexico (1980-2016)


norma.rodriguez@cimav.edu.mx
Programs on energy efficiency & renewables

International
- LEED & EDGE

National
- Hipoteca Verde (Green Mortgage) & Sisevive-Ecocasa & LAIF-Ecocasa

National NOM’s

Government buildings
- Energy efficiency on federal government buildings (APF)

FIDE – Trust for electricity savings
- Energy efficiency and distributed generation support programs

Mexico City
- Sustainable buildings certification & Solar City

norma.rodriguez@cimav.edu.mx
LEED (Leadership in Energy & Environmental Design)

- Framework for healthy, efficient, carbon and cost-saving green buildings.
- Globally recognized symbol of sustainability achievement and leadership.

Mexico ranks 8th of the top 10 countries in the world with the most LEED Certifications (Excluding the U.S.)

- 370 Projects*
- 8.41 millions Gross Square Meters*

*Up to 2019

https://www.usgbc.org/leed

https://www.bbva.com/es/sostenibilidad/

norma.rodriguez@cimav.edu.mx
EDGE (Excellence in Design for Greater Efficiencies)

Green building certification system focused on making buildings more resource-efficient

Zero Carbon Pledge

- **6,842** Certified houses
- **324,685 m²** Final Floor Space Certified
- **9,358 tCO₂/year** CO₂ savings certified

https://edgebuildings.com/certify/mexico

norma.rodriguez@cimav.edu.mx
The objective of this NAMA is to promote cost and energy-efficient building concepts.

Long-term impact and use of energy efficient houses and decreasing GHG emissions.

Less carbon-intensive housing sector.

1,850 tCO$_2$ over 40 years of the house’s operation.

81,400 Financed houses*

*Up to 2017

https://www.nama-facility.org/projects/mexico-implementation-of-the-new-housing-nama

norma.rodriguez@cimav.edu.mx
The INFONAVIT is the national benchmark in financial solutions, with a 74% share of the traditional housing market.

“Hipoteca verde”, created in 2007, is the credit that grants an additional credit to acquire efficient technologies that reduce the consumption of water, electricity and gas.

2.8 millions Credits given*
215 kWh/month Average Energy saved per home**
$224 MXN/month Average saved per home**

*Up to 2017  **Data from 2016

https://portalmx.infonavit.org.mx
In 2013 Sociedad Hipotecaria Federal (SHF) started **ECOCASA** to give incentives for the construction of energy-efficient houses.

Promotes a **20-percent reduction in greenhouse gas (GHG) emissions** in comparison to a baseline house.

- **61,979** Homes Financed*
- **2,219 MtCO$_2$e** Emissions reduction over the useful life of the houses*

EcoCasa Program, received resources from the **Latin American Investment Fund of the European Union (LAIF)** for the construction of “Passive Homes”.

- 7 states: Sonora, Michoacan, Jalisco, Oaxaca, Nuevo León, Veracruz & Mexico City
- Up to **70% subsidy** on eco-technologies and sustainability measures

*Data from 2020

https://www.gob.mx/shf/documentos/59439

https://www.gob.mx/shf/documentos/laif

norma.rodriguez@cimav.edu.mx
Energy efficiency NOM & Sustainable building NMX

NOM Technical specifications, of mandatory application which ensure a more efficient use of energy in appliances, equipment and systems that are manufactured and marketed in the country. 

*NMX are voluntary.*

NOMs focused on buildings

<table>
<thead>
<tr>
<th>NOM code</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOM-008-ENER-2001</td>
<td>Non-residential buildings envelope</td>
</tr>
<tr>
<td>NOM-018-ENER-2011</td>
<td>Thermal insulation for buildings</td>
</tr>
<tr>
<td>NOM-020-ENER-2011</td>
<td>Residential buildings envelope</td>
</tr>
<tr>
<td>NOM-024-ENER-2012</td>
<td>Thermal and optical characteristics of glass</td>
</tr>
<tr>
<td>NMX-AA-164-SCFI-2013</td>
<td>Sustainable building - criteria and minimum environmental requirements</td>
</tr>
</tbody>
</table>

NOM-020 -ENER-2011

12.9 GWh/year

Energy saved

*Data from 2020*

[https://www.conuee.gob.mx/transparencia/](https://www.conuee.gob.mx/transparencia/)

norma.rodriguez@cimav.edu.mx
Energy efficiency program for buildings of the Federal Public Administration (APF)

This Program originated in 1999 and aims to establish a continuous improvement process to increase energy efficiency in buildings of the APF.

The Program sets specific annual energy savings goals for participating buildings, vehicle fleets and industrial facilities.

7 582 Participant buildings*
28.88 GWh / year Energy savings registered*
$54.06 millions MXN/ year Money savings registered*

*Data from 2017
FIDE – Trust for electricity savings

FIDE finances energy efficiency measures & renewable energy systems

Sectors:
- Residential
- Industry
- Micro, small and medium companies

Distributed generation

<table>
<thead>
<tr>
<th>Project</th>
<th>Number of projects</th>
<th>Total investment (MDP)</th>
<th>Installed capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry, companies PV</td>
<td>2,112</td>
<td>851.1</td>
<td>27.38</td>
</tr>
<tr>
<td>Residential PV</td>
<td>1,085</td>
<td>166.33</td>
<td>4.48</td>
</tr>
<tr>
<td>PV Solar fields</td>
<td>22</td>
<td>174.25</td>
<td>6.97</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3,219</td>
<td>1,191.68</td>
<td>38.83</td>
</tr>
</tbody>
</table>

Thermal envelope
- Insulation
- Reflective coating
- Waterproofing
- Thermal Windows
- Solar control films
- Solar control windows

Renewable systems
- PV system
- Solar water heater

Efficient technologies
- Refrigerator
- Air conditioning
- Led lights
- Gas heater
- Water saving technologies
- Ventilator & dehumidifier

norma.rodriguez@cimav.edu.mx
Distributed generation

Currently in Mexico there are 3 models in which a user can be interconnected to the grid and generate energy (Net Metering, Net billing & Total sale).

Requests for interconnection of power systems ( < 500 kW)

![Graph showing the increase in requests for interconnection of power systems over the years.](https://anes.org.mx/wp-content/uploads/2021/05/Estadisticas_GD_2020__Primer_Semestre.pdf)


norma.rodriguez@cimav.edu.mx
Distributed generation

Electricity PRICE / COST proportion by tariff * 2015

- Residential
  - 1F
  - 1E
  - 1D
  - 1C
  - 1B
  - 1A
  - 1
  - DAC
- Commercial
  - 3
  - 2
- Medium Ind
  - HM
  - OM
- Large Ind
  - HT
  - HS
- Average

Subsidized tariff: [Orange Bars]
Unsubsidized tariff: [Purple Bars]

norma.rodriguez@cimav.edu.mx
Mexico City- Sustainable Building Certification Program

The sustainable building certification program (PCES) started in 2020

Self-regulatory program

- Efficient use of natural resources during the design, construction and operation of buildings in Mexico City

Energy obligatory specifications for new buildings:
- To have an efficient envelope
- To include renewable energy system

It is only mandatory for those projects that are considered to have a considerable environmental impact due to their size, location or type of use.
Mexico City - Solar city

**Solar City** is the program that seeks to promote the efficient use of energy and renewable sources in Mexico City, it is part of the Environmental and Climate Change Program 2019-2024.

Solar City includes actions and financial aid in the following areas:

- Electric self-generation
- Technical training
- Solar energy for SMEs
- Solar water heating
- Biodiesel plant

**Some objectives of the program:**
- Provide 134,611 houses with solar heaters
- Provide 10,000 SMEs with PV systems (100 MW total)
- Install a PV system in 300 government’s buildings
- Train 1,000 technicians in solar systems
- Build the Abasto’s PV system with a capacity of 18 MW

SMEs: Small and mid-size enterprises
Summary

• In the last decades several programs have been implemented (all levels federal, state and municipal...)
• Programs and actions focused on energy efficiency
• Over the last years, the contribution of renewables is increasing (in buildings particularly solar thermal & PV)
• Complex ecosystem where investment costs, regulations and subsidies coexist
• Production of electricity is still mainly with fossil fuels ($/CO₂)
Dra. Norma A. Rodríguez Muñoz
Tel. +52 614 439 4898 ext 302
norma.rodriguez@cimav.edu.mx

Carlos A. Espino Reyes
PhD student - CIMAV