

RENEWABLE ENERGY

Non-Conventional Sources of Renewable Energy



MINCOMERCIO
INDUSTRIA Y TURISMO



PROCOLOMBIA
EXPORTACIONES TURISMO INVERSIÓN MARCA PAÍS



TODOS POR UN
NUEVO PAÍS
PAZ EQUIDAD EDUCACIÓN



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EXPOSITS TOURISM INVESTMENT COUNTRY BRAND

Renewables in the world

The global energy transition



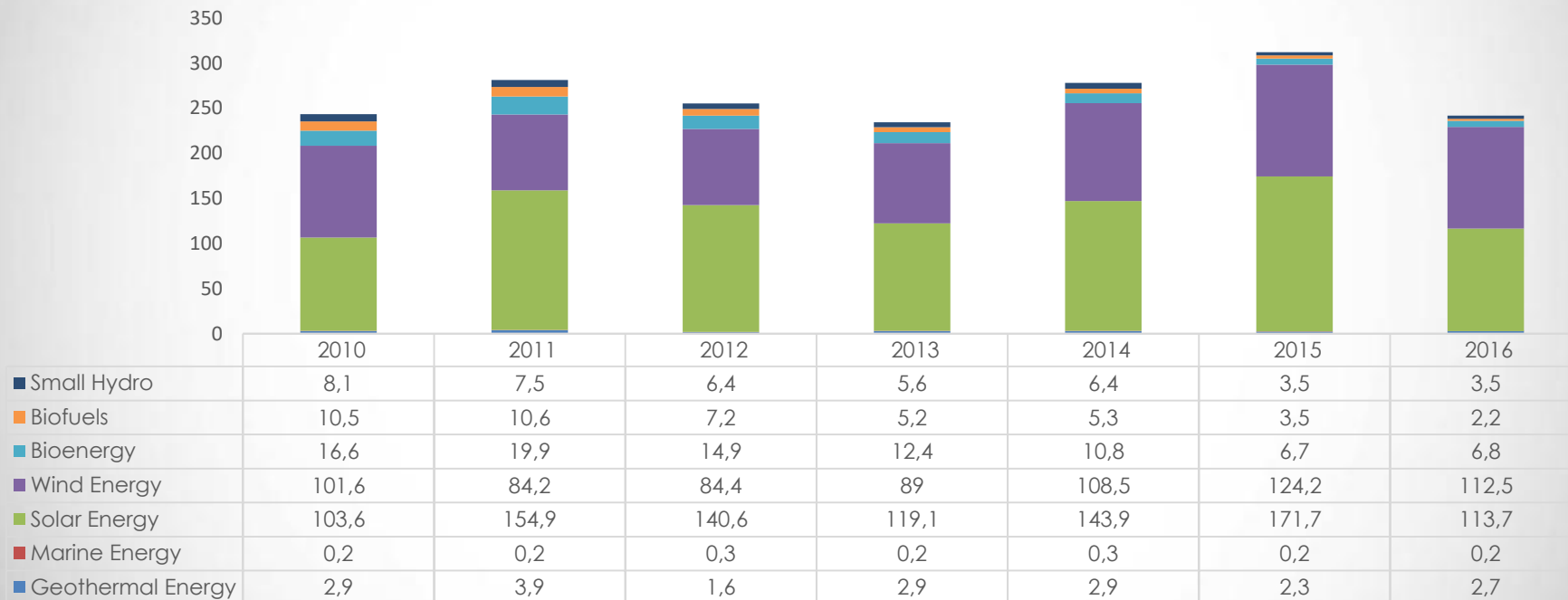
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1. Renewable energies, including hydroelectric energy, account for 30% of the total global installed generation capacity.
2. Renewable Energies have become a big business: in 2015 USD 286 billion were invested in 154 GW of Renewable Energy (76% in wind and PV), exceeding the investment in conventional generation 97 GW.
3. The combination of technological improvements and cost reductions was leading to lower CAPEX of non-conventional renewable energy in particular in PV.
4. Correct location with high wind or solar factors and low connection costs are the key to the success of large-scale NCRE projects.

Investment in renewable energy in the world by sector



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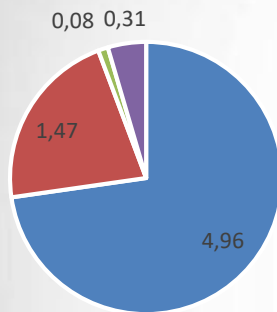
Source: International Renewable Energy Agency

Growth of renewable energies in Latin America

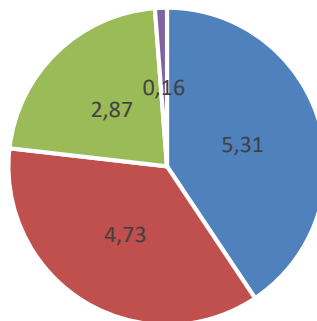


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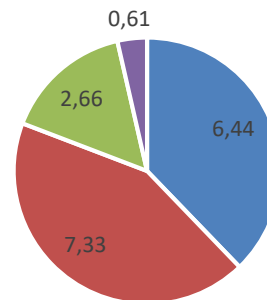
Energy generation 2014



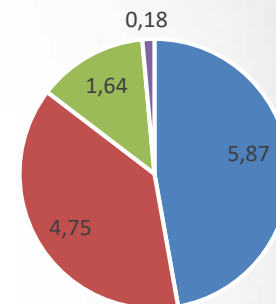
Energy generation 2030 -Scenario 1



Energy generation 2030 – Scenario 2



Energy generation - Scenario 3



■ Biomass ■ Wind ■ Solar ■ Geothermal

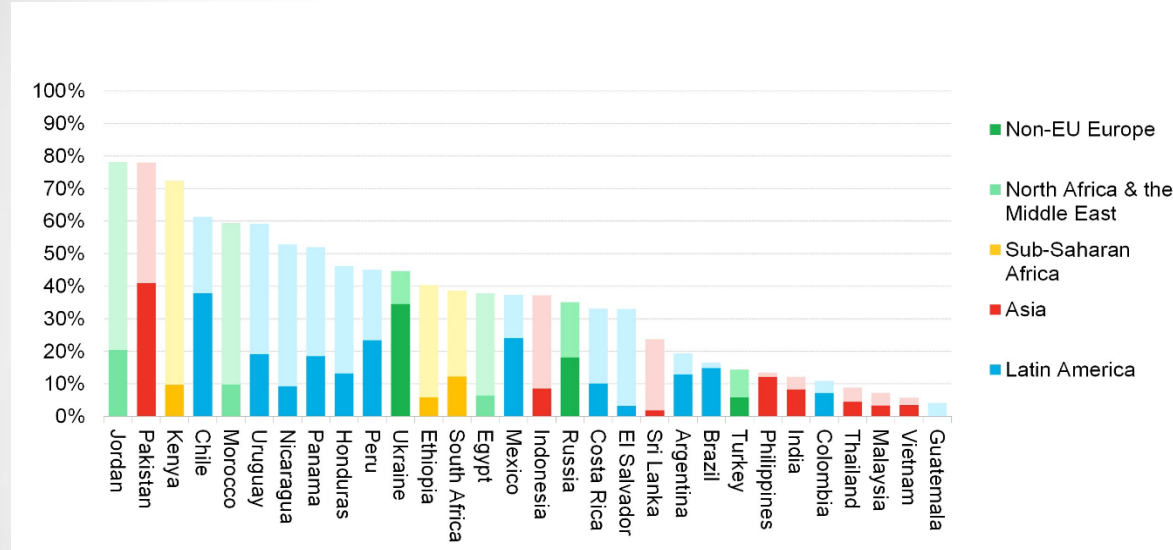
■ Biomass ■ Wind ■ Solar ■ Geothermal

■ Biomass ■ Wind ■ Solar ■ Geothermal

■ Biomass ■ Wind ■ Solar ■ Geothermal

	2014		2030 Stage 1.		2030 Stage 2.		2030 Stage 3.	
Generation of electricity	Twh	%	Twh	%	Twh	%	Twh	%
Biomass	64	4,96	100	5,31	116	6,44	100	5,87
Wind	19	1,47	89	4,73	132	7,33	81	4,75
Solar	1	0,08	54	2,87	48	2,66	28	1,64
Geothermal	4	0,31	3	0,16	11	0,61	3	0,18
Total	88	6,82	246	13,07	307	17,04	212	12,44

Ranking of emerging markets with the highest foreign investment in clean energy, 2010-2016



% foreign capital (dark) and % debt (clear) in total clean energy assets

Colombia is in the top 30 of the emerging markets that attracted most of the foreign investment in clean energy

2030 Scenario



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**Scenario with greater
participation ERNC ***



**Scenario with less
participation ERNC ***

World



16%

10%

Latin America



11%

7%

Colombia



7%

3%

*ERNC: Renewable energy unconventional

Source: Perspectiva mundial de las energías renovables - José Antonio Vargas, World Energy Council.

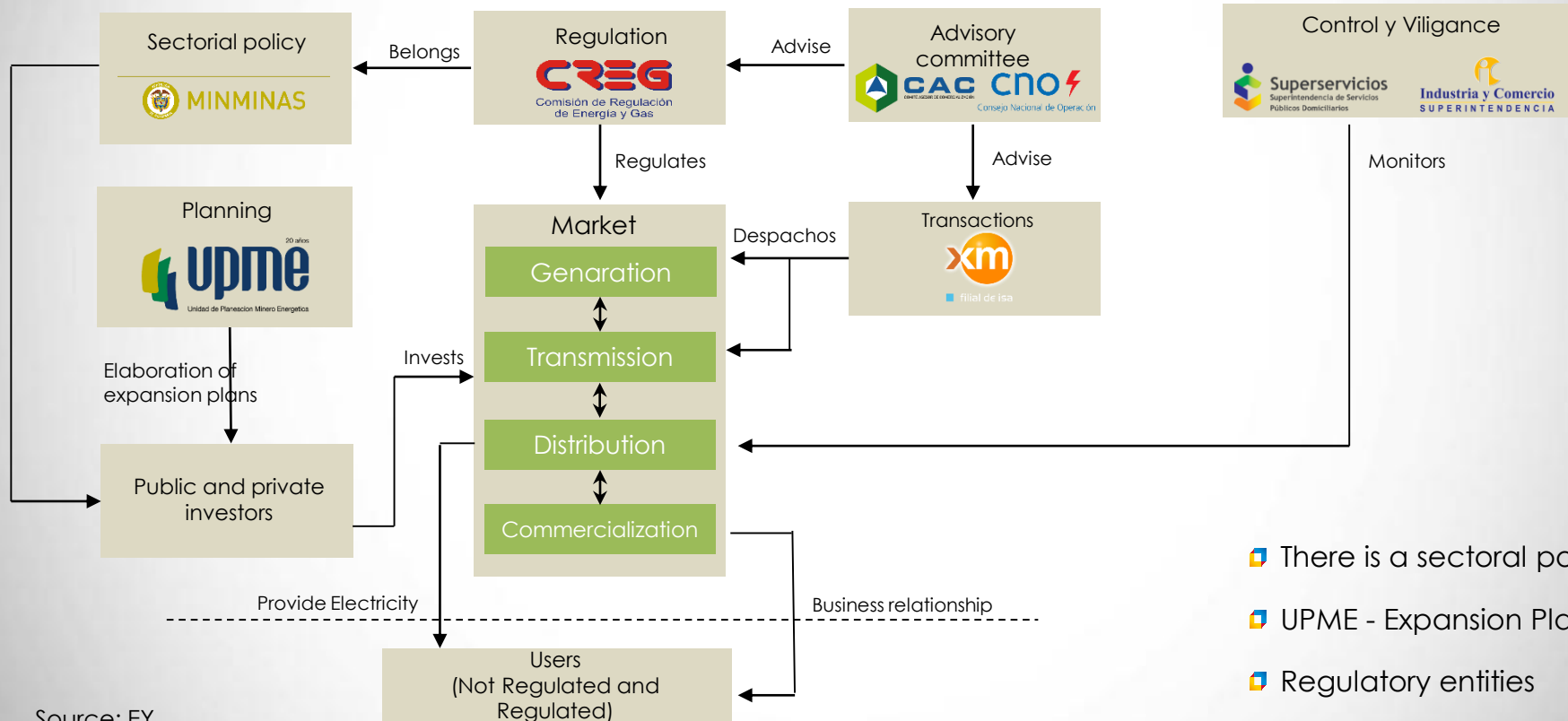


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Energy Market

Institutional structure of the energy sector in Colombia



Source: EY

- There is a sectoral policy.
- UPME - Expansion Plans.
- Regulatory entities



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Supply Chain trends

- ⚡ In transmission networks, there is a growing need to increase transmission capacity and connect remote areas with each other.
- ⚡ In addition to expanding the network with new lines and new technologies, the workload can be better distributed through the use of reactive energy management.
- ⚡ As renewable energies increase in the supply of electricity, the importance of storage capacity and load management increases.

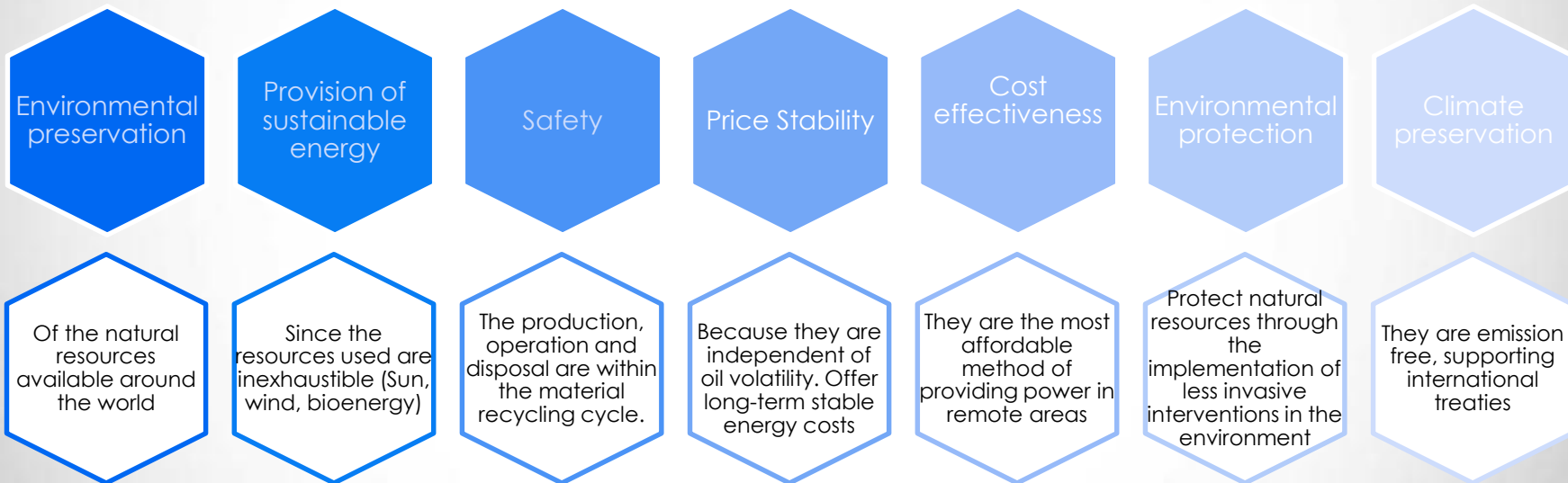




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Renewable energy, sustainable future

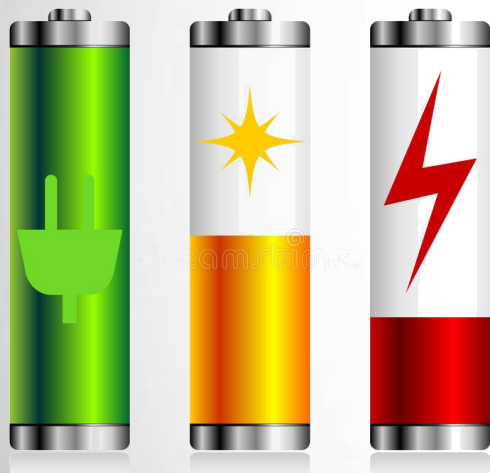
Beyond the objective of a reliable and efficient energy supply, the use of renewable energy has great advantages and benefits:





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Storage of renewable energy



- With an efficiency of up to 80%, storage stations are currently the only economical energy storage option for hourly and daily compensation that is available on an industrial scale.
- Large multi-megawatt batteries are gaining increasing importance as they provide system services such as voltage and frequency maintenance, which ensures stability and security of supply.
- The idea power to gas, seeks to convert renewable energy into hydrogen or methane, so that the gas can be transported and stored in pipes and then be used in several areas of applicability (mobility, industry, heating and electricity generation).



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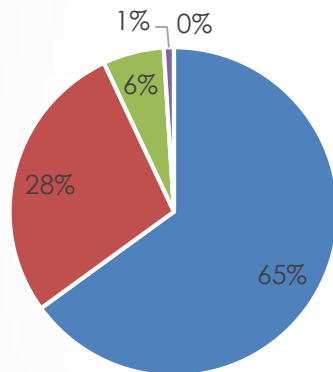
Energy Matrix and Projections



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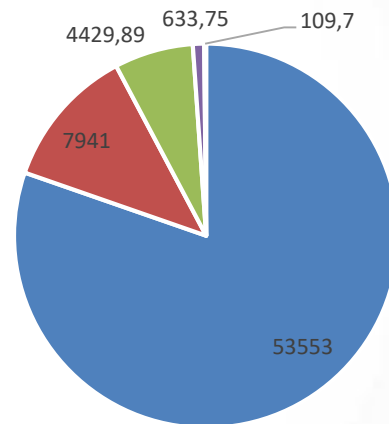
Diversification of the Energy Matrix

Installed capacity of SIN 2017 (MW)



SIN generation 2017 (MW)

- Hydraulic
- Thermal
- Minors
- Cogenerators
- Self-Generators



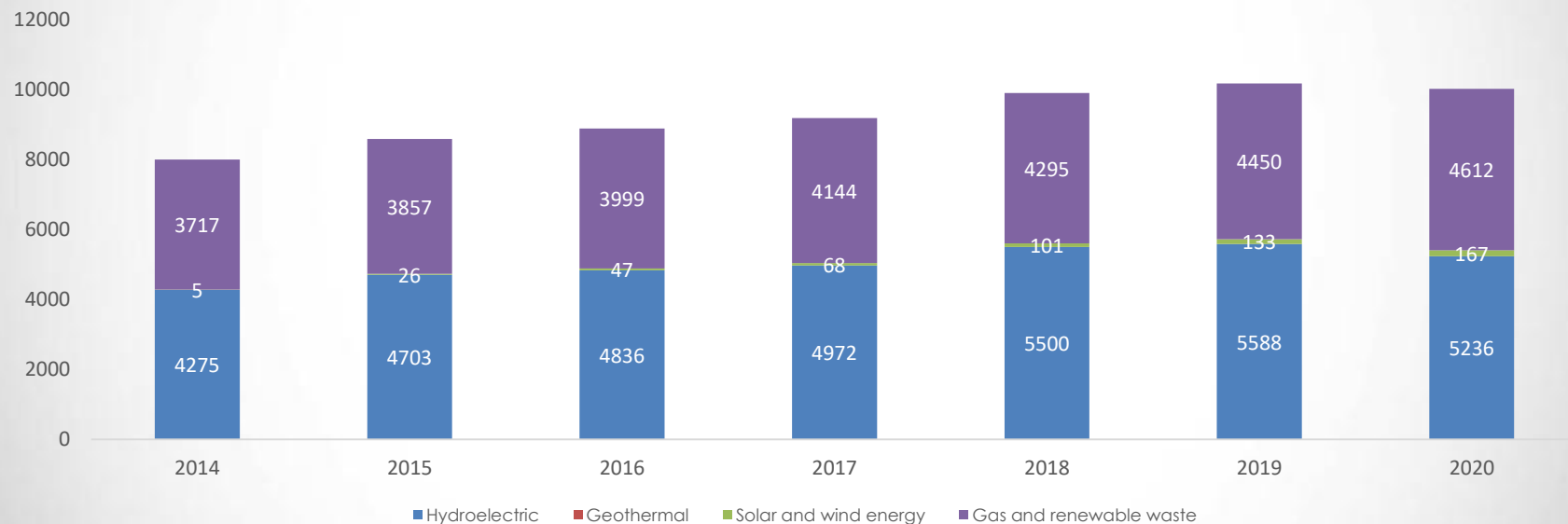
The generation in 2017 was 66.667 Gwh.
The installed capacity in 2017 was 16.778,85 MW

Projection of renewable consumption in Colombia



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Projection of Consumption of Renewable Energies 2020



Source: The Economist Intelligence Unit 2016, Country Report Colombia

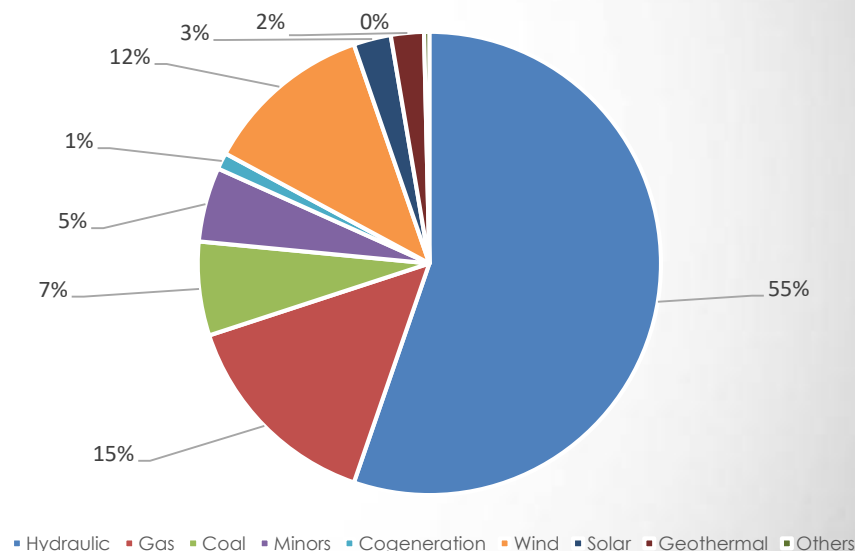


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UPME's expansion plan: Scenario 1

- Scenario 1 of the expansion plan in generation 2017 - 2031 of the UPME
 - 4025 MW new FCER for 2031

Resource	Base	Reliability charge	Additional Expansion	Total
Hydraulic	10.963	1.200	1.255	13.418
Gas	3.509	-	57	3.566
Coal	1339	250	0	1.589
Minors	787	-	475	1.262
Cogeneration	126	-	154	280
Wind	18	-	2.858	2.876
Solar	-	-	633	633
Geothermal	-	-	560	560
Others	-	89	-	89
Total	16.742	1.539	5.992	24.273

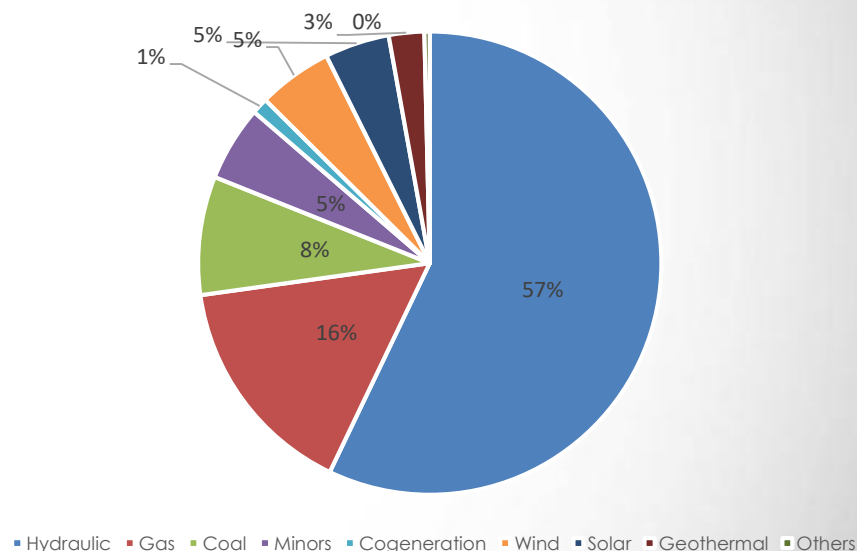


Scenario 1 UPME generation expansion plan

UPME's expansion plan: Scenario 2

- Scenario 2 of the expansion plan in generation 2017 - 2031 of the UPME
- 3058 MW new FCER for 2031

Resource	Base	Reliability charge	Additional Expansion	Total
Hydraulic	10.963	1.200	1.566	13.729
Gas	3.509	-	261	3.770
Coal	1339	250	400	1.989
Minors	787	-	475	1.262
Cogeneration	126	-	146	272
Wind	18	-	1.231	1.249
Solar	-	-	1086	1086
Geothermal	-	-	595	595
Others	-	89	-	89
Total	16.742	1.539	5.760	24.041



Scenario 2 UPME generation expansion plan



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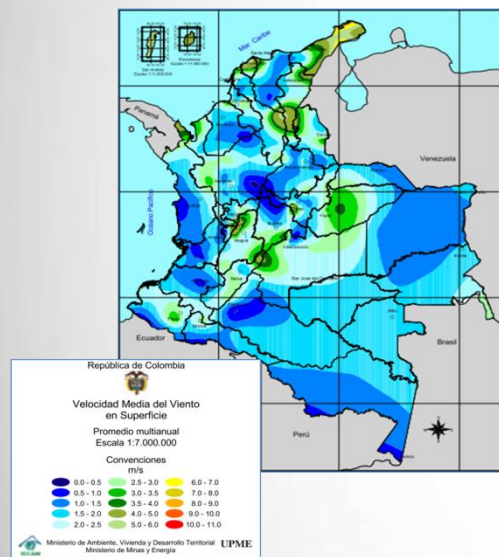
Renewable Energy Potential

Regions with Potential for the Development of Non-Conventional Renewable Energy

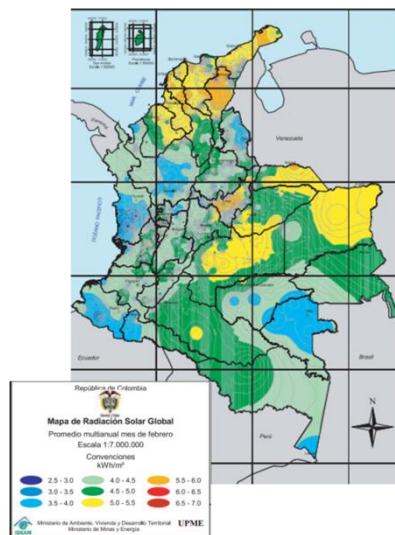


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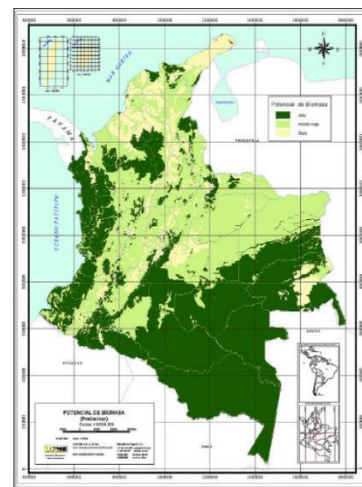
Wind Potential



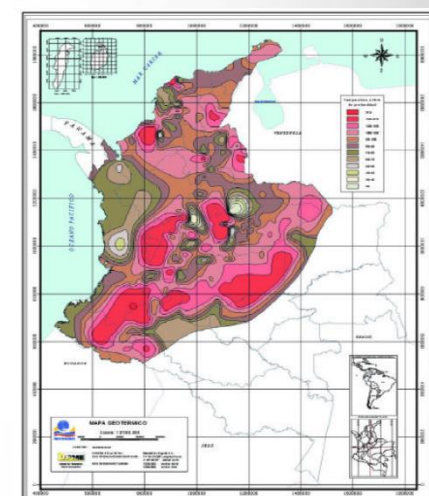
Solar Radiation



Biomass in Colombia



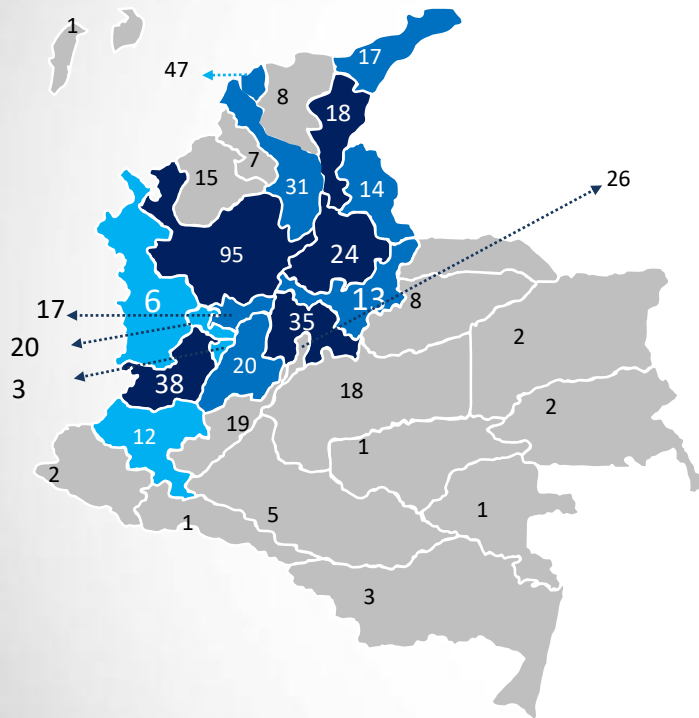
Geothermal Potential



Generation projects in Renewable energy



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Source: Registry of power generation projects subscribed to UPME. March 2018



2.269,40 MW Wind



92,22 Biomass



3.773,42 MW Solar



963,06 MW PCH



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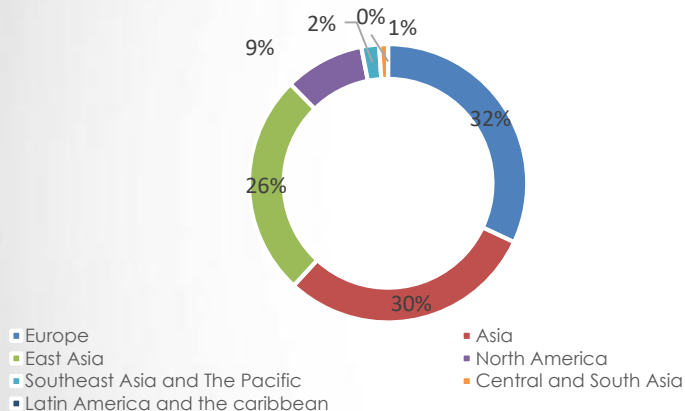
Solar energy

Solar Energy worldwide

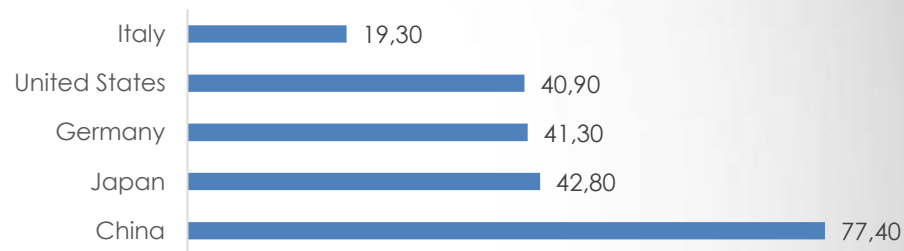


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Installed Solar Energy Capacity by Region 2016



Top 5 World - GW Solar Energy Installed Capacity



Top 10 Latin America MW



Solar Energy Trends



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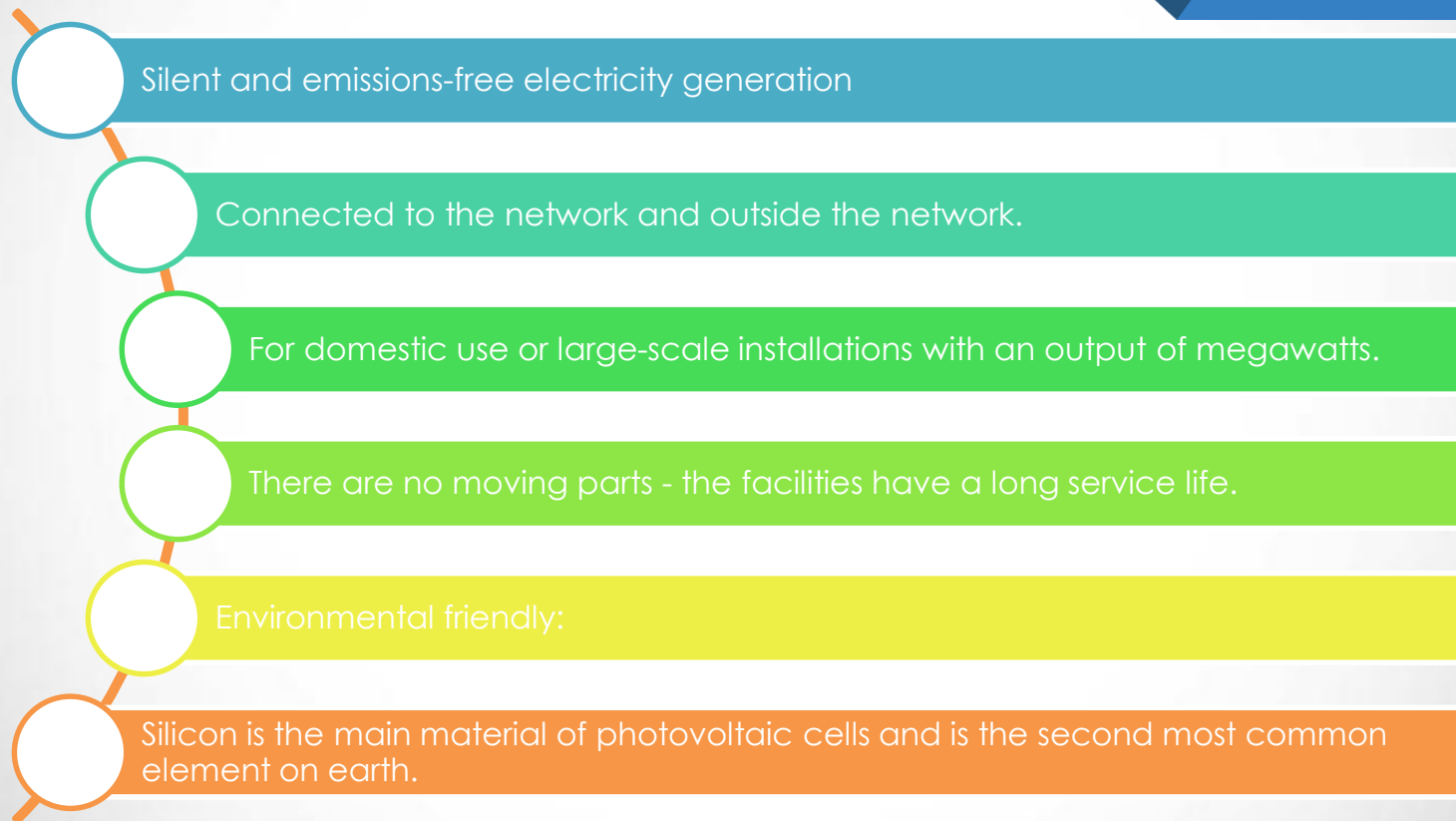
- In one hour the sun delivers more energy to the earth than the world uses in a whole year.
- Photovoltaic systems convert sunlight directly into electrical energy.
- The solar thermal power plants are more efficient in "the solar belt of the world", where the solar radiation is direct, this region extends approximately 40 degrees of latitude in the northern hemisphere to 40 degrees in the southern hemisphere.
- Total installed production worldwide exceeded 170 GW at the end of 2014.





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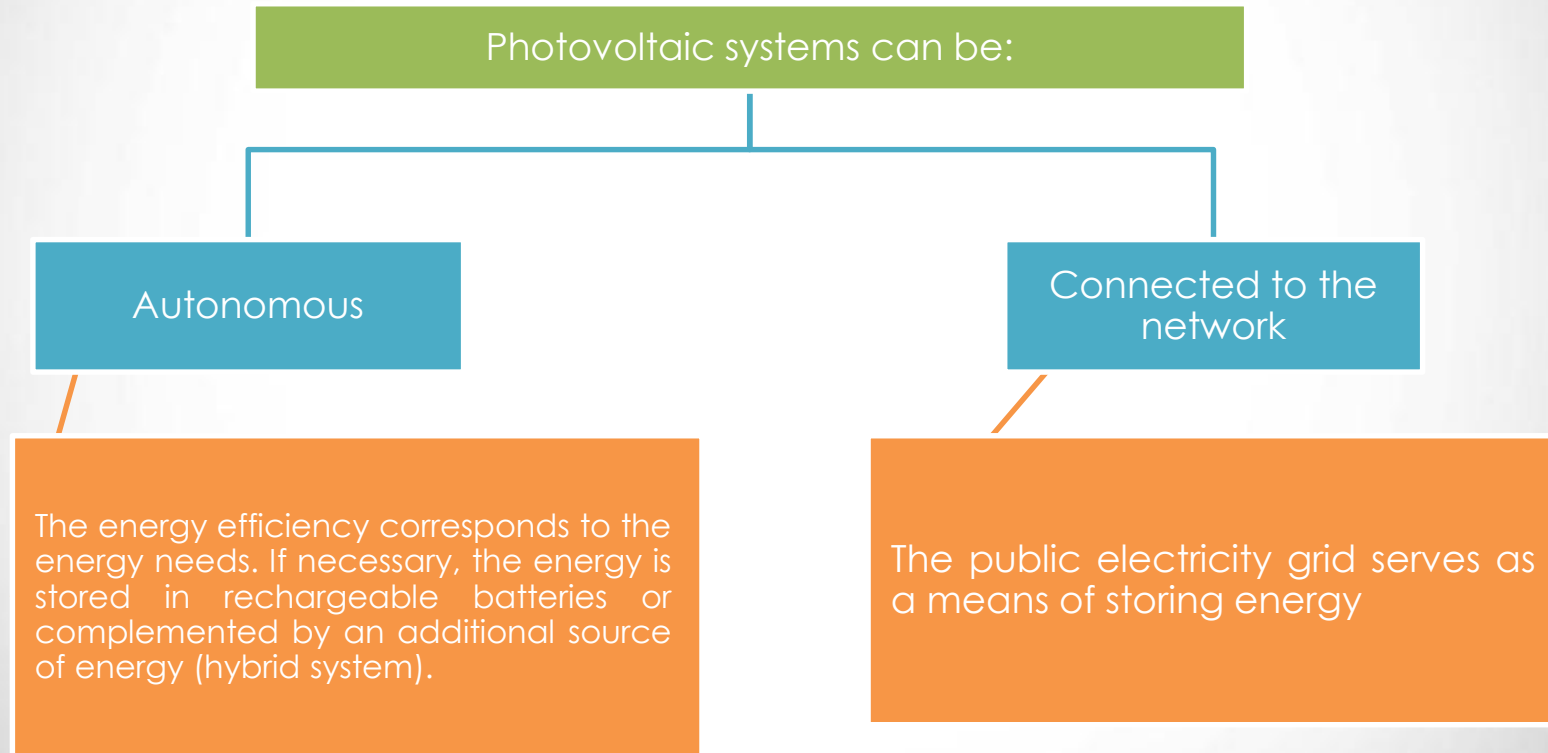
Advantages of Solar Energy



Photovoltaic systems



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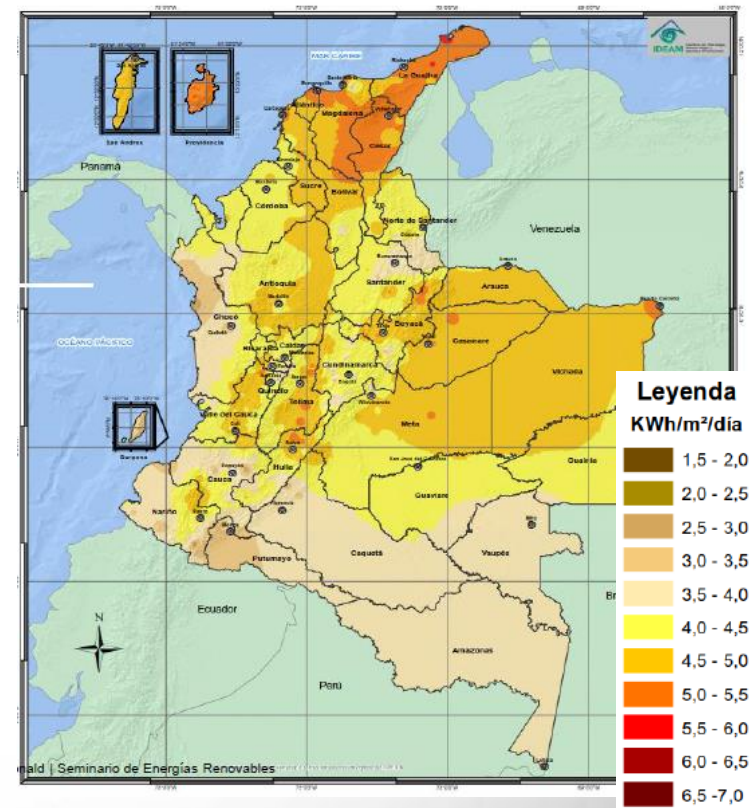


Photovoltaic Potential



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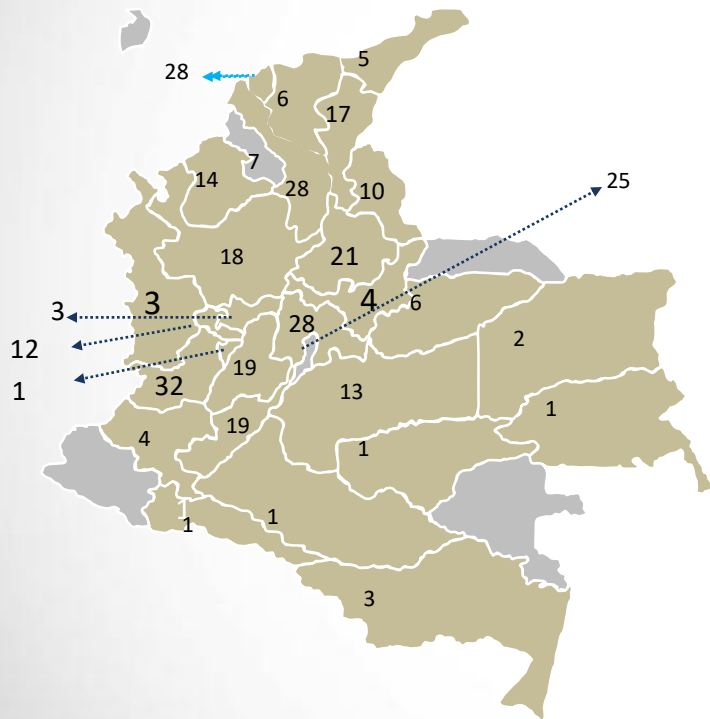
- Colombia has a multiannual daily average of about 4.5 kWh/m^2 , thus exceeding the global daily average of 3.9 kWh/m^2 .
- Solar resource for energy generation on most of the territory, mainly La Guajira, San Andres, Bolivar and Boyaca
- Major potential for small-scale projects
- Implementation potential of solar plants: 260 MW
- The Guajira Peninsula can generate 6.0 kWh/m^2 per day, with a potential of nearly 42 GW.



Solar energy generation projects in Colombia



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3.773,42 MW Solar

Capacity range	N° Projects	Capacity (MW)
0 - 20	331	1.692
21 - 99	13	1.274
> 100	8	808
Total	352	3.773

Phase	N° Projects	Capacity (MW)
1*	270	2.438
2**	58	1.331
3***	24	4



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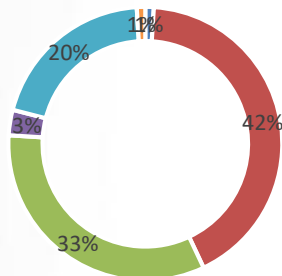
Wind energy

Wind Energy worldwide



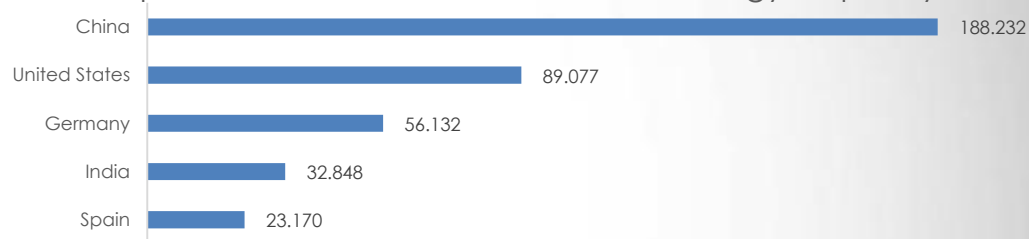
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Installed Wind Energy Capacity by Region

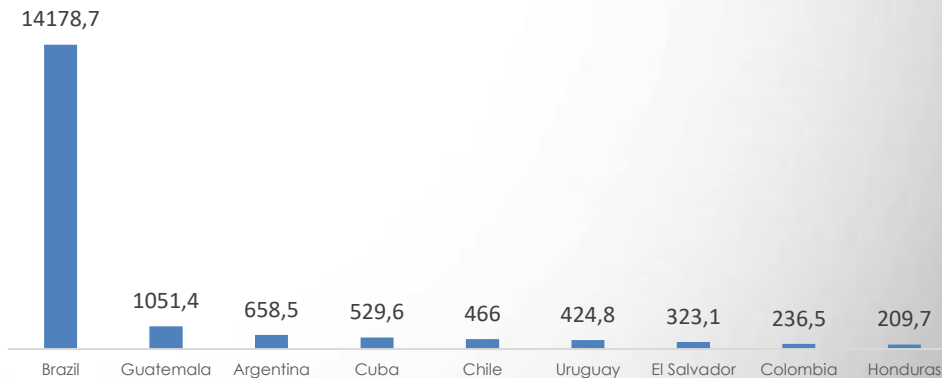


■ AFRICA & MIDDLE EAST SOUTH AFRICA
■ EUROPE
■ NORTH AMERICA USA
■ ASIA PR CHINA*
■ LATIN AMERICA & CARIBBEAN
■ PACIFIC REGION

Top 5 worldwide - Installed GW Wind Energy Capacity



Top 10 Latin America MW





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Trends in Wind Energy



- ✎ Wind energy is the most important source of renewable generation, and has had the fastest growth in the medium term.
- ✎ The Global Wind Energy Council (GWEC) predicts that by 2020, up to 12% of the world's electricity supply will be wind energy.
- ✎ For 2017, the total installed capacity of the world 539,581 MW. The largest markets are China (188,232 MW), USA (89,077 MW) and Germany (56,132 GW) *.

FUENTE: Renewables – Made in Germany - DENA

FUENTE: Global Wind Energy Council - 2017

Trends in Wind Energy



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- ✚ In recent decades it has become a pillar of sustainable energy supply
- ✚ Most of the world's turbines are currently installed on land (onshore) and are connected to a public network.
- ✚ Turbines in the sea (offshore) have yields of up to 40% higher than on land.





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Advantages of Wind Power

Wind energy offers clean and friendly energy to the environment

Competitive prices

Wind farms generate jobs, and economically benefit the regions

Turbines can generate from kW to MW

Wind power plants are the basis for an energy mix



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Onshore Wind Power

- ✦ Today, land-based wind farms are often installed near the coast.
- ✦ To achieve high yields, the turbines were developed with tall towers and blades with a large sweep.

Investment costs are lower than offshore plants



Decentralized electricity generation is done closer to the consumption centers.

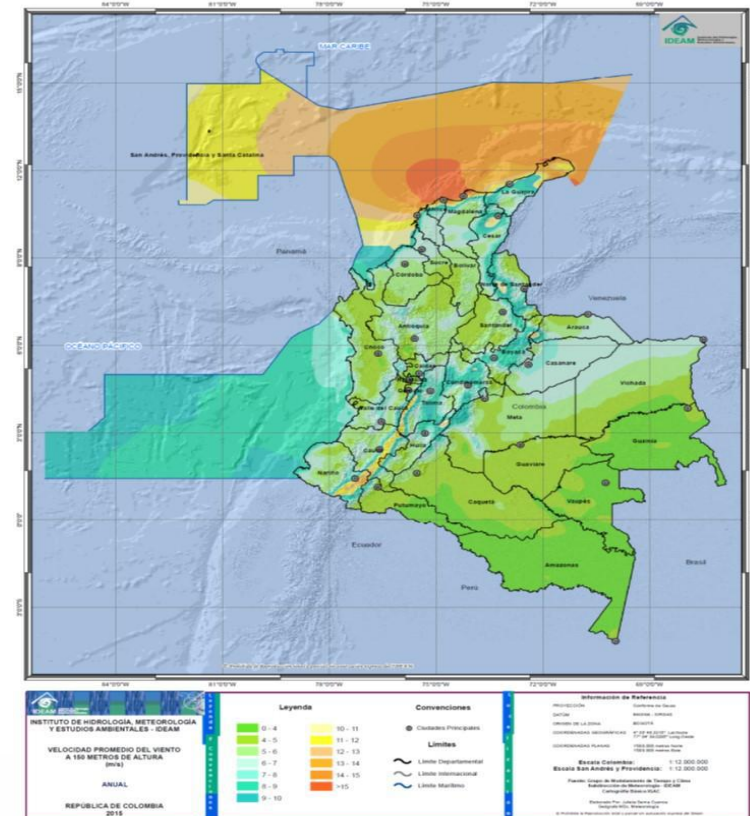


Wind Potential



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- ✦ The Caribbean Coast has the best wind energy potential.
- ✦ An implementation potential of wind farms of more than 25 GW has been determined, with a plant factor from 30% to 40%.
- ✦ In the department of La Guajira, currents with average speeds of 9 m/s are produced at an altitude of 80 meters above sea level, with a potential of nearly 15 GW.



Wind Power Generation Projects in Colombia



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2.269,40 MW Wind

Capacity range	N° Projects	Capacity (MW)
0 - 20	3	10
21 - 99	4	244
> 100	8	2.016
Total	15	2.269

Phase	N° Projects	Capacity (MW)
1*	10	1.700
2**	5	569
3***	-	-



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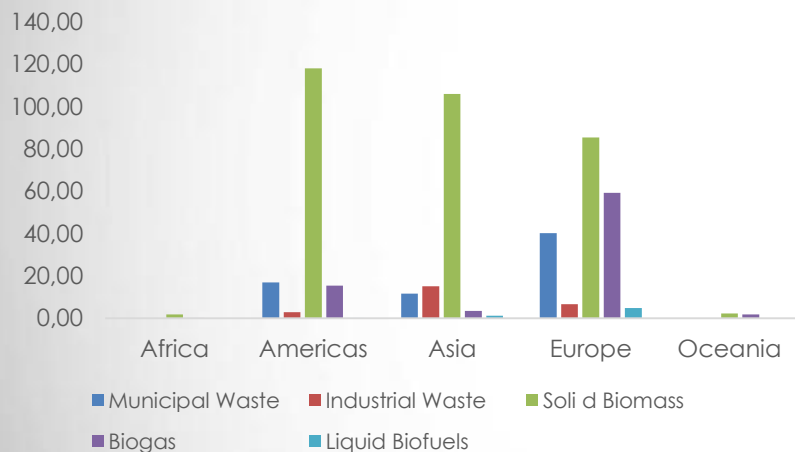
Biomass



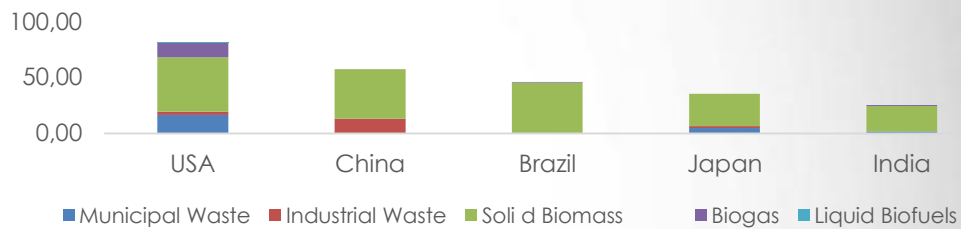
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Energy derived from biomass worldwide

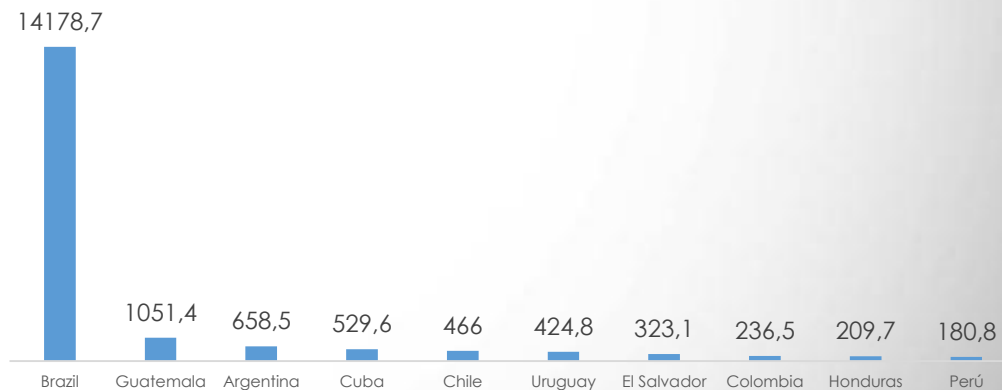
Generation of electricity from Biomass 2014 (Twh)



Generation of electricity from Biomass 2014 (Twh)



Top 5 Latin America MW





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Biomass Trends

- 🌱 Bioenergy in solid, liquid or gaseous form is used to generate electricity / heat and to manufacture biofuels.
- 🌱 Bioenergy can be stored, and used to generate electricity and heat.
- 🌱 Fermentation residues from biogas production can be used in agriculture as high quality fertilizer.
- 🌱 Biogas is being processed to achieve the quality of natural gas, and can be used as a transport fuel.





- ♻️ Biomass can be used to produce fuel, heat and energy. Biomass includes wood, organic waste, manure and other plant and animal substances.
- ♻️ The use of solid biomass is of enormous importance in the supply of energy worldwide; in particular in developing countries for heating and cooking.
- ♻️ In 2010, bioenergy was the most widespread form of renewable energy in the world, representing 9.5% of the world's primary energy consumption.



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Classification of Bioenergy



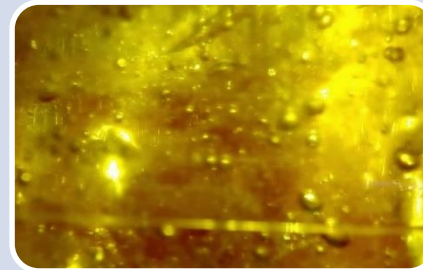
Solid

- * Wood waste
- * Vegetable waste
- * Energy crops



Gaseous

- * Biogas
- * Sewage gas
- * Sanitary landfill gas
- * Synthetic Biogas



Liquid

- * Vegetable oil
- * Biodiesel
- * Bioethanol
- * Synthetic biofuels



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Advantages of Bioenergy

Bioenergy is CO₂ neutral.

Biomass is storable and flexible in its use.

Biomass balances the fluctuations of solar and wind energy

It is available in almost all countries.

It helps reduce the problems of waste disposal.

Creation of jobs in agriculture and forestry.

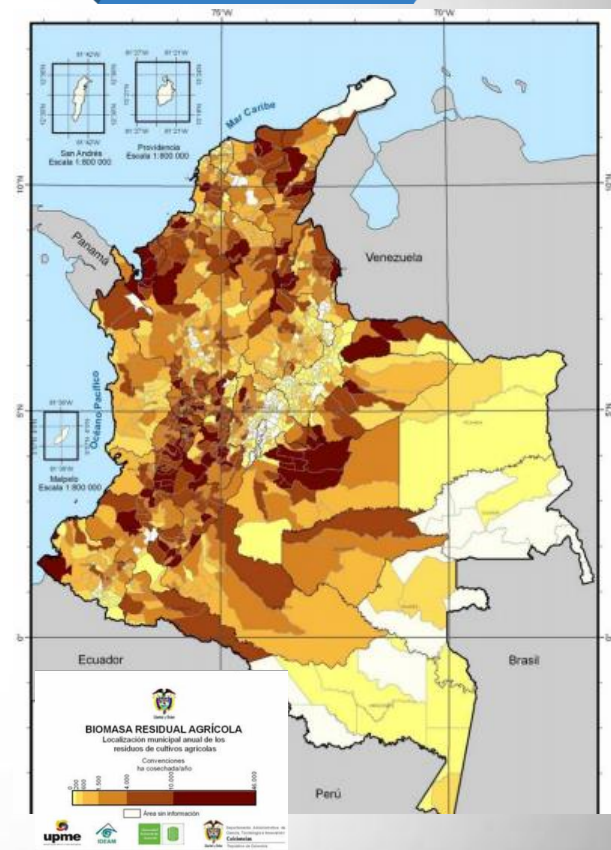
Biomass in Colombia



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✈ Colombia has a potential of producing more than 500,000 TJ of biomass per year, which is equivalent to 46% of the national energy demand.

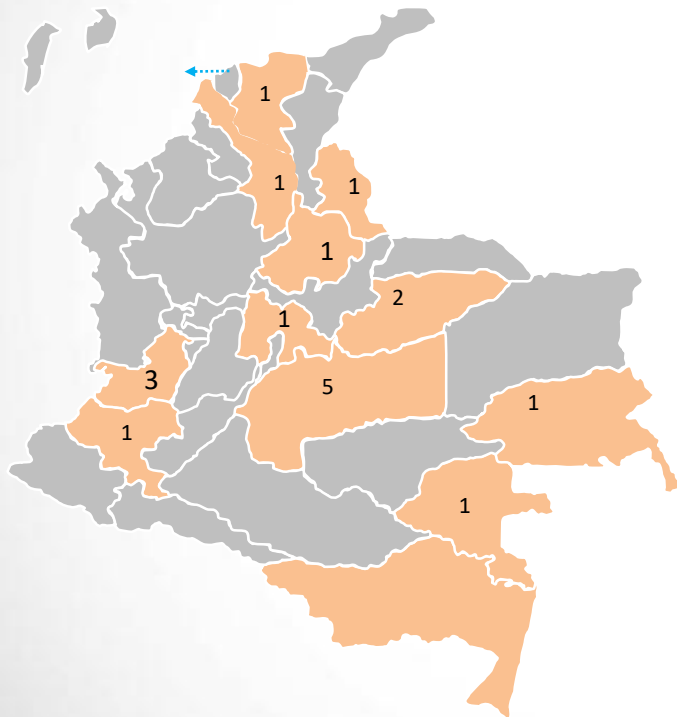
Sector	Origin	Potential [TJ]
Agricultural	Palm Oil	16,014
	Sugar cane	199,634
	Coffee	49,107
	Corn	20,796
	Rice	27,836
	Bananas	6,596
	Plantain	11,657
Livestock	Cattle	84,256
	Pigs	4,309
	Fowl	117,748
Urban solid waste	Supply centers	92
	Pruning	318
Total		538,361



Biomass energy generation projects in Colombia



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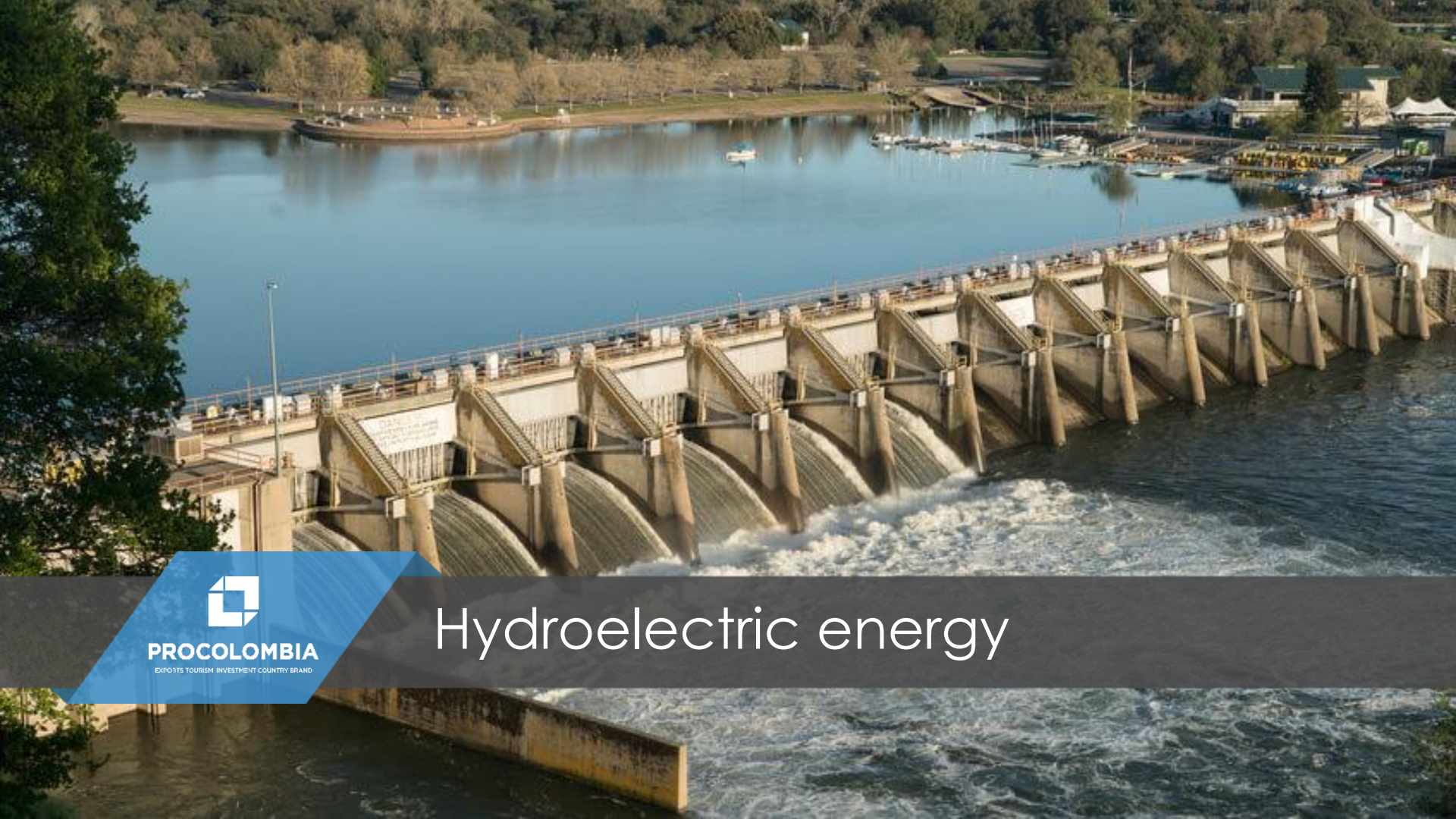


92,22 Biomass

Range of capacity	N° Projects	Capacity (MW)
0 - 20	16	42
21 - 99	2	50
> 100	-	-
Total	18	92

Phase	N° Projects	Capacity (MW)
1*	10	1.700
2**	5	569
3***	-	-

Source: Registry of power generation projects subscribed to UPME. March 2018



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Hydroelectric energy



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Hydroelectric energy trends

- Today, it is the most widely used renewable energy source to generate electricity around the world.
- Hydropower is used almost exclusively to generate electricity.
- Around 16% of the world's electricity is currently generated by hydroelectric power.
- Small hydropower plants are considered a sustainable form of exploitation, since they are easier to integrate into existing ecosystems.





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Advantages of hydroelectric power

Hydroelectric

Storage and flexible in use

Base load capacity and network stabilization:

Constant availability

Reduce the amount of imported energy,

Promotes regions that are not yet developed and connected to the network,

Provide decentralized energy



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Hydropower Potential

- Hydroelectric power is the most widely used form of renewable energy in the world
- It represents one fifth of the world's electricity¹.
- 70% of the energy demand in Colombia comes from hydropower sources
- A potential of 56 GW is distributed on Colombian territory.

Installed hydropower capacity (GW) 2016²

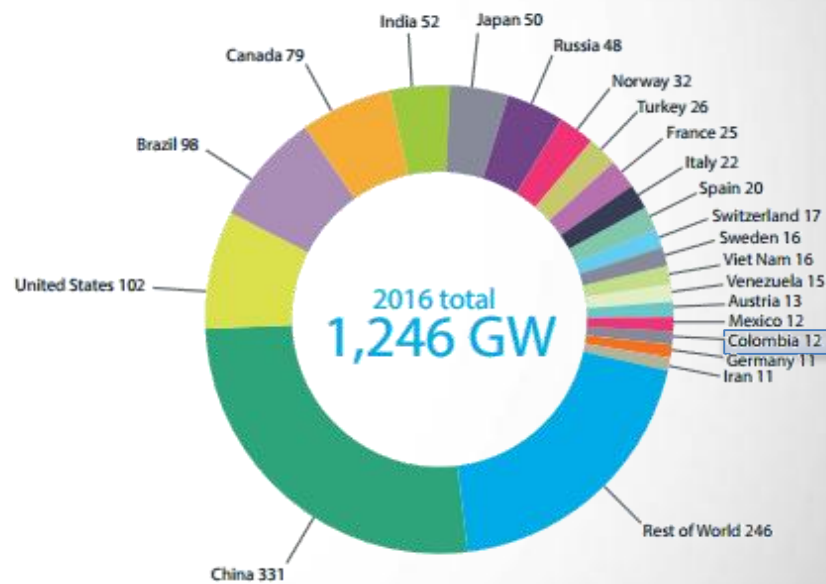


Figure 2: Global total of installed hydropower capacity (GW) by country at the end of 2016, including pumped storage

¹. World Bank

². Key Trends in Hydropower, 2017

Small Hydroelectric Plants



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- Colombia is a country with a strong potential for the creation of SHP because it has 742,725 watersheds, a multiannual flow of 52,075 m³ / s, rivers that flow into the Atlantic and Pacific oceans and an eastern region with equivalent water resources discharges to 104,631 L / s / km².
- Colombia the PCH have an installed capacity between 500 and 20,000 kW, operation at the edge of water, applicable to non-interconnected areas and interconnected areas (without the possibility of participating in the electric dispatch, less than 500 kW, and with the possibility of doing so the largest 10,000 kW).
- The PCH seeks to provide energy to isolated areas.

PCH generation projects that came into operation during 2016.

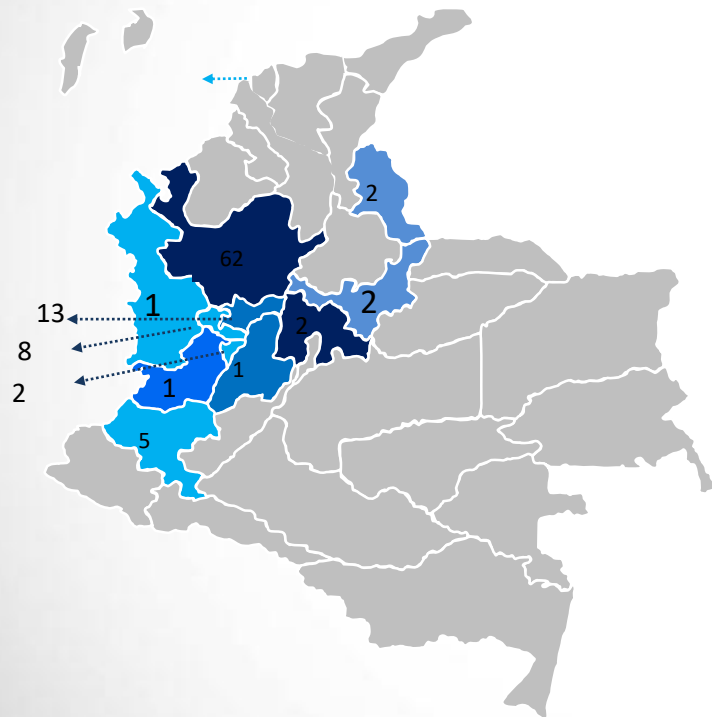
Ítem	Project type	Projects
1	Minor plant generation (Hydraulics)	Magallo 5.7 MW
2		PCH Coello 3x1.2 MW
3		PCH Morro Azul 19.9 MW
4		PCH Tunjita 19.7 MW
5		PCH El Cocuyo 0.7 MW
6		PCH La Frisolera 0.5 MW
7		PCH Guavio 9.9 MW
8		PCH Porce III

Fuente: XM

PCH projects in Colombia



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963,06 MW PCH

Capacity range	N° Projects	Capacity (MW)
0 - 20	99	963
21 - 99	-	-
> 100	-	-
Total	99	963

Phase	N° Projects	Capacity (MW)
1*	64	562
2**	30	361
3***	3	39

Source: Registry of power generation projects subscribed to UPME. March 2018



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Investment Incentives for Energy Generation

Legal Incentives for Unconventional Renewable Energy Projects



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Unconventional sources of renewable energy are those renewable sources not used or used marginally in the country, such as wind, solar, geothermal, biomass or tidal power

1

- Companies that make investments in FNCER may deduct up to 50% of the total value of these investments from their corporate tax.
- The purchase of equipment and the acquisition of services destined to new investments, are exempt from VAT.
- Machinery, equipment, materials and inputs destined for investment in unconventional renewable energy projects are exempt from the payment of Import Tariffs.
- The machines, equipment and civil works are depreciated rapidly at an annual rate of 20%.



Legal Incentives for Unconventional Renewable Energy Projects



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Revenues from unconventional renewable energy is Tax-exempt income until the year 2032.

2

- Article 235-2 of the Tax Statute establishes that as from January 1, 2018, the sale of electric energy based on wind, biomass, solar, geothermal or sea energy, carried out by generators, will be considered as exempt of income tax until the year 2032



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Investment Opportunities in renewable energy

Reasons to Invest in Renewable Energy Generation Projects



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Colombia has high potential in terms of availability of renewable and alternative energy resources, such as: Sun, wind, biomass, ocean energy and geothermal energy.



Colombia needs to diversify the energy basket, including energy generation through non-conventional sources.



Law 1715 / 2014 regulates the integration of non-conventional renewable energy to the national energy system by promoting investment through tax incentives.



Renewable energy projects being developed



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Hydroelectric



Phase	N° Projects	Capacity (MW)
1*	64	562
2**	32	361
3***	3	39

Solar



Phase	N° Projects	Capacity (MW)
1*	270	2.438
2**	58	1.331
3***	24	4

Wind



Phase	N° Projects	Capacity (MW)
1*	10	1.700
2**	5	569
3***	-	-

Biomass



Phase	N° Projects	Capacity (MW)
1*	15	47
2**	3	45
3***	-	-

First auction for long term energy contracts



Date: January 2019

Term: 10 Years

Currency: COP

Target quantity: 3,300,000MWh per year



Voluntary participation for energy generators and utilities

Closed envelop auction

Two – pronged acution



Qualification parameters:

- Increase resiliency of the energy matrix
- Complement the energy matrix
- Increase energy security
- Lower carbon emissions

Reliability Charge Energy Auction



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Date: January 2019
Term: up to 20 Years
Currency: USD
Target quantity: 82,802,000MWh year.



Power plants are paid the Reliability Charge in monthly USD-equivalent payments for a 20 years period to be on standby to dispatch



Awarded plants are obliged to provide a fixed amount of energy to the network when the spot market price for electricity exceeds a threshold previously established by CREG called the Scarcity Price, and at a price at which the energy under the OEF obligation will be paid (Cap Price).





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Some Energy Developers in Colombia

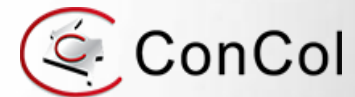
Energy Developers



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SIEMENS



TAIKU PALDIES ΕΥΧΑΡΙΣΤΩ TANAN благодаря
SHUKRAN DANKE TERMA KASSIH DÍKY
GRATIAS 감사합니다 MATONDO MAAKE NANNI DIAKUIU
HVALA GRACIAS
TÄNAN DIAKUIU MERCI MOCHCHAKKERAM DIOLCH
SPASIBO дякую FALEMINDERIT

THANK YOU

תודה ASANTE CHOKRANE ESKERRAK MISAOTRA GRAZIE
谢谢 OBRIGADO ARIGATO VINAKA
SULPÁY SPASIBO
DIOLCH ACIU DIOLCH WELALIN TAK KÖSZÖNÖM
EKELE NGIYABONGA MATUR NUWUN KIITOS DZIĘKUJĘ