

The Electric Power System

- MEXICO -

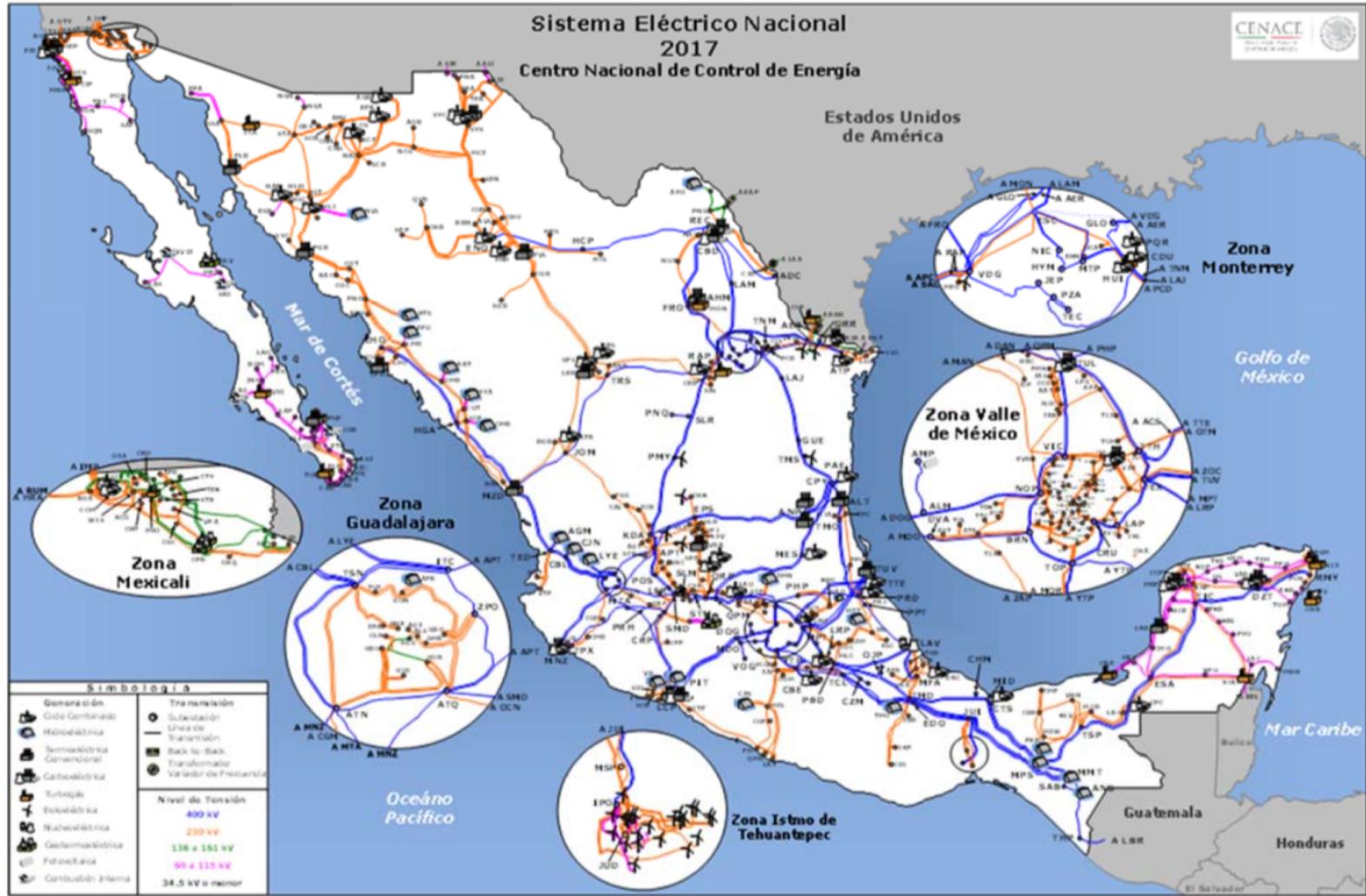
Basic facts 2016

- ❑ Area: 1 964 375 km²
 - ❑ Population: 122.3 millions
 - ❑ Number of electricity consumers: 40.8 millions*
 - ❑ Number of TSOs: 1 divided in 53 regions
 - ❑ Number of DSOs: 1 divided in 16 divisions
 - ❑ Peak load: 40 893 MW
 - ❑ Average interruption of electricity: 28.28 min
- *Represents 98.58% of population with electricity.



D.F. Distrito Federal
Ag. Aguascalientes
Co. Colima
Mo. Morelos
TI. Tlaxcala

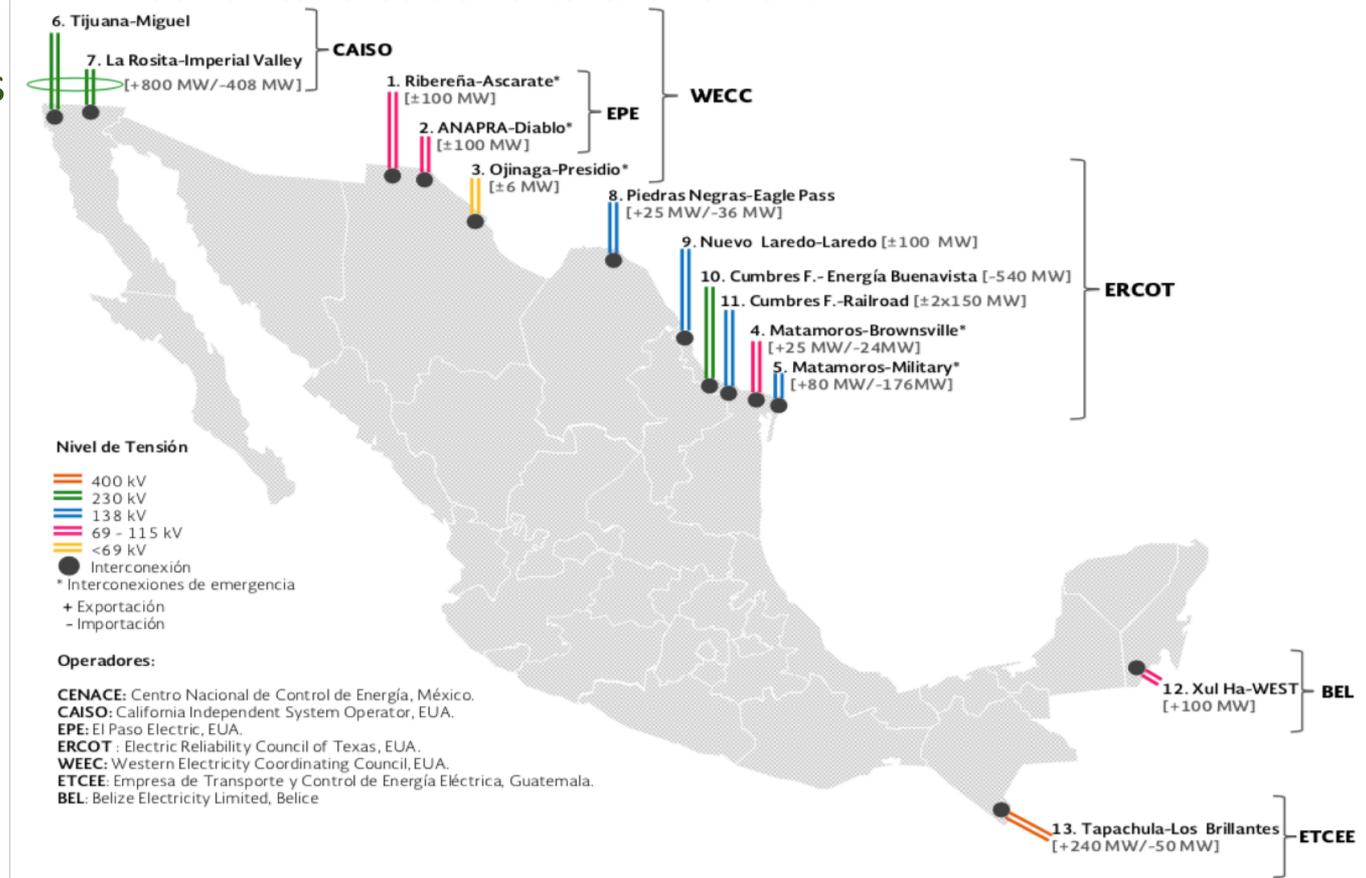




Grid interconnections

Interconnectors

- USA
- Guatemala
- Belize



Fuente: Elaborado por la SENER con datos del CENACE.



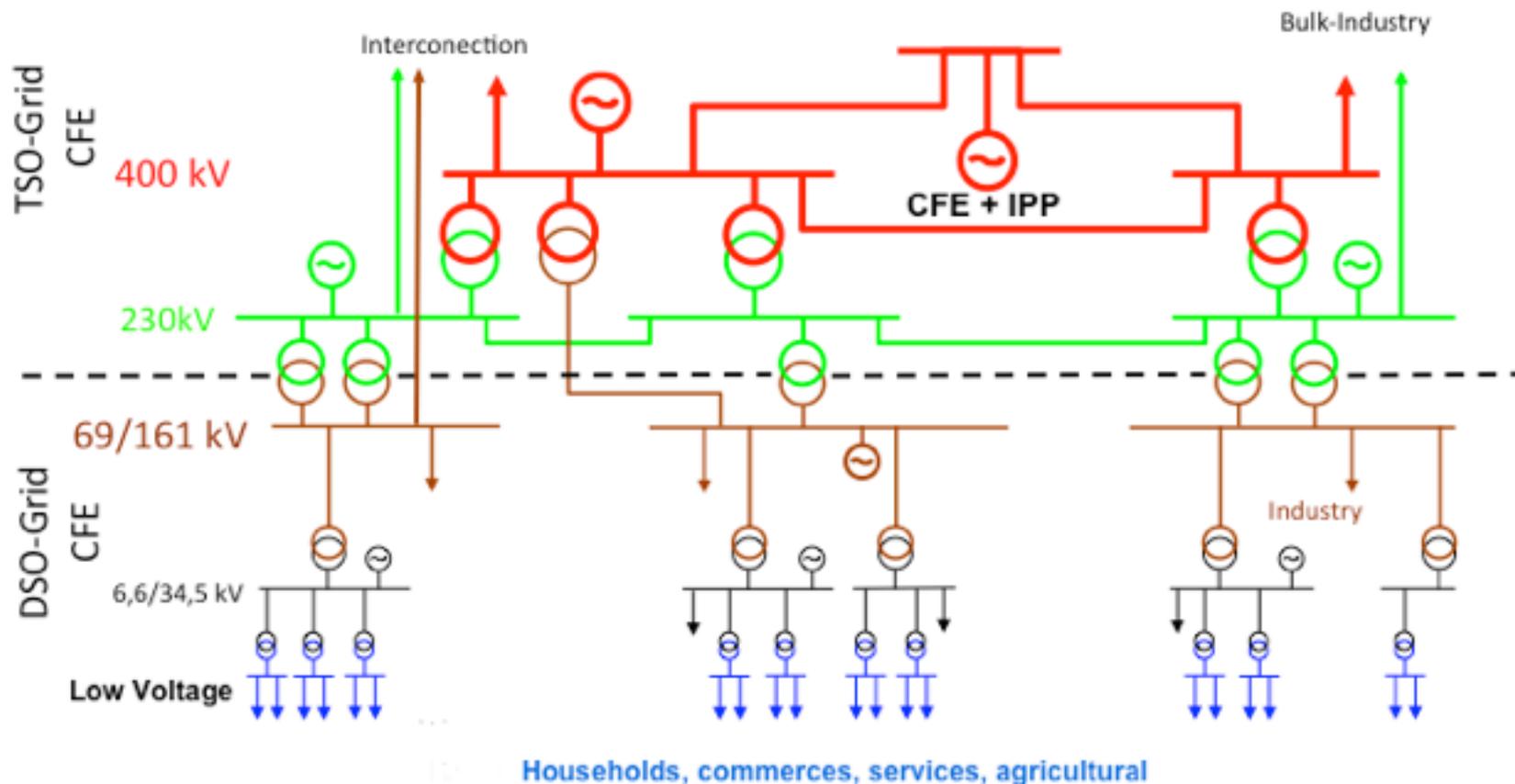
Grid facts and characteristics

Transmission lines (km)			
Voltage (kV)	2015	2016	AAG (%)*
400	24,697	24,714	0.07
230	28,518	28,566	0.17
161	522	523	0.19
138	1,608	1,152	-28.36
115	46,147	46,326	0.39
85	156	180	15.38
69	2,745	2,672	-2.66
Total	104,393	104,133	-0.25

Distribution lines (km)			
Voltage (kV)	2015	2016	AAG (%)
34.5	79,413	80,013	0.76
23	62,755	65,047	3.65
13.8	312,757	317,118	1.39
6.6	162	127	-21.60
2.4	6	9	50.00
Low voltage	319,065	316,805	-0.71
Total	774,158	779,119	0.64

*AAG = Average Annual Growth

Structure of electrical power system



CFE: Comisión Federal de Electricidad (Mexican Utility) IPP: Independent Power Producer



Map of the high voltage grid



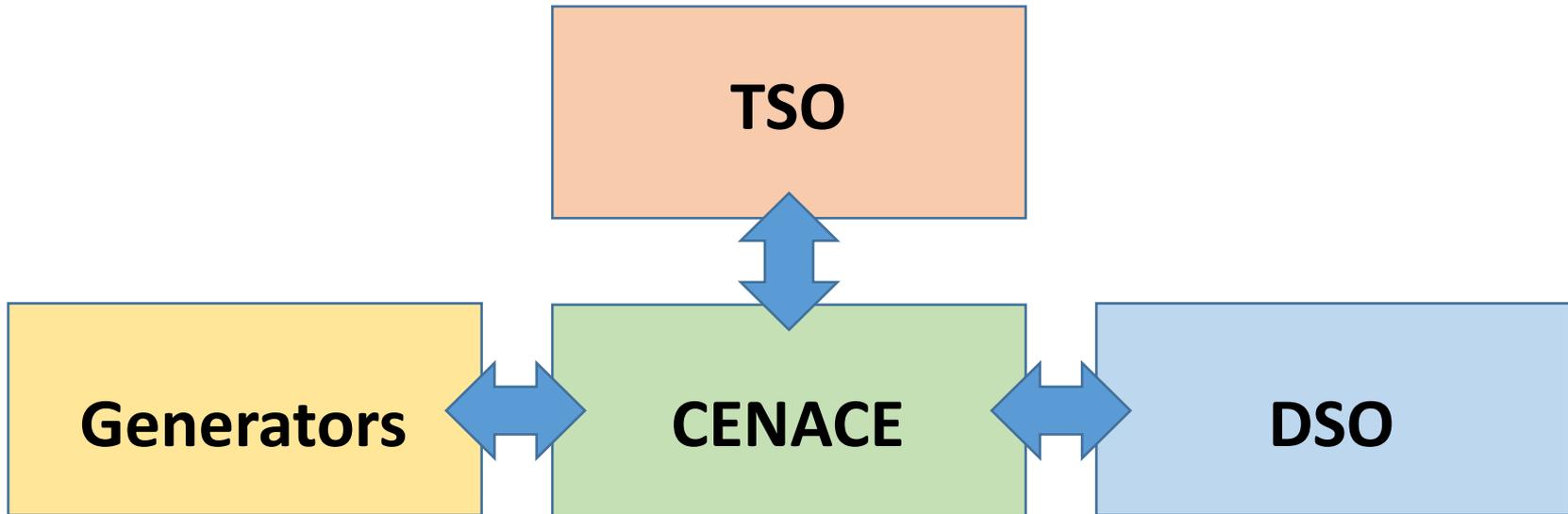
Fuente: Programa de Ampliación y Modernización de la Red Nacional de Transmisión y Redes Generales de Distribución del Mercado Eléctrico Mayorista, 2 0 1 7 - 2 0 3 1, CENACE.



Information on TSO

- Name: Comisión Federal de Electricidad - Transmisión
- Network length (km): 104 133
- Served area (km²): 1 964 375
- Annual transmitted energy (TWh): 249.372
- website: <http://www.cfe.mx>

Relationship between TSO and DSO



CENACE : National Energy Control Center

The CENACE main function is to plan, direct and supervise the operation of the country's electrical system to achieve the basic objectives which are safety, continuity, quality and economy of electric service.

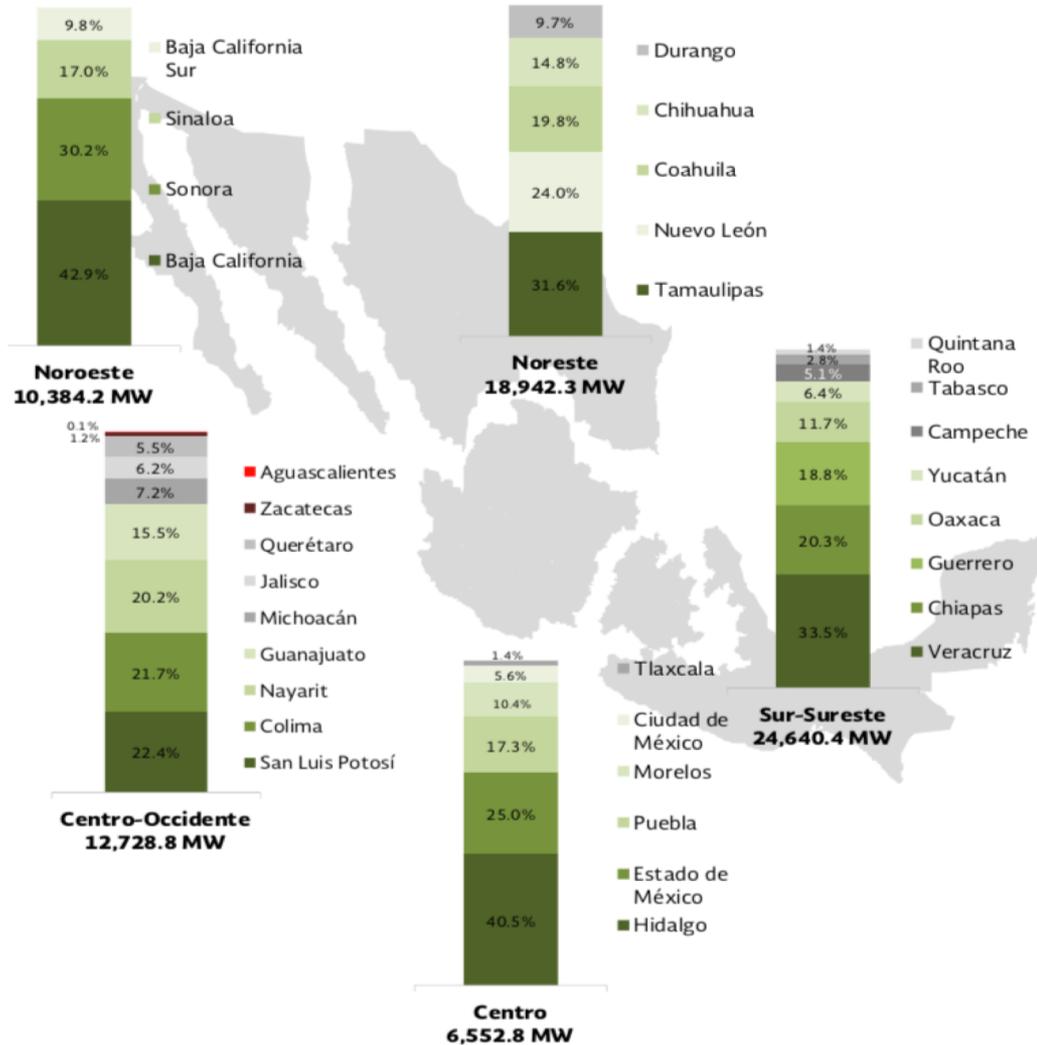


Responsibilities of TSO & DSO

- The Mexican State maintains the ownership of the Public Transmission and Distribution Service.
- The Transmission System Operator and the Distribution System Operator have the responsibility of maintaining the network availability and reliability of transmission, distribution and transformation as well as operate the national grid maintaining continuity, power quality and frequency with maximum safety and economy.
- The State, through the Energy Secretary, the Transporter or the Distributor, may form associations or enter into contracts with individuals to carry out, among others, the financing, installation, maintenance, management, operation and extension of the necessary infrastructure to provide Public Service of T & D.



Power structure of the country



Fuente: Elaborado por SENER.

Installed capacity with reference to primary resources

Electrical Energy Generation Installed capacity		
Technology	Power stations	Power (MW)
Conventional	517	52,301
Combined cycle	71	27,274
Conventional thermoelectric	60	12,564
Coal	3	5,378
Turbogas	128	5,052
Internal combustion	253	1,453
Fluidized bed	2	580
Clean	249	20,925
Renewable	225	18,267
Hydroelectric	84	12,589
Wind power	41	3,735
Geothermal	8	909
Photovoltaic	17	145
Bioenergy	75	889
Others	24	2,658
Nuclear	1	1,608
Efficient cogeneration	22	1,036
Thermosolar	1	14
TOTAL	766	73,226

Net capacity for public service: 56,524 MW



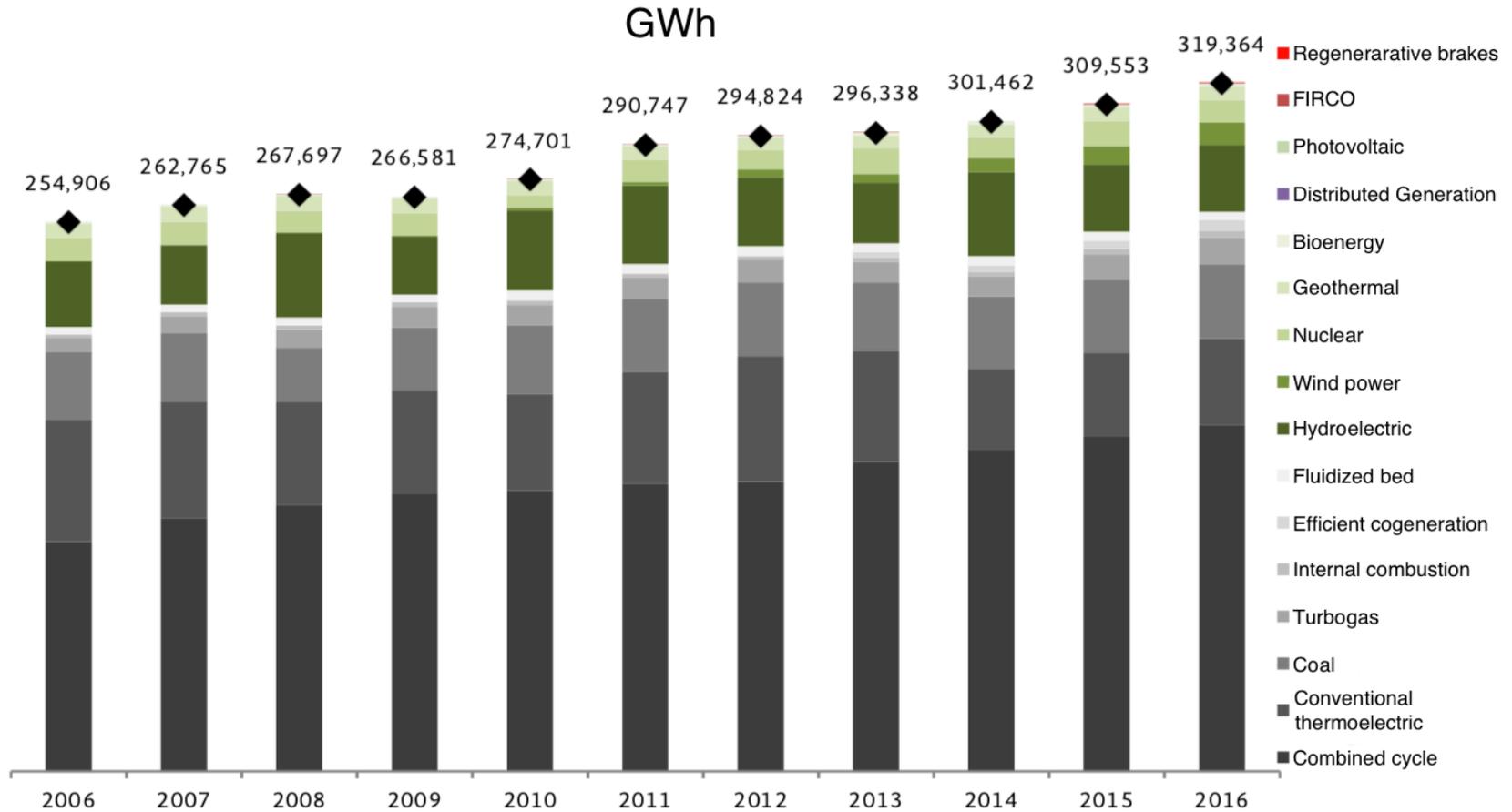
Energy production with reference to primary resources

Electrical Energy Generation (GWh)			
Technology	2015	2016	AAG
Conventional	246,601	254,496	3.2
Combined cycle	155,185	160,378	3.3
Conventional thermoelectric	39,232	40,343	2.8
Coal	33,599	34,208	1.8
Turbogas	11,648	12,600	8.2
Internal combustion	2,651	3,140	18.4
Fluidized bed	4,286	3,826	-10.7
Clean	62,952	64,868	3.0
Renewable	47,576	49,244	3.5
Hydroelectric	30,892	30,909	0.1
Wind power	8,745	10,463	19.6
Geothermal	6,331	6,148	-2.9
Photovoltaic	78	160	105.1
Bioenergy	1,369	1,471	7.5
Distributed generation (DG)	128	56	-56.3
DG Wind power	0	0	-92.2
DG Photovoltaic	112	55	-50.9
DG Bioenergy	16	2	-87.5
DG Hybrid	0	0	-96.4
FIRCO	33	36	9.5
Others	15,376	15,624	1.6
Nuclear	11,577	10,567	-8.7
Efficient cogeneration	3,795	5,053	33.1
Regenerative brakes	4	4	0.0
TOTAL	309,553	319,364	3.2

AAG: Annual Average Growth
FIRCO: Joint venture trust



Development of generation capacity since 2006

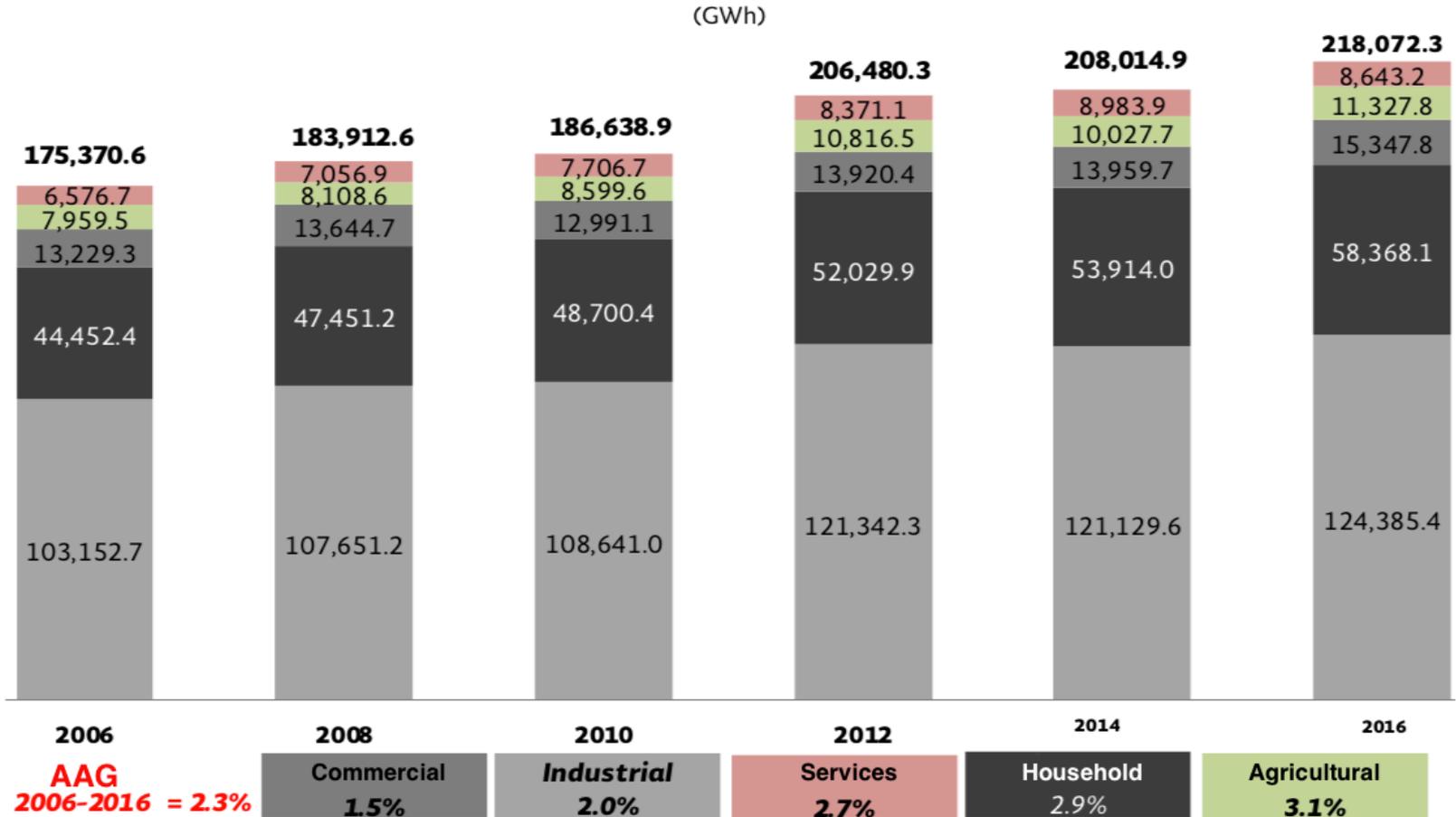


Fuente: Elaborado por SENER con datos de CFE, CRE y Subsecretaría de Planeación y Transición Energética.





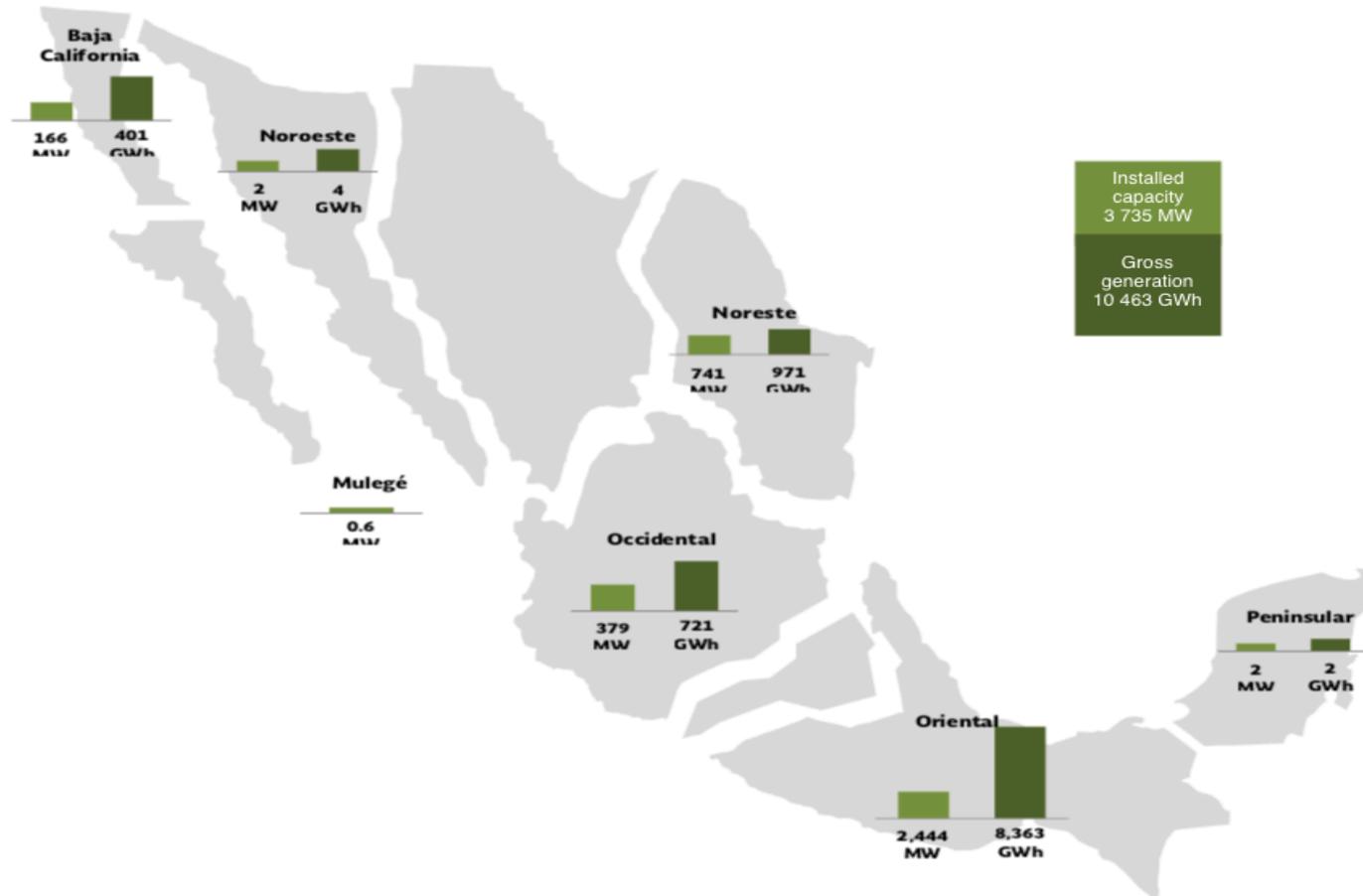
Consumption per customer groups



Fuente: Elaborado por SENER con datos del CENACE.

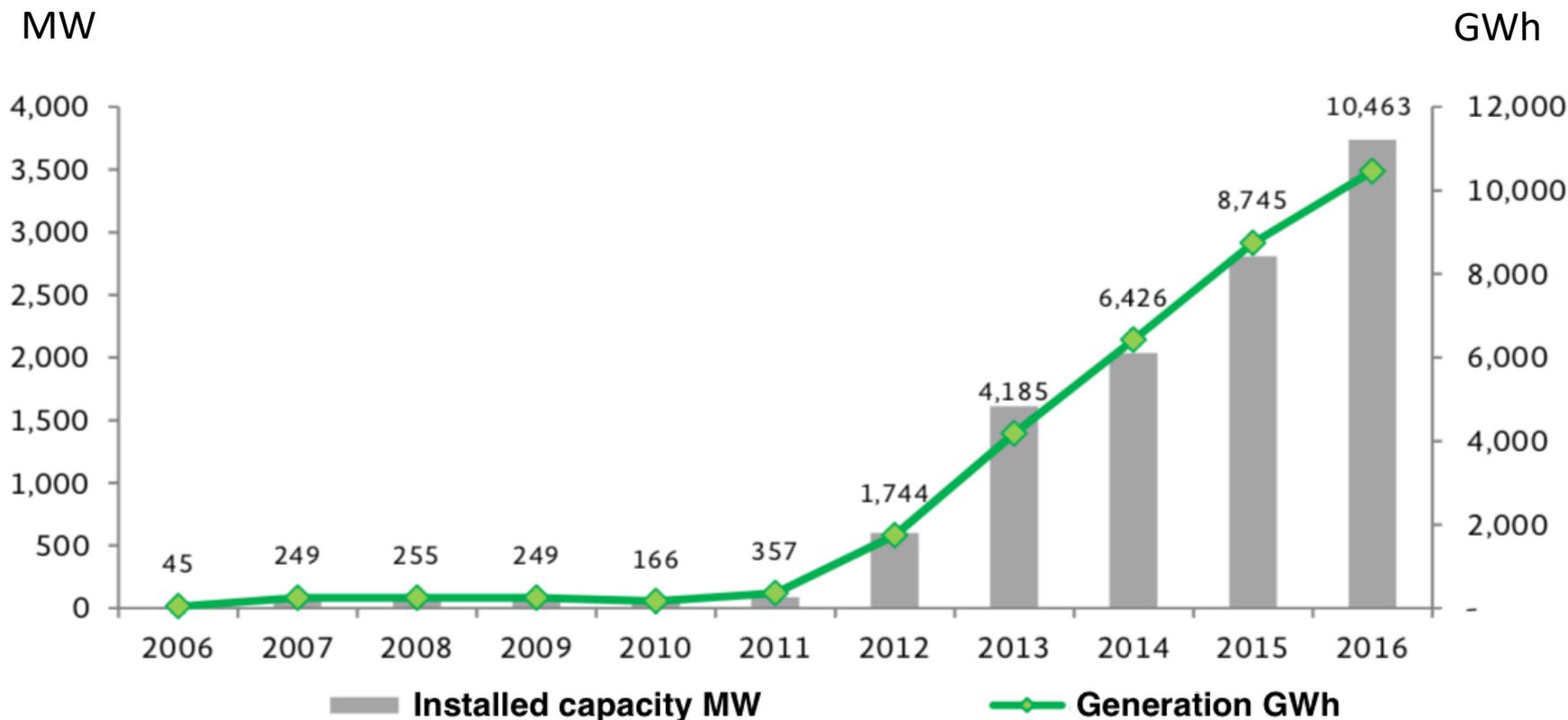


Location of wind power energy sources (2016)



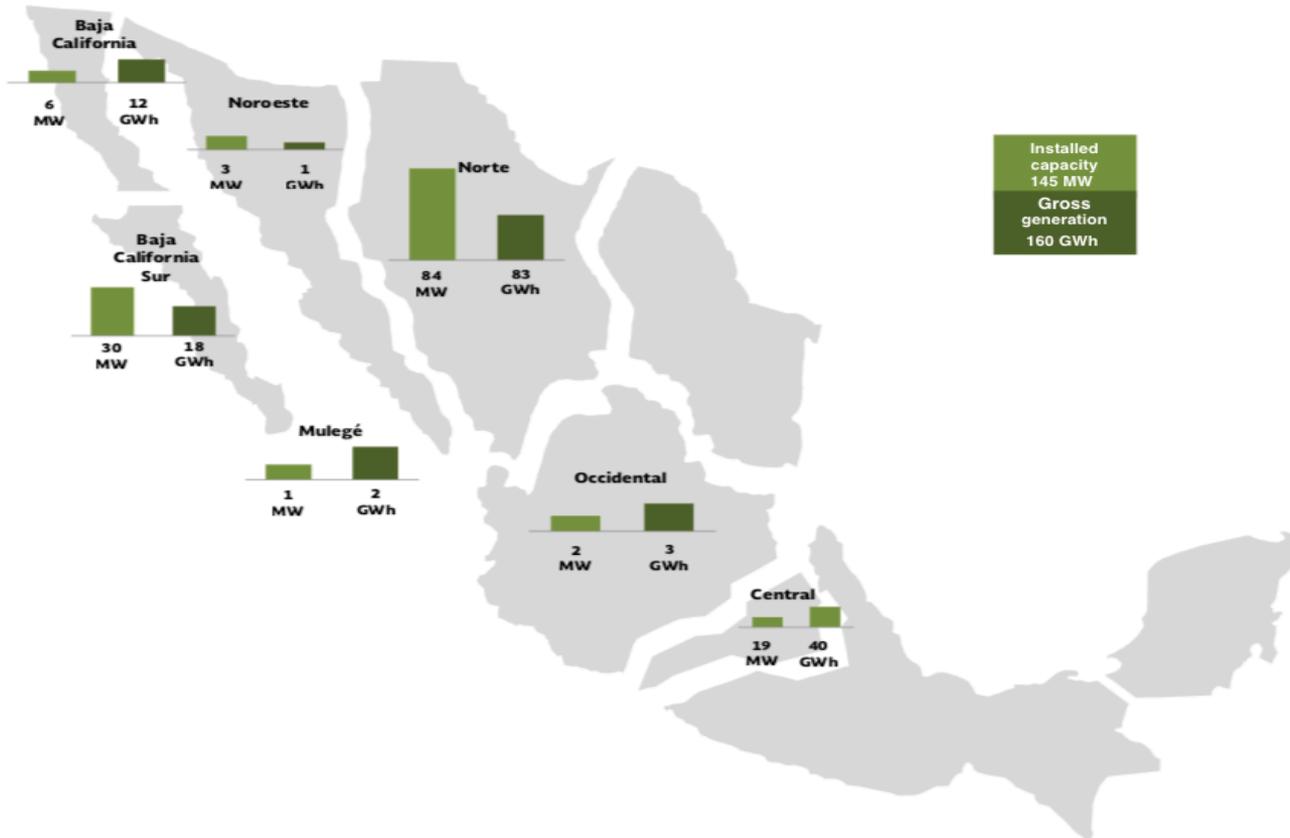
Fuente: Elaborado por SENER con datos de PRODESEN 2017-2031.

Development of wind power



Fuente: Elaborado por SENER.

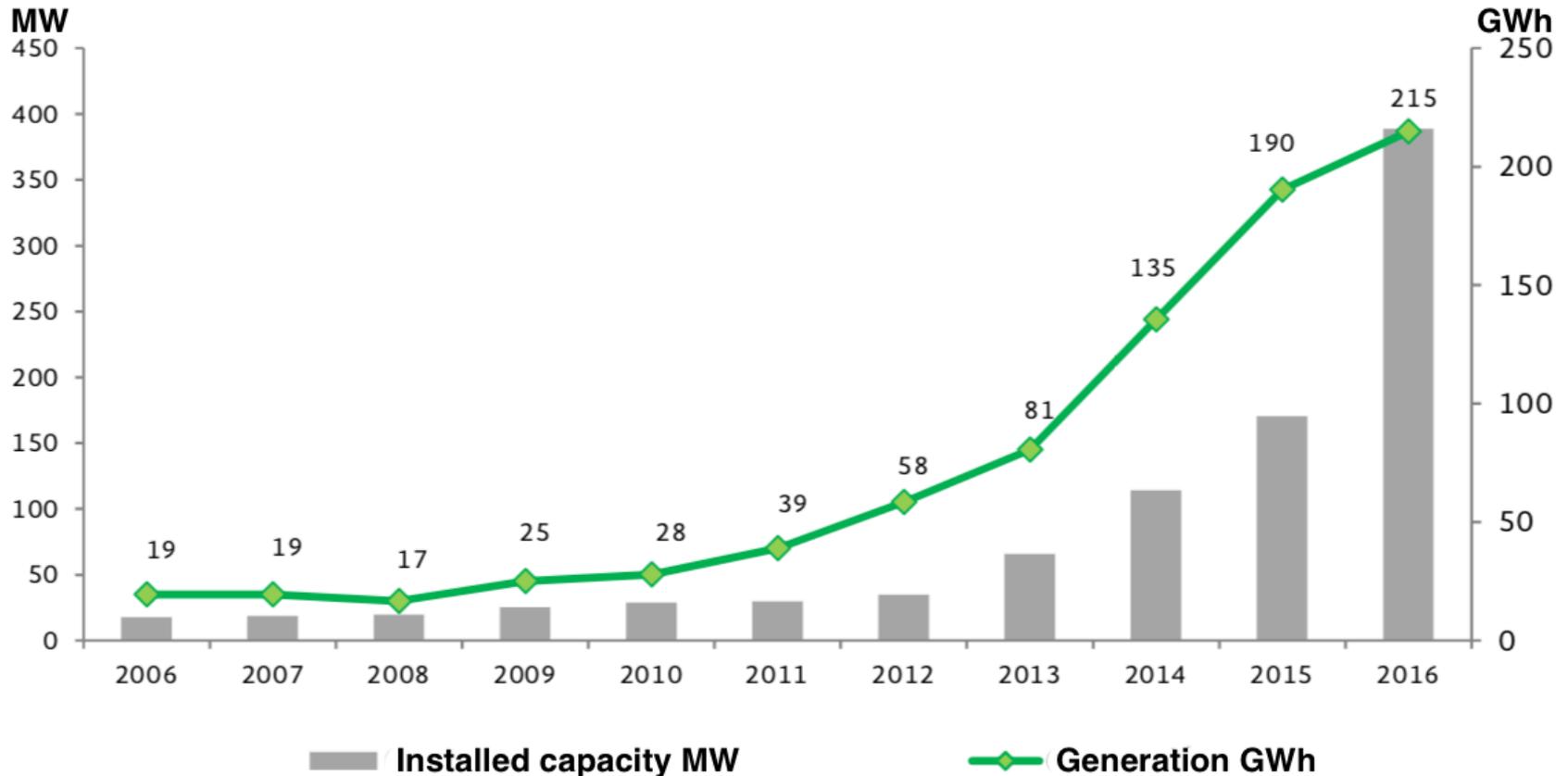
Location of photovoltaic energy sources (2016)



Does not include photovoltaic distributed generation

Fuente: Elaborado por SENER con información de PRODESEN 217-2031.

Development of photovoltaic power

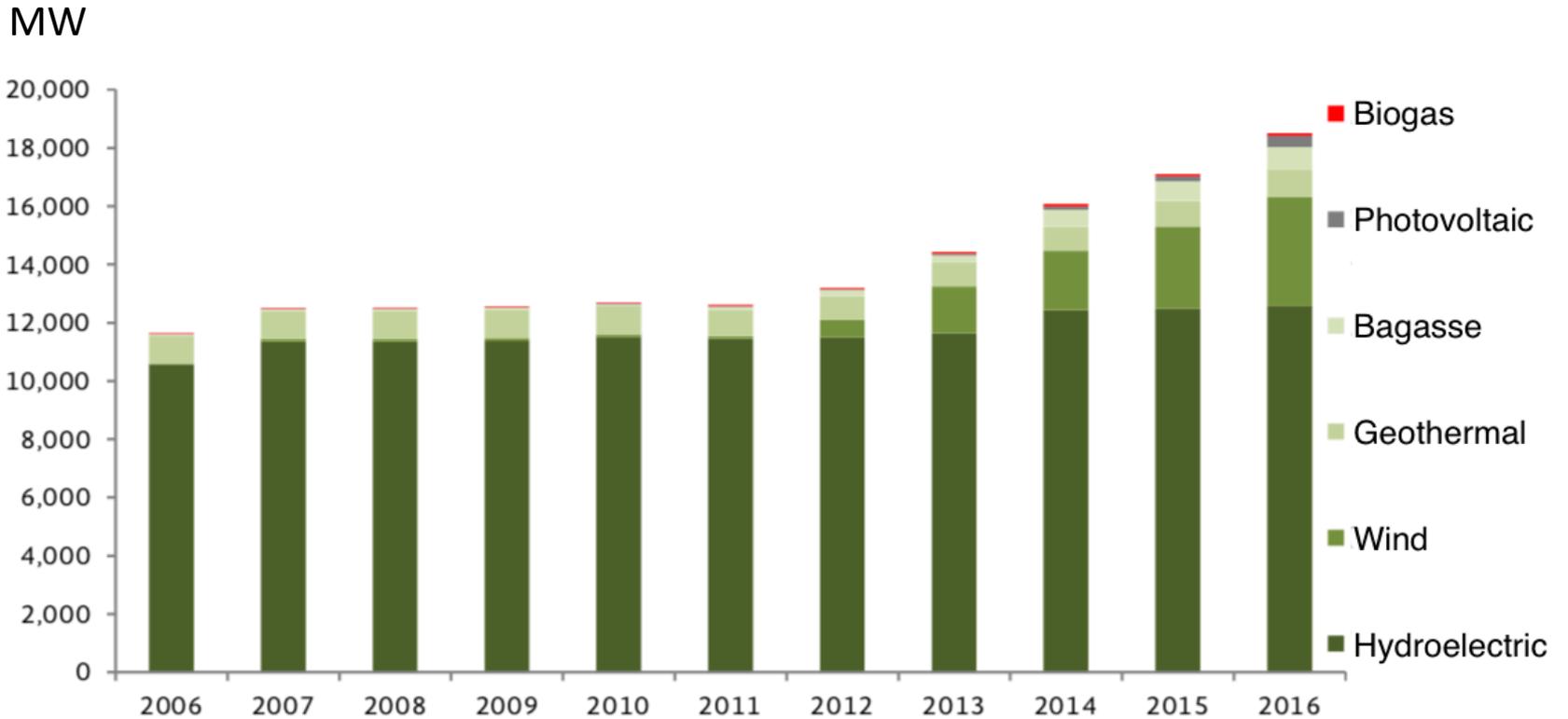


Includes photovoltaic distributed generation

Fuente: Elaborado por SENER.



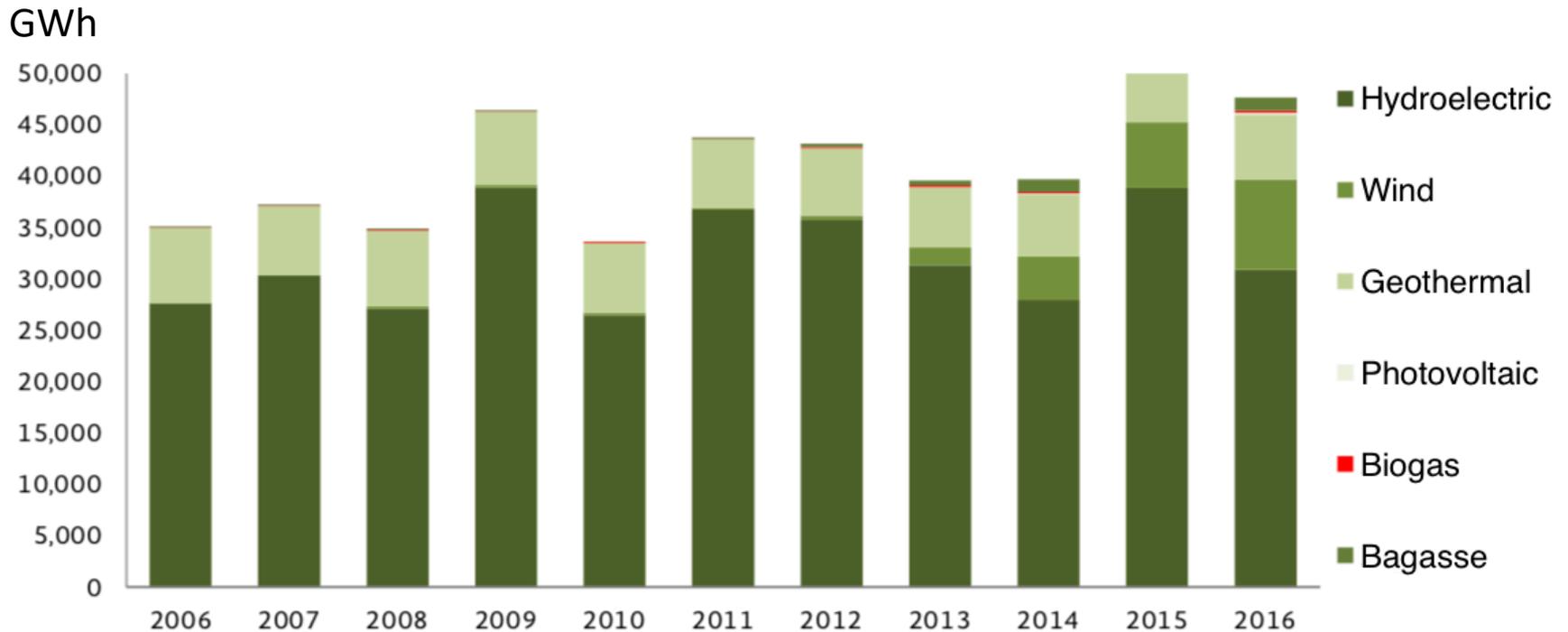
RES installed capacity (2006 – 2016)



Photovoltaic includes distributed generation

Fuente: Elaborado por la SENER.

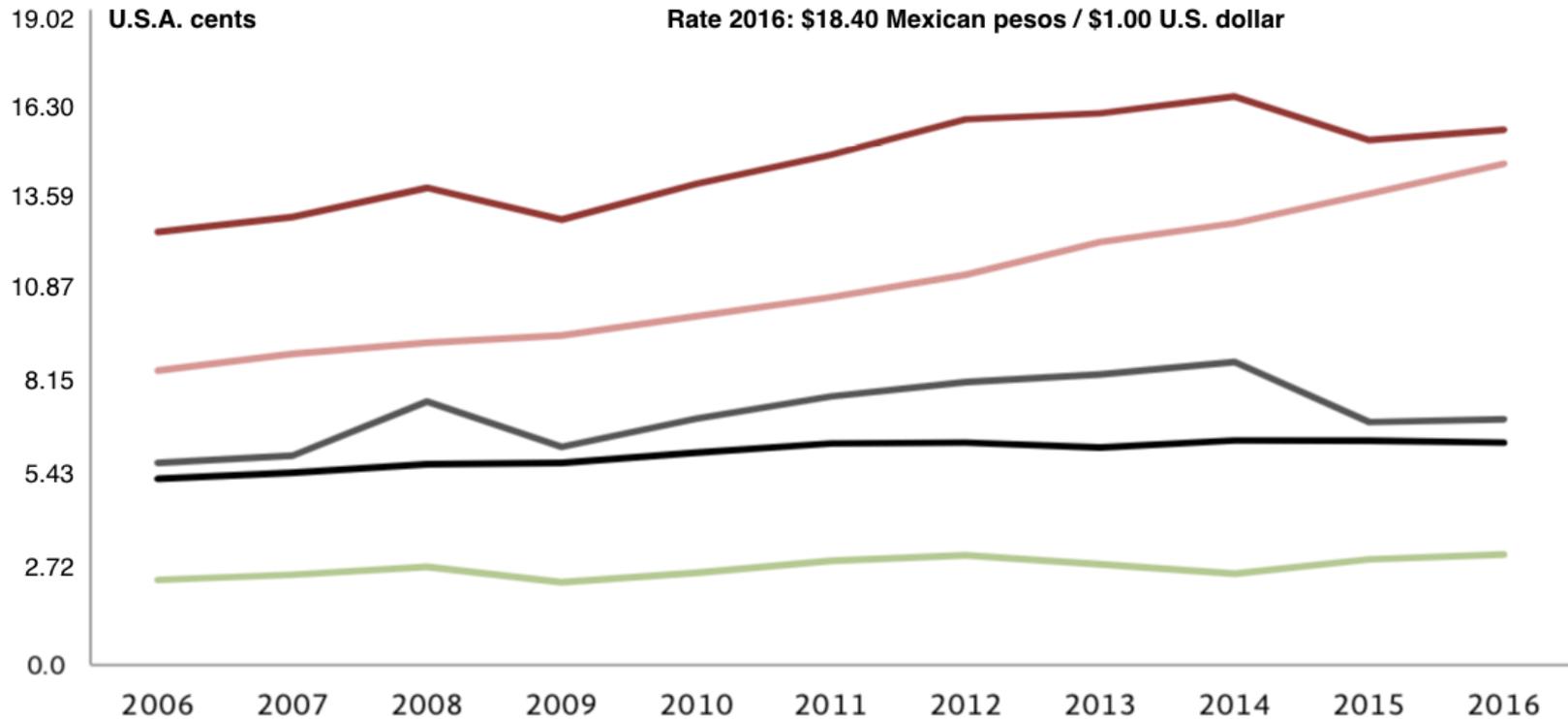
RES production (2006 – 2016)



Photovoltaic includes distributed generation

Fuente: Elaborado por la SENER.

Price development (U.S.A. cents/kWh)



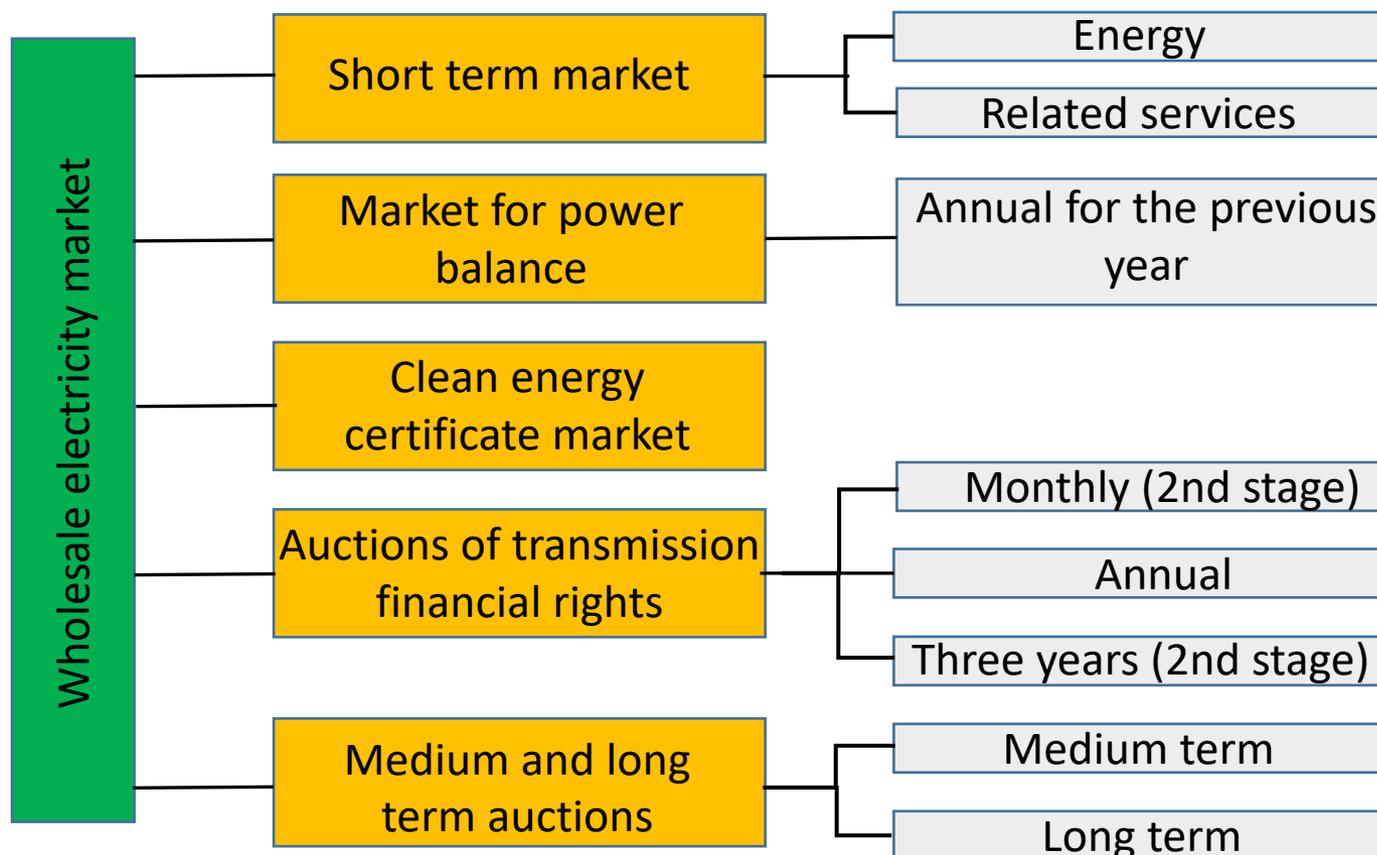
Average annual growth total 2006-2016 = 2.9%	Commercial 3.0%	Services 5.5%	Industrial 2.9%	Household 2.3%	Agricultural 2.7%
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Fuente: Elaborado por SENER con información del Sistema de Información Energética.





Electricity market organisation (Working since 2016)



Wholesale electricity market members



Fuente: Elaborado por SENER, con información del Centro Nacional de Control de Energía y CRE.



Power balance in 2016

all figures in TWh

- ❑ Generation
 - Gross generation: 265.951
 - Generation own uses: 9.303
 - Net generation: 256.647
- ❑ Remote self supply : 33.547
- ❑ Imports: 2.516
- ❑ Comissioning: 0.016
- ❑ Transmission and distribution
 - T&D own uses: 2.977
 - T&D losses: 40.378
- ❑ Consumption : 219.205
- ❑ Exports: 2.300
- ❑ Remote self supply energy: 28.986



References

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- “Programa de desarrollo del Sistema Eléctrico Nacional 2017 – 2031 PRODESEN” – Secretaría de Energía – México, 2017
- “Prospectiva del Sector Eléctrico 2017 – 2031” – Secretaría de Energía – México, 2017
- “Prospectiva de Energías Renovables 2017 – 2031” – Secretaría de Energía – México, 2017
- “Balance nacional de energía 2016” – Secretaría de Energía – México, 2017

Elaboró: E.Bolívar V. – CIGRE México – Julio, 2018