RENEWABLES 2017
GLOBAL STATUS REPORT

REN21 Renewable Energy Policy Network for the 21st Century

7 June 2017
REN21 Secretariat
gsr@ren21.net

REN21 is a **global multi stakeholder network** dedicated to the rapid uptake of **renewable energy worldwide.**

NGOs:
CAN, CEEW, FER, GACC, GFSE, Greenpeace International, ICLEI, ISEP, MFC, SLoCaT, REI, WCRE, WFC, WRI, WWF

Science & Academia:
Fundacion Bariloche, IIASA, ISES, NREL, SANEDI, TERI,

International Organisations:
ADB, APERC, ECREEE, EC, GEF, IEA, IRENA, RCREEE, UNDP, UNEP, UNIDO, World Bank

Industry Associations:
ACORE, ALER, APREN, ARE, CREIA, CEC, EREF, GOGLA, GSC, GWEC, IGA, IHA, IREF, RES4MED, WBA, WWEA

National Governments:
Afghanistan, Brazil, Denmark, Germany, India, Norway, South Africa, Spain, UAE, UK, USA

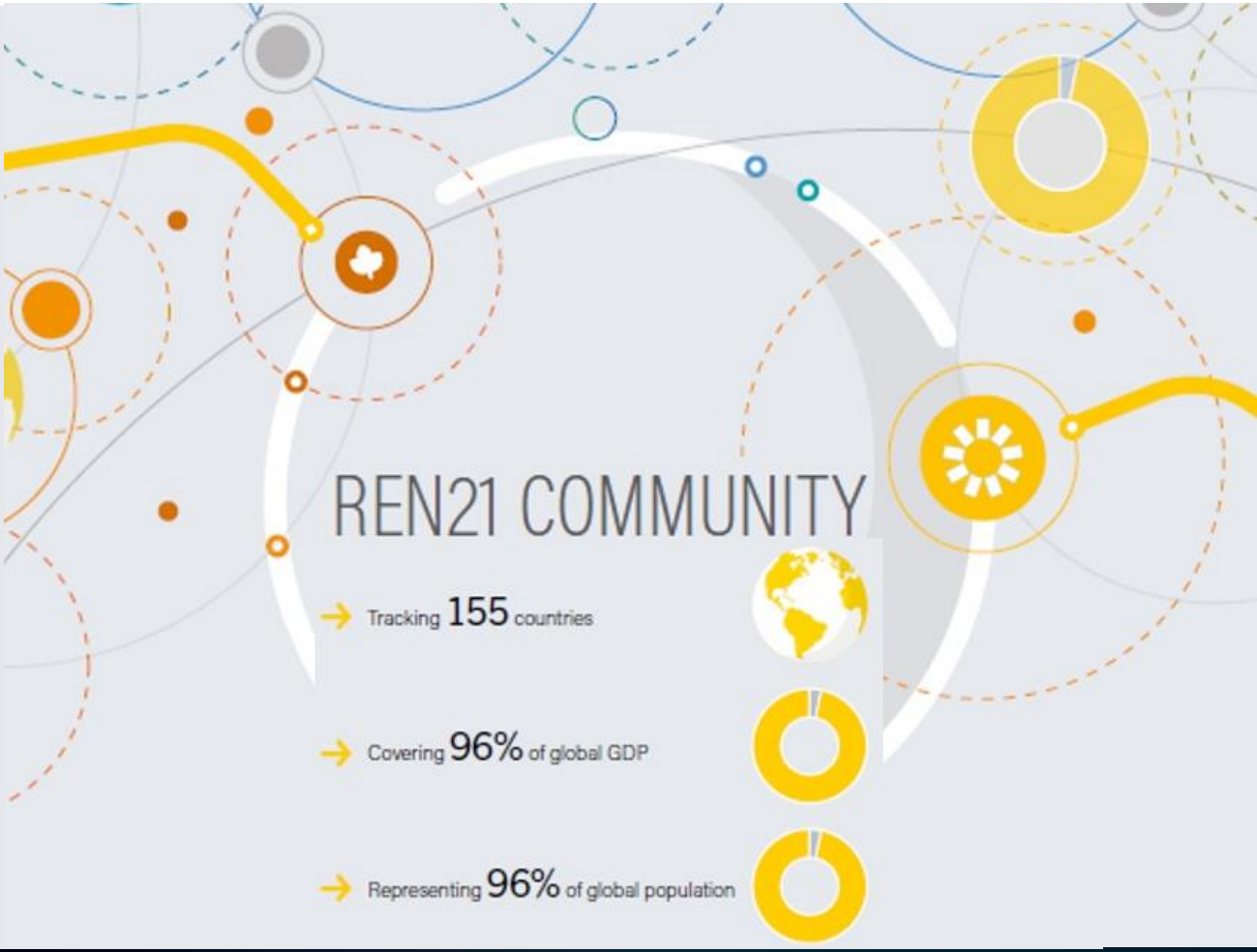
REN21 Renewables 2017 Global Status Report

- **The report features:**
  - Global Overview
  - Market & Industry Trends
  - Distributed Renewable Energy for Energy Access
  - Investment Flows
  - Policy Landscape
  - NEW: Enabling Technologies and Energy Systems Integration
  - Energy Efficiency
  - Feature: Deconstructing Baseload

REN21 Community

GSR Network:

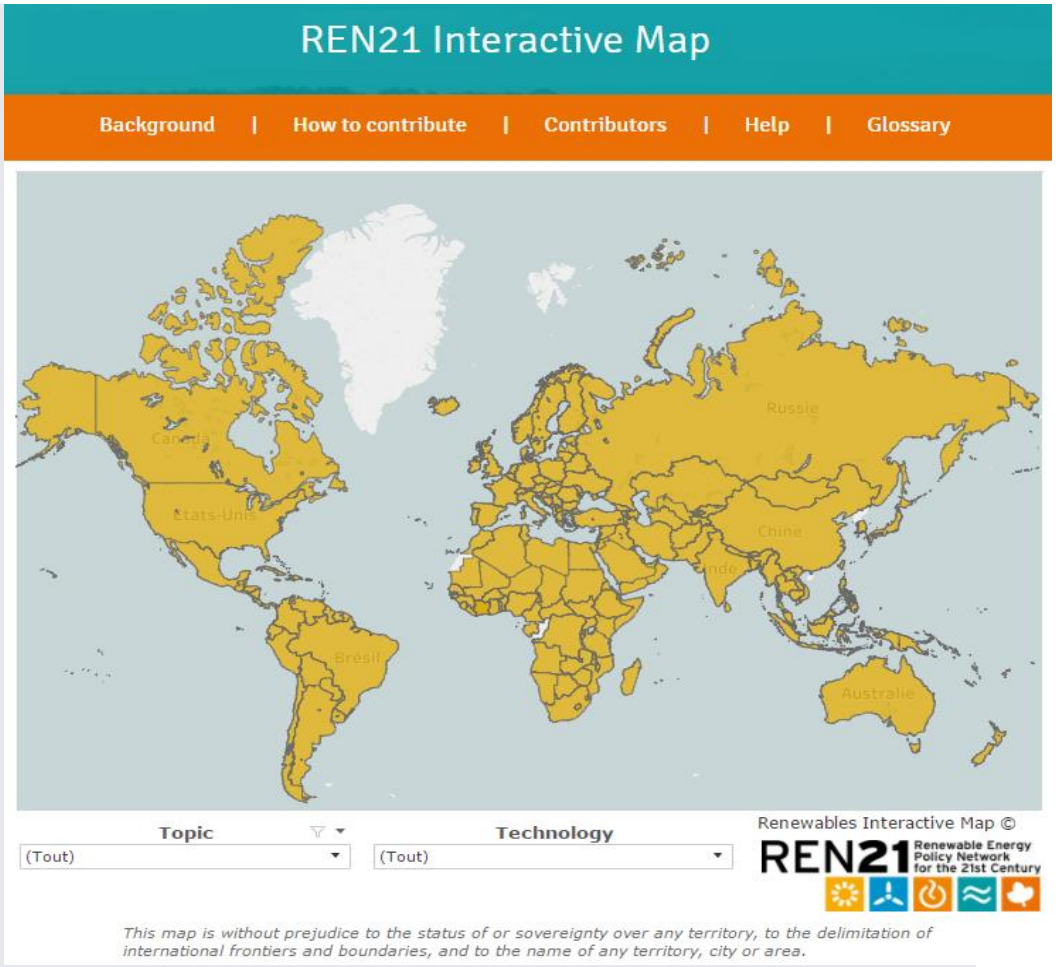
- Over **800** active contributors and reviewers
- Tracking **155** countries
- Covering **96%** of global GDP
- Representing **96%** of global population



REN21 Renewables Interactive Map

- Research tool for tracking the development of renewable energy worldwide
- Complements perspectives and findings of REN21's **Global and Regional** Status Reports with **infographics** and detailed, exportable **data packs**

www.ren21.net/map



Another extraordinary year for renewable energy

Total global capacity was **up 9%** compared to 2015, to more than **2,016 GW** at year's end (**920 GW** not including hydro)

- → Solar PV - **47%** of newly installed renewable power capacity in 2016
- → Wind - **34%**
- → Hydropower - **15.5%**

		2015	2016
INVESTMENT			
New investment (annual) in renewable power and fuels[1]	billion USD	312.2	**241.6**
POWER			
Renewable power capacity (total, not including hydro)	GW	785	**921**
Renewable power capacity (total, including hydro)	GW	1,856	**2,017**
Hydropower capacity[2]	GW	1,071	**1,096**
Bio-power capacity	GW	106	**112**
Bio-power generation (annual)	TWh	464	**504**
Geothermal power capacity	GW	13	**13.5**
Solar PV capacity	GW	228	**303**
Concentrating solar thermal power capacity	GW	4.7	**4.8**
Wind power capacity	GW	433	**487**
HEAT			
Solar hot water capacity[3]	GW_{th}	435	**456**
TRANSPORT			
Ethanol production (annual)	billion litres	98.3	**98.6**
Biodiesel production (annual)	billion litres	30.1	**30.8**

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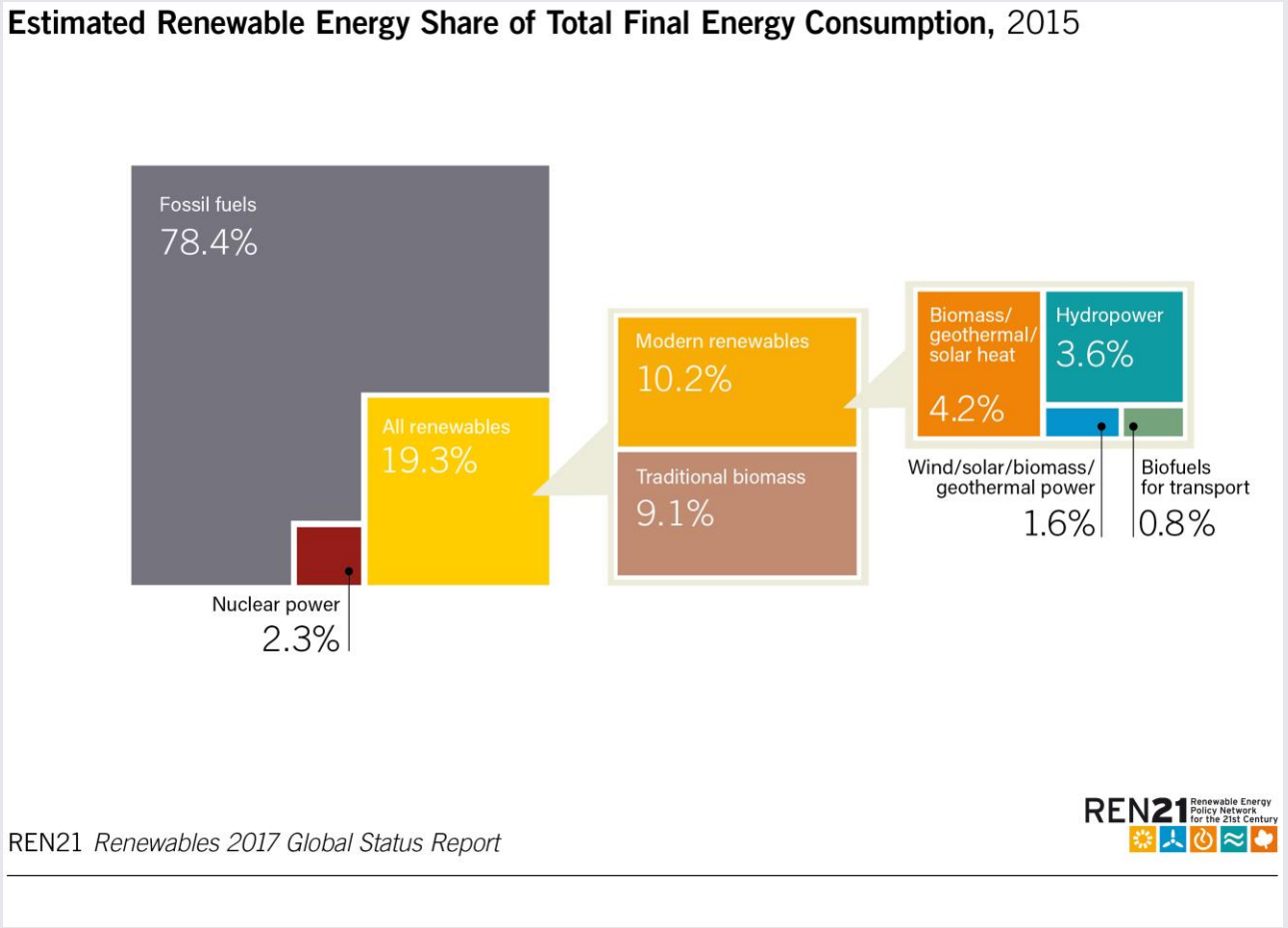
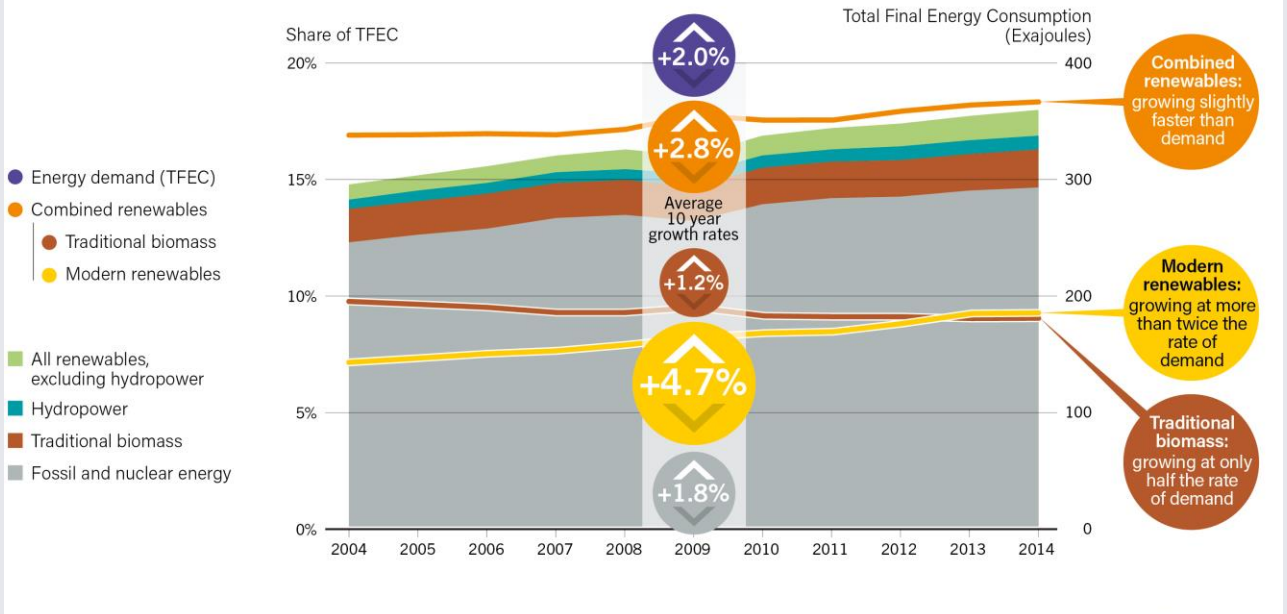
Renewable Energy in the World

As of 2015, renewable energy provided an estimated **19.3%** of global final energy consumption



Renewable Energy in the World

Growth in Global Renewable Energy Compared to Total Final Energy Consumption, 2004-2014



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Source: based on IEA World Energy Balances, 2016.

Renewable Energy “Champions”

Annual Investment/Net Capacity Additions/Production in 2016

	1	2	3	4	5
Investment in renewable power and fuels (not including hydro > 50 MW)	**China**	United States	United Kingdom	Japan	Germany
Investment in renewable power and fuels per unit GDP[1]	**Bolivia**	Senegal	Jordan	Honduras	Iceland
Geothermal power capacity	**Indonesia**	Turkey	Kenya	Mexiko	Japan
Hydropower capacity	**China**	Brazil	Ecuador	Ethopia	Vietnam
Solar PV capacity	**China**	United States	Japan	India	United Kingdom
Concentrating solar thermal power (CSP) capacity[2]	**South Africa**	China	–	–	–
Wind power capacity	**China**	United States	Germany	India	Brazil
Solar water heating capacity	**China**	Turkey	Brazil	India	United States
Biodiesel production	**United States**	Brazil	Argentina/Germany/Indonesia		
Fuel ethanol production	**United States**	Brazil	China	Canada	Thailand

Renewable Energy "Champions"

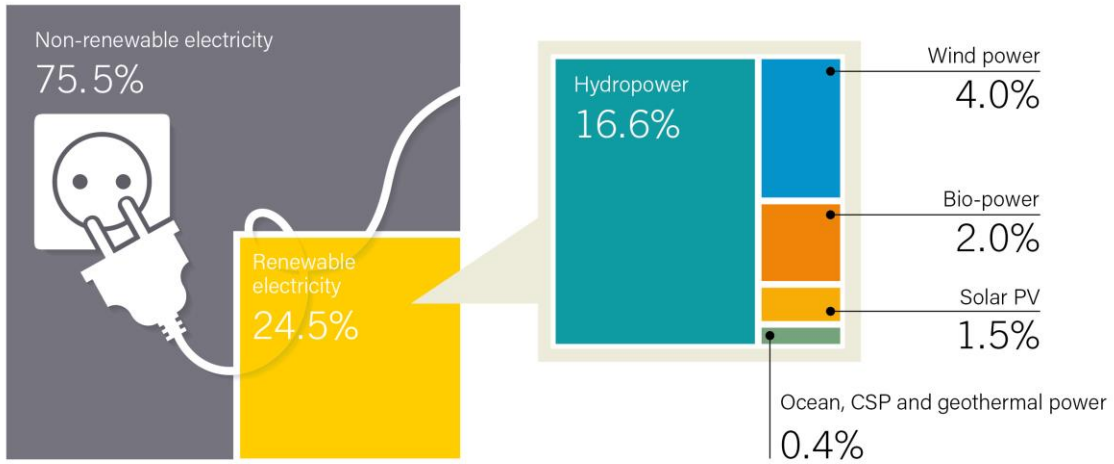
Total capacity or generation as of end-2016

	1	2	3	4	5
POWER					
Renewable power (incl. hydro)	**China**	United States	Brazil	Germany	Canada
Renewable power (not incl. hydro)	**China**	United States	Germany	Japan	India
Renewable power capacity *per capita* (among top 20, not including hydro[3])	**Iceland**	Denmark	Sweden/ Germany	Spain/Finland	–
Biopower generation	**United States**	China	Germany	Brazil	Japan
Geothermal power capacity	**United States**	Philippines	Indonesia	New Zealand	Mexico
Hydropower capacity[4]	**China**	Brazil	United States	Canada	Russian Federat.
Hydropower generation[4]	**China**	Brazil	Canada	United States	Russian Federat.
CSP	**Spain**	United States	India	South Africa	Morocco
Solar PV capacity	**China**	Japan	Germany	United States	Italy
Solar PV capacity *per capita*	**Germany**	Japan	Italy	Belgium	Australia/Greece
Wind power capacity	**China**	United States	Germany	India	Spain
Wind power capacity *per capita*	**Denmark**	Sweden	Germany	Ireland	Portugal
HEAT					
Solar water heating collector capacity[5]	**China**	United States	Turkey	Germany	Brazil
Solar water heating collector capacity *per capita*[5]	**Barbados**	Austria	Cyprus	Israel	Greece
Geothermal heat capacity[6]	**China**	Turkey	Japan	Iceland	India
Geothermal heat capacity *per capita*[6]	**Iceland**	New Zealand	Hungary	Turkey	Japan

Power Sector

By year's end, renewables comprised an estimated **30%** of the world's power generating capacity and **24.5%** of global electricity demand

Estimated Renewable Energy Share of Global Electricity Production, End-2016



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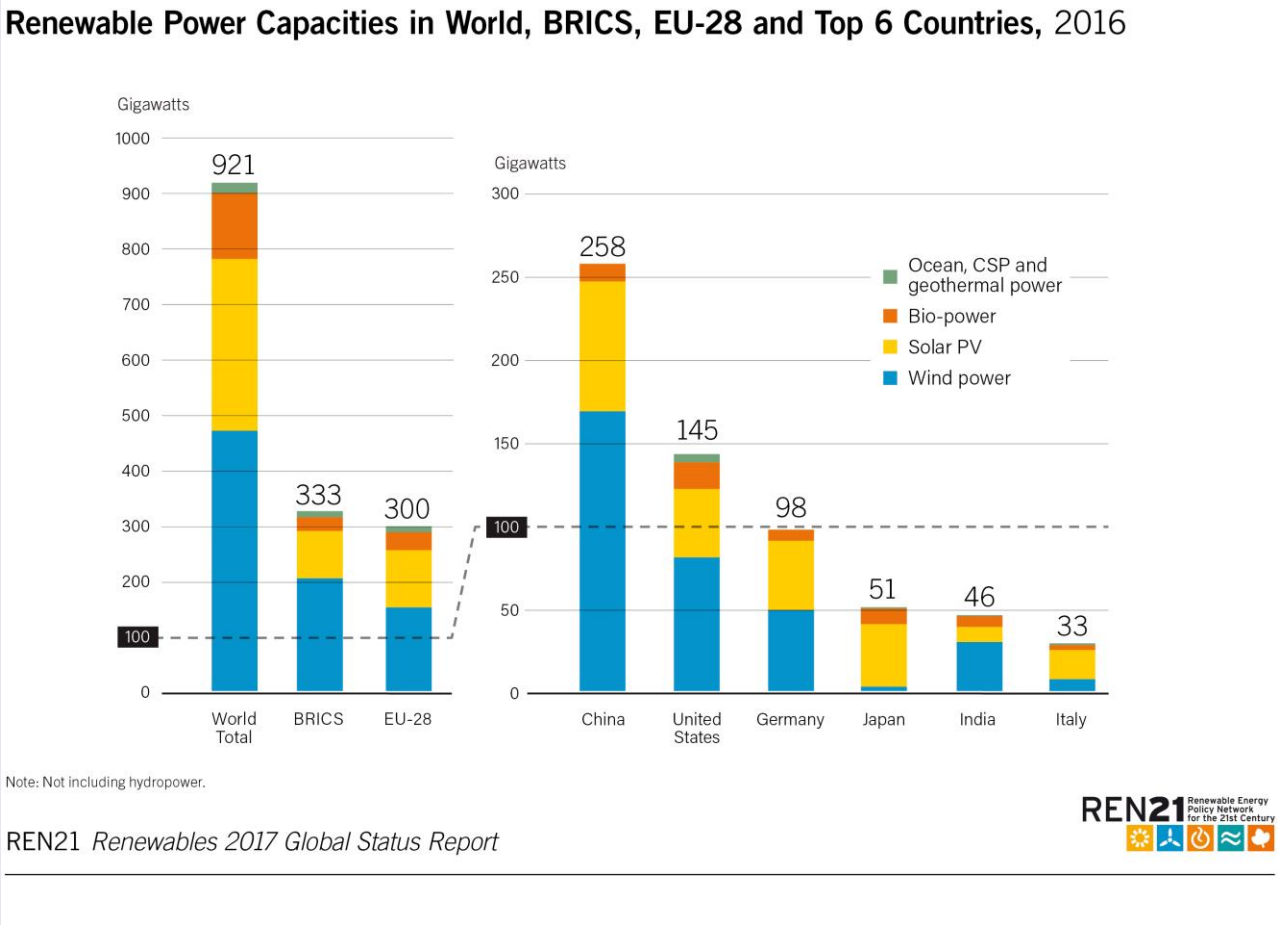
Power Sector

By the end of 2016, **China** was home to more than **one-quarter** of the world's renewable power capacity



Heating and Cooling

Modern renewable energy supplies approx. **9%** of total global heat demand.

In 2016, the vast majority of renewable heat continued to be supplied by **biomass**, with smaller contributions from **solar thermal** and **geothermal** energy.

Deployment of renewable technologies in this market continued to be constrained by factors such as comparatively **low fossil fuel prices** and a relative **lack of policy support.**

Transport

In 2016, **liquid biofuels** provided around **4%** of world road transport fuels, which account for the majority of transport energy use.

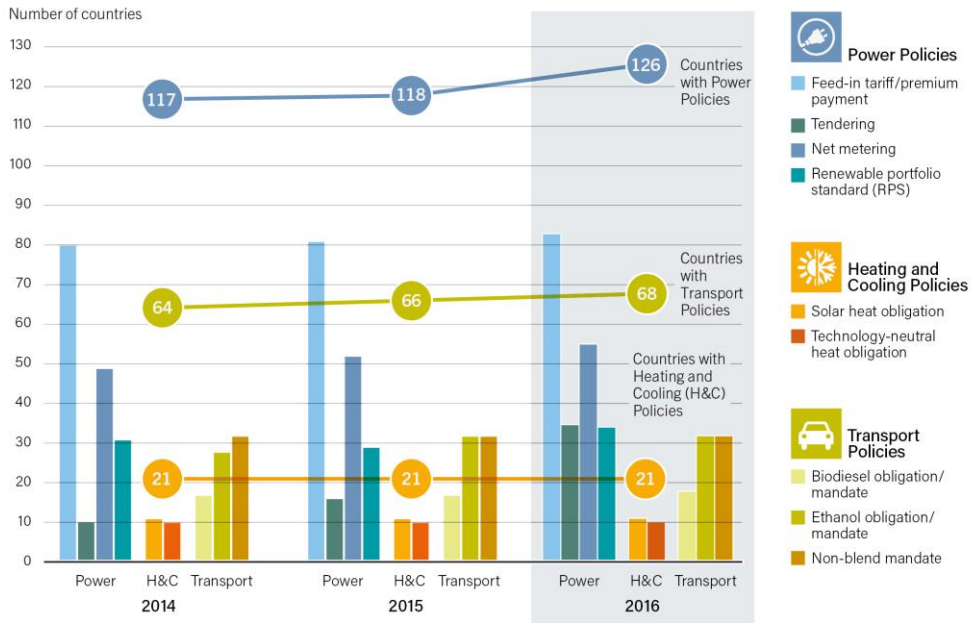
Biogas use in transport grew substantially in the **United States** and continued to gain shares of the transportfuel mix in Europe.

Further **electrification** of the transport sector has the potential to create a **new market** for renewable energy and to facilitate the integration of **variable renewable energy**.

Renewable Energy Policy Landscape

- **176** countries had renewable energy **targets**
- **126** countries had power policies
- **68** countries had transport policies
- **21** countries had heating and cooling policies

Number of Renewable Energy Regulatory Incentives and Mandates, by Type, 2014-2016



Note: Figure does not show all policy types in use. In many cases countries have enacted additional fiscal incentives or public finance mechanisms to support renewable energy. Heating and cooling policies do not include renewable heat FITs (i.e., in the United Kingdom). Countries are considered to have policies when at least one national or state/provincial-level policy is in place. A country is counted a single time if it has one or more national and/or state/provincial-level policies. Some transport policies include both biodiesel and ethanol; in this case, the policy is counted once in each category (biodiesel and ethanol).Tendering policies are presented in a given year if a jurisdiction has held at least one tender during that year.

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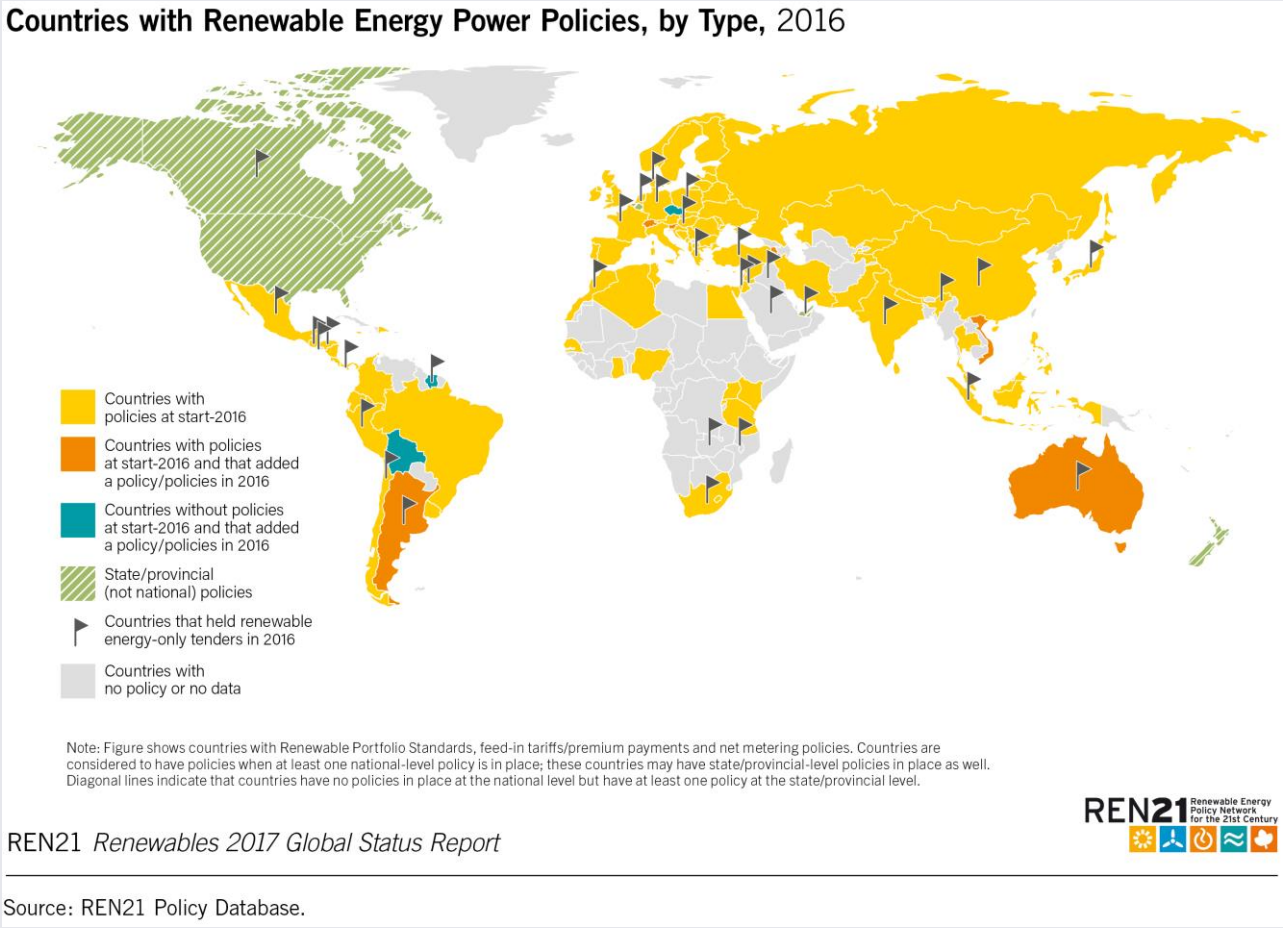
Source: REN21 Policy Database.

Renewable Energy Policy Landscape

Auctions are the most rapidly expanding form of renewable energy policy support.

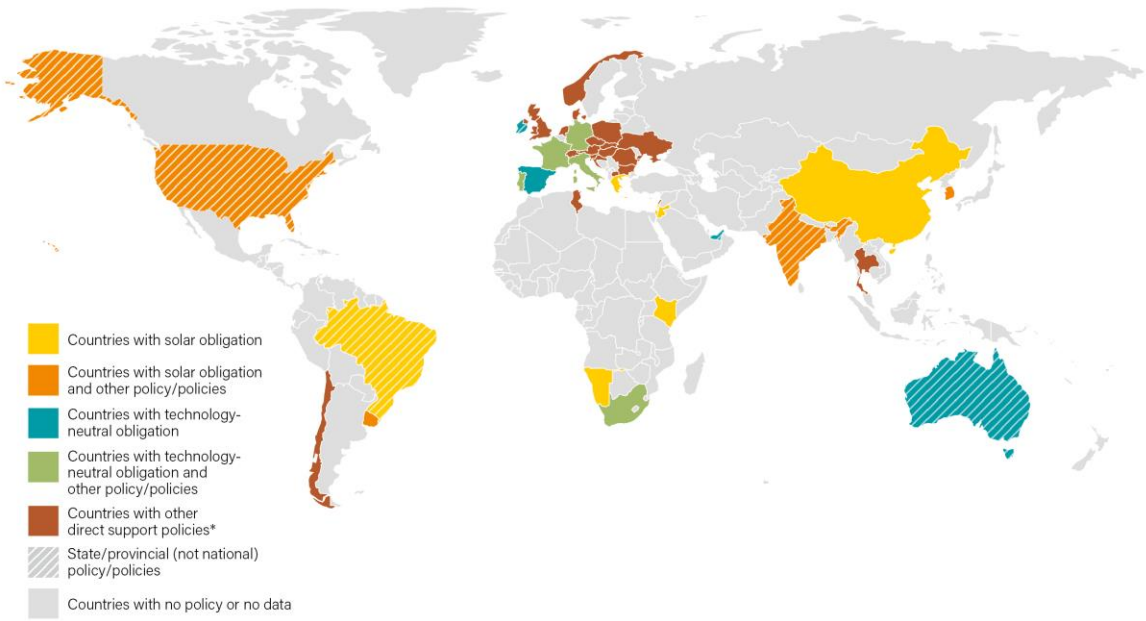
Renewable energy auctions **held in 34 countries** in 2016 – more than double the year before



Renewable Energy Policy Landscape

Most support for renewable heating and cooling was provided through **financial incentives** (grants, loans, rebates, tax incentives)

Countries with Renewable Energy Heating and Cooling Policies, 2016



* Indicates countries with other policies that directly support renewable heating and cooling technologies, including rebates, tax credits, FITs, tenders, etc.

Note: Figure shows countries with direct support regulatory policies and financial incentives for renewable heating and cooling technologies. Countries are considered to have policies when at least one national-level policy is in place; these countries may have state/provincial-level policies in place as well. Diagonal lines indicate that countries have no policies in place at the national level but have at least one policy at the state/provincial level.

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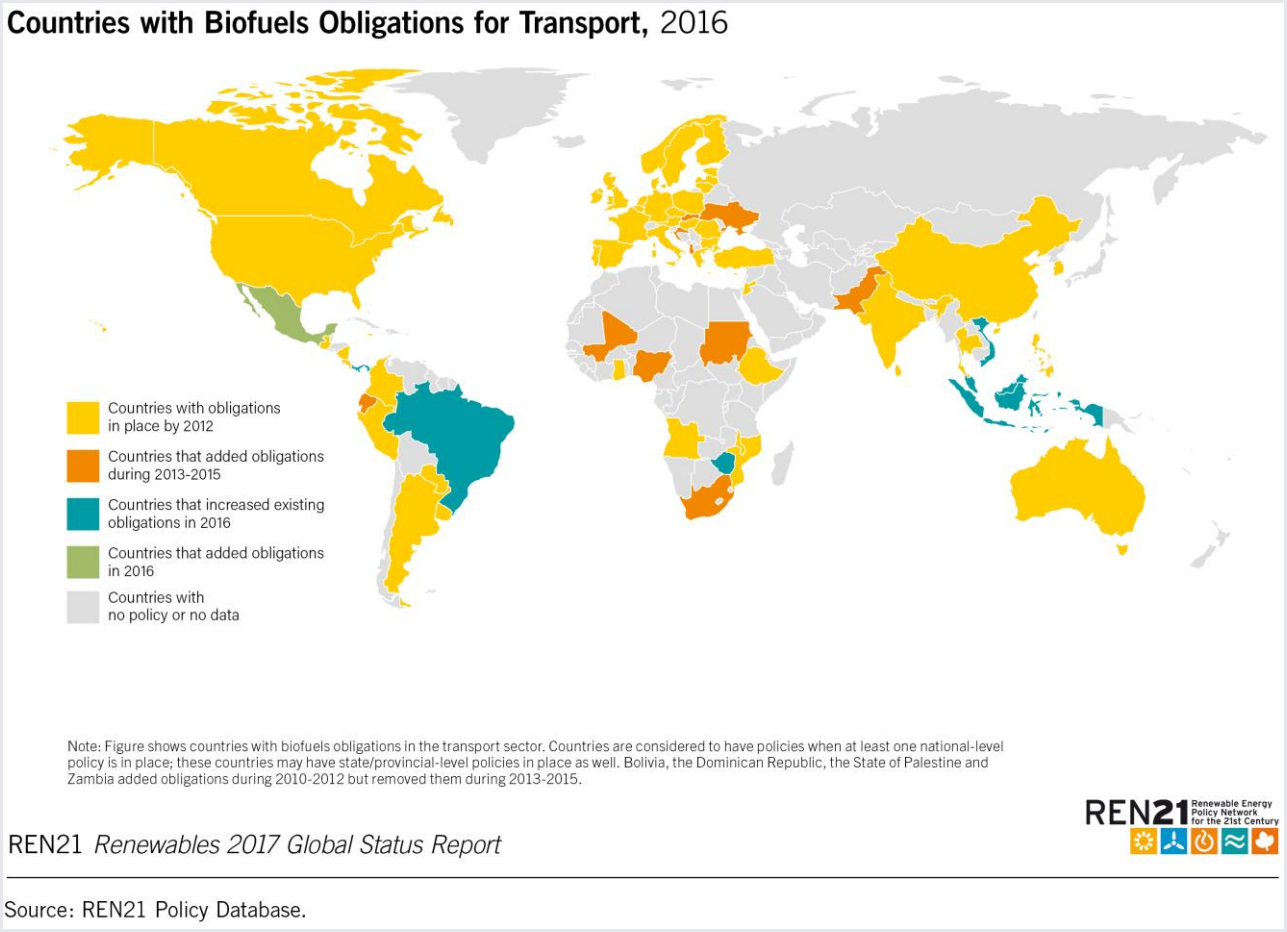
Source: REN21 Policy Database.

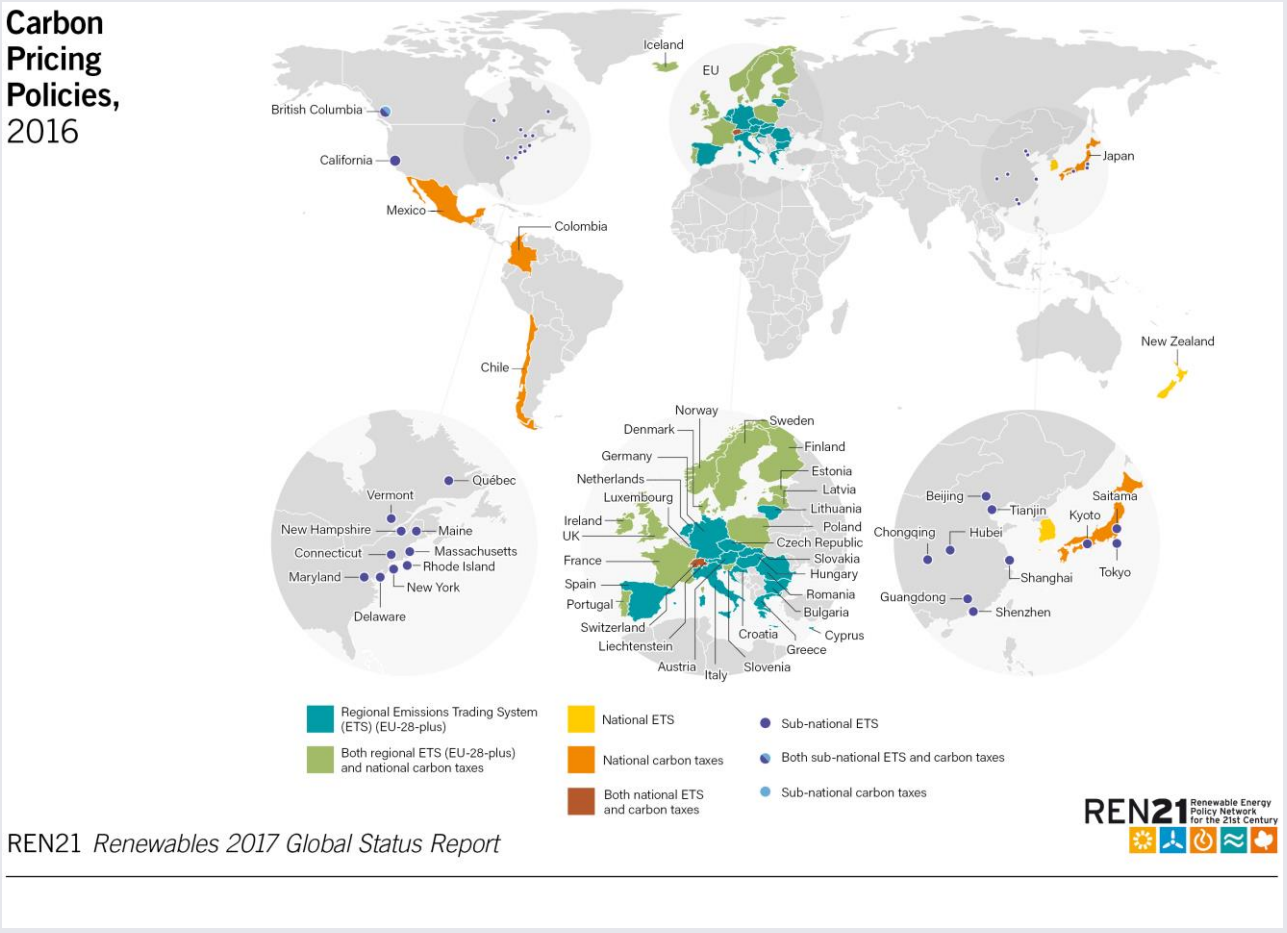
Renewable Energy Policy Landscape

Biofuel blend mandates and financial support for **biofuel blending programmes** are most common forms of support for renewable energy in transport



Carbon Pricing Policies

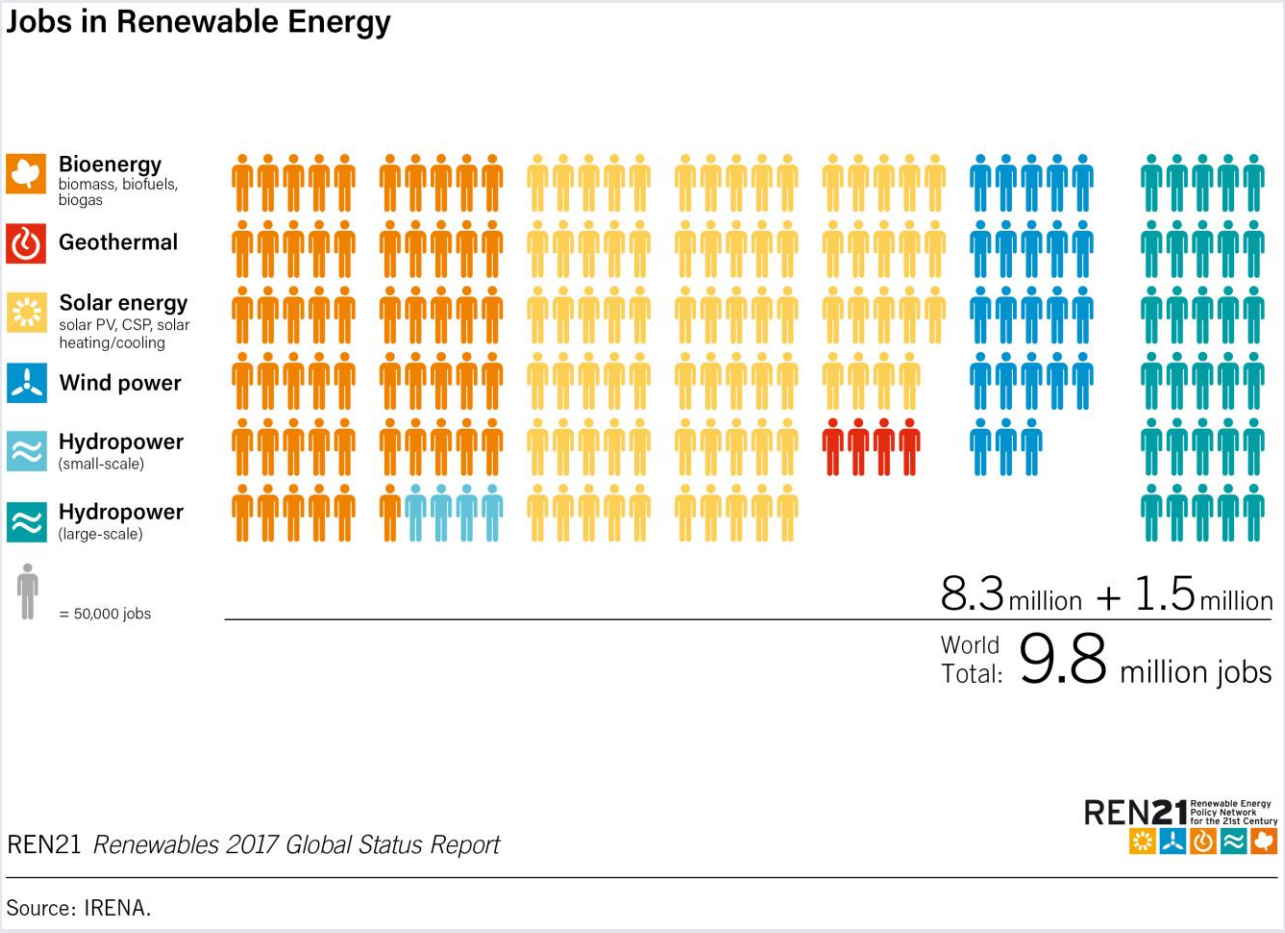
Carbon pricing policies were in place in **57 jurisdictions** worldwide in 2016



Jobs in Renewable Energy

The renewable energy sector employed

9.8 million people in 2016 - a **1.1% increase** over 2015

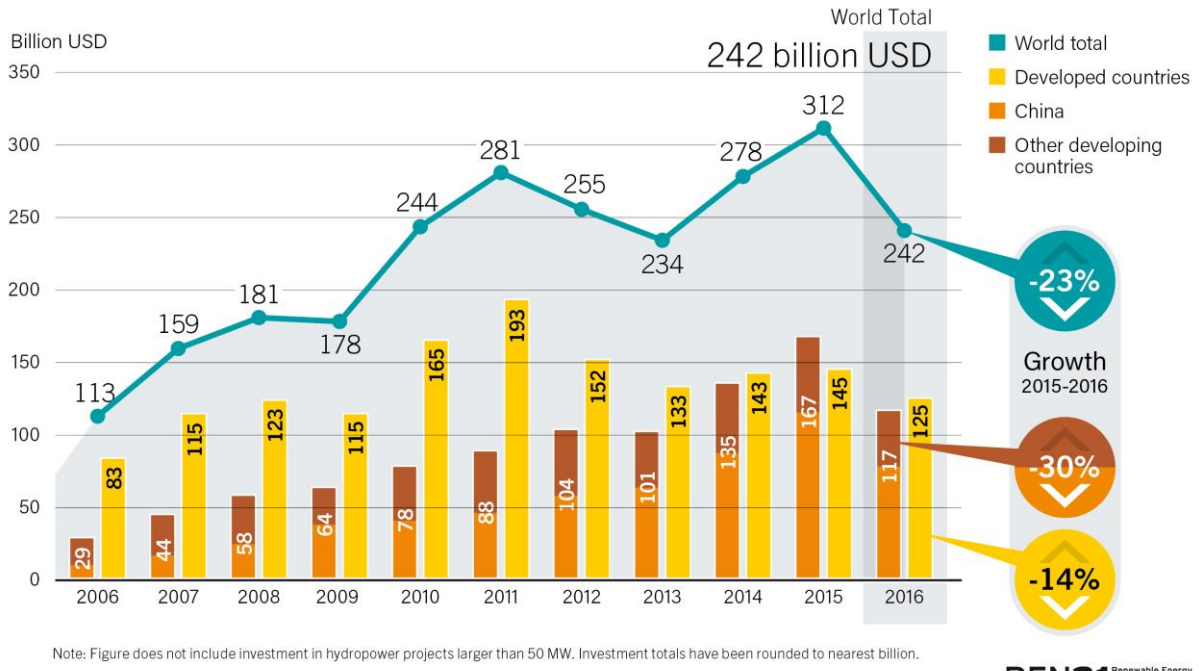


Global Investment in Renewable Energy

Global new investment in renewables was **USD 241.6 billion** in 2016

For the fifth consecutive year, **investment in new renewable power** capacity was roughly **double that in fossil fuel** capacity.

Global New Investment in Renewable Power and Fuels, Developed, Emerging and Developing Countries, 2006-2016



Note: Figure does not include investment in hydropower projects larger than 50 MW. Investment totals have been rounded to nearest billion.

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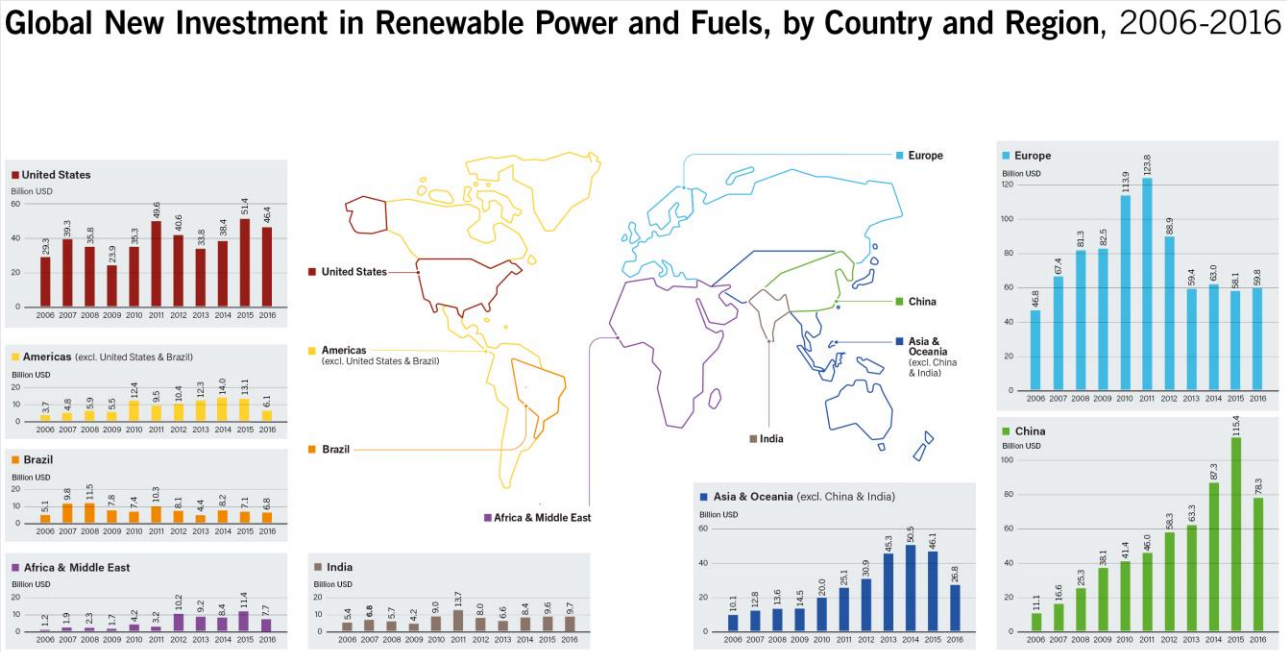
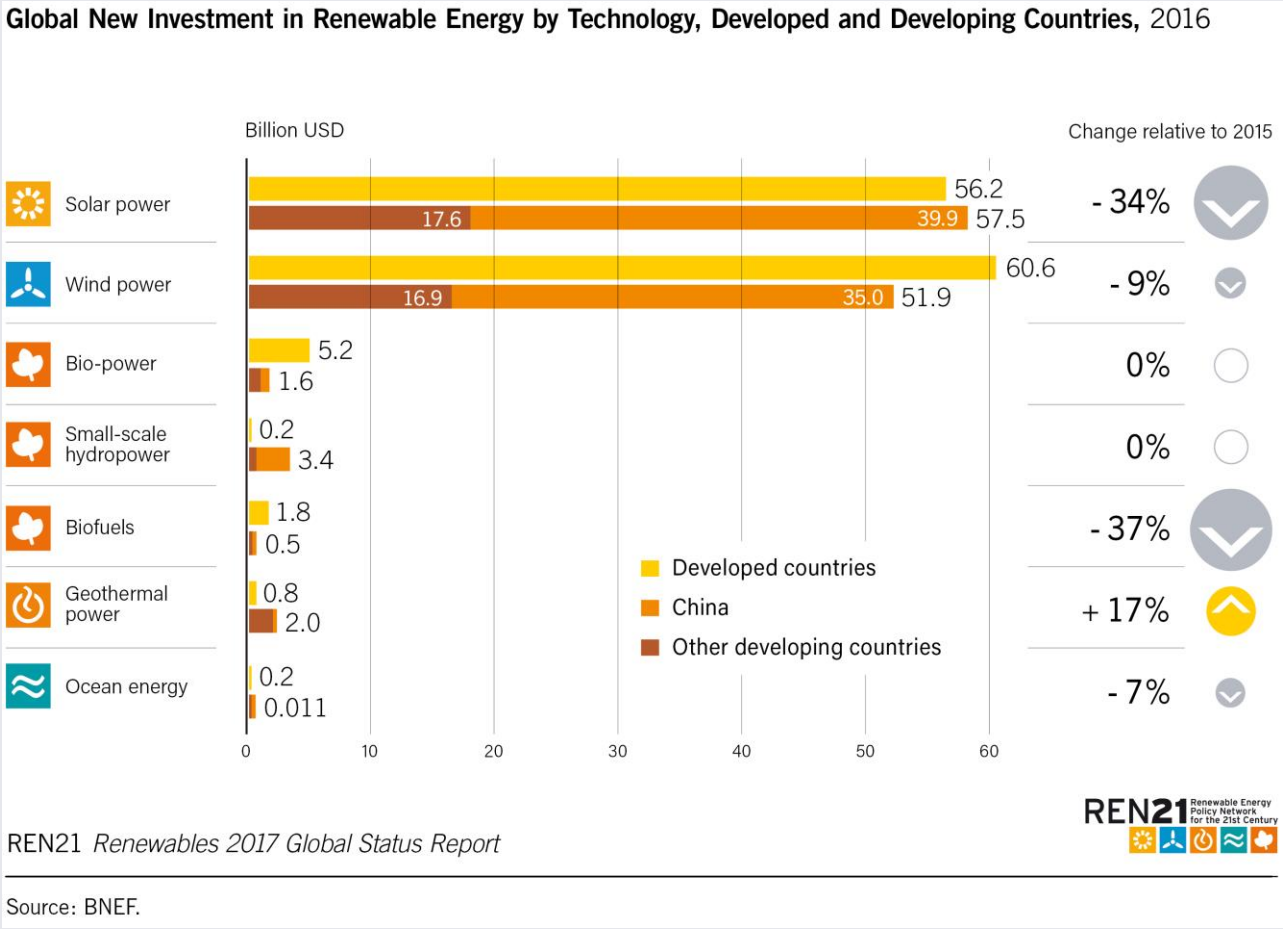
Source: BNEF.

Global Investment in Renewable Energy



Global Investment in Renewable Energy

Solar and wind power continue to lead for money committed during 2016, each accounting for roughly **47%** of total investment

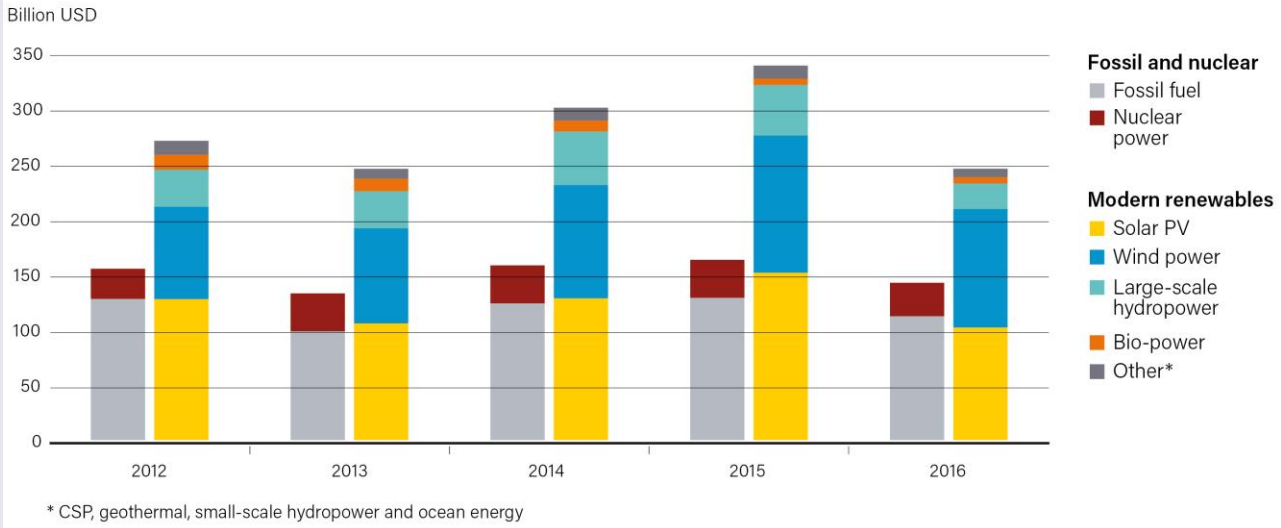


Global Investment in Renewable Energy

An estimated **USD 249.8 billion** was committed to constructing new renewable power plants, compared to:

- Fossil fuel capacity: USD 113.8 billion
- Nuclear capacity: USD 30 billion

Global Investment in Power Capacity, by Type (Renewable, Fossil Fuel and Nuclear Power), 2012-2016



* CSP, geothermal, small-scale hydropower and ocean energy

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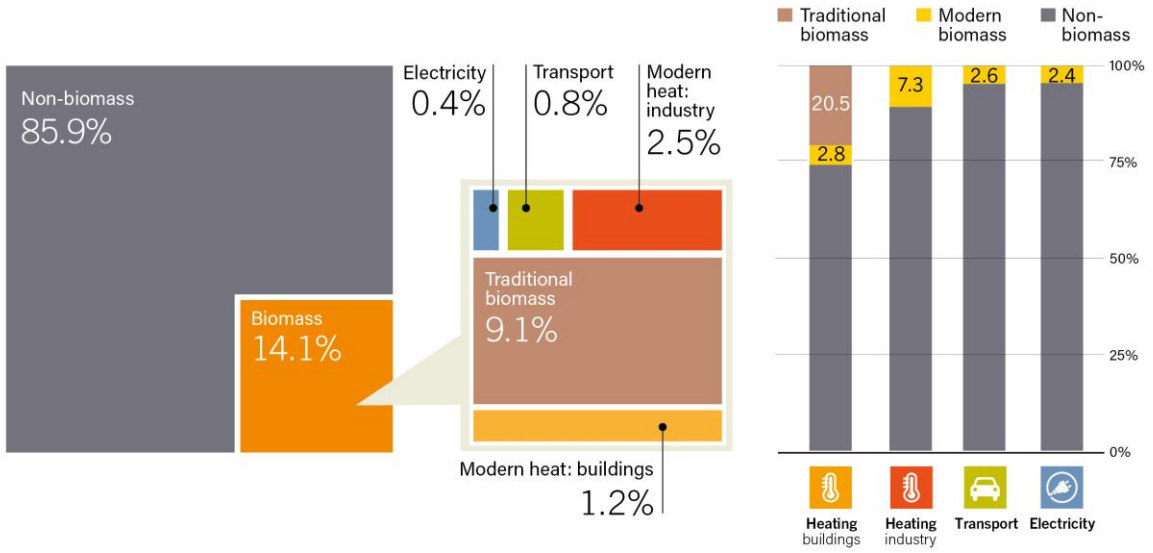
Source: BNEF.

Biomass Energy

Biomass accounted for **14.1%** of total final energy consumption

Shares of Biomass in Total Final Energy Consumption and in Final Energy Consumption, by End-use Sector, 2015



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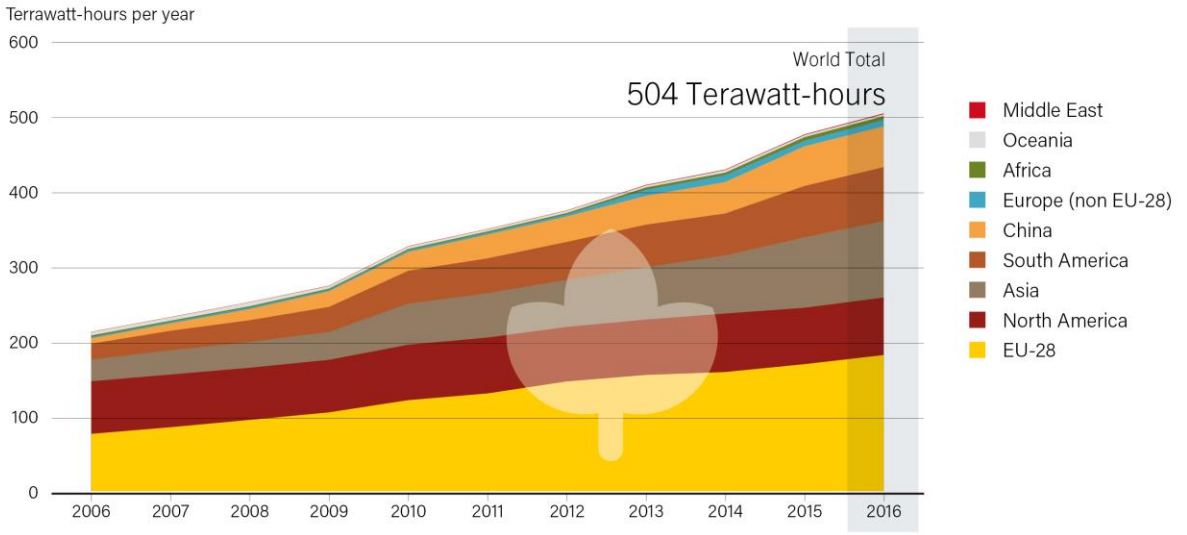
Biomass Energy

Global bio-power capacity increased 6% in 2016 to **112 GW**

Generation increased 6% to **504 TWh**

Global Bio-Power Generation, by Region, 2006-2016



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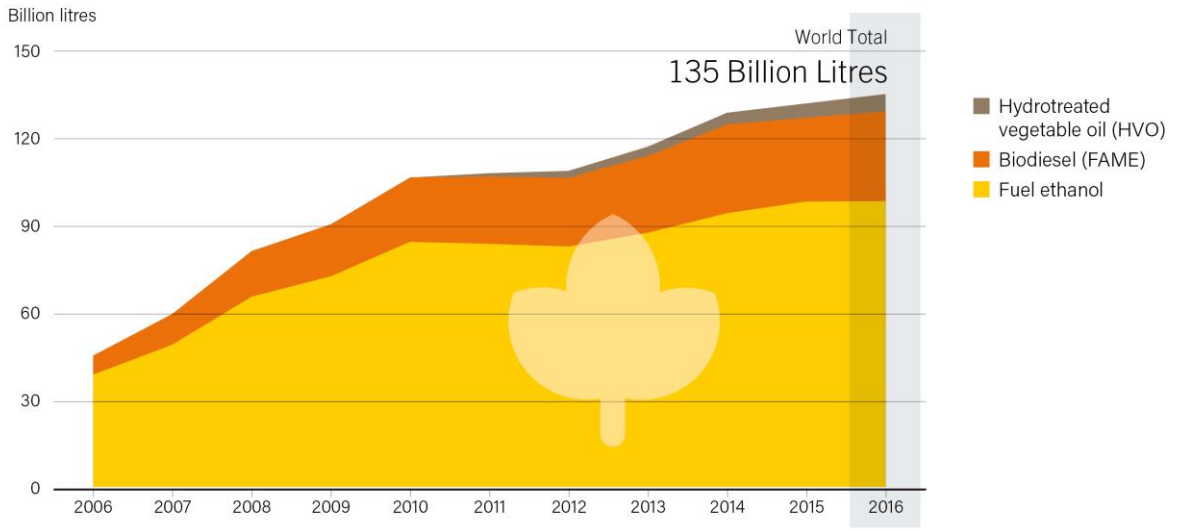
Biomass Energy

Global biofuels production increased **2%** to **135 billion litres**

The United States and Brazil accounted for **70%** of all biofuels between them

Global Trends in Ethanol, Biodiesel and HVO Production, 2006-2016



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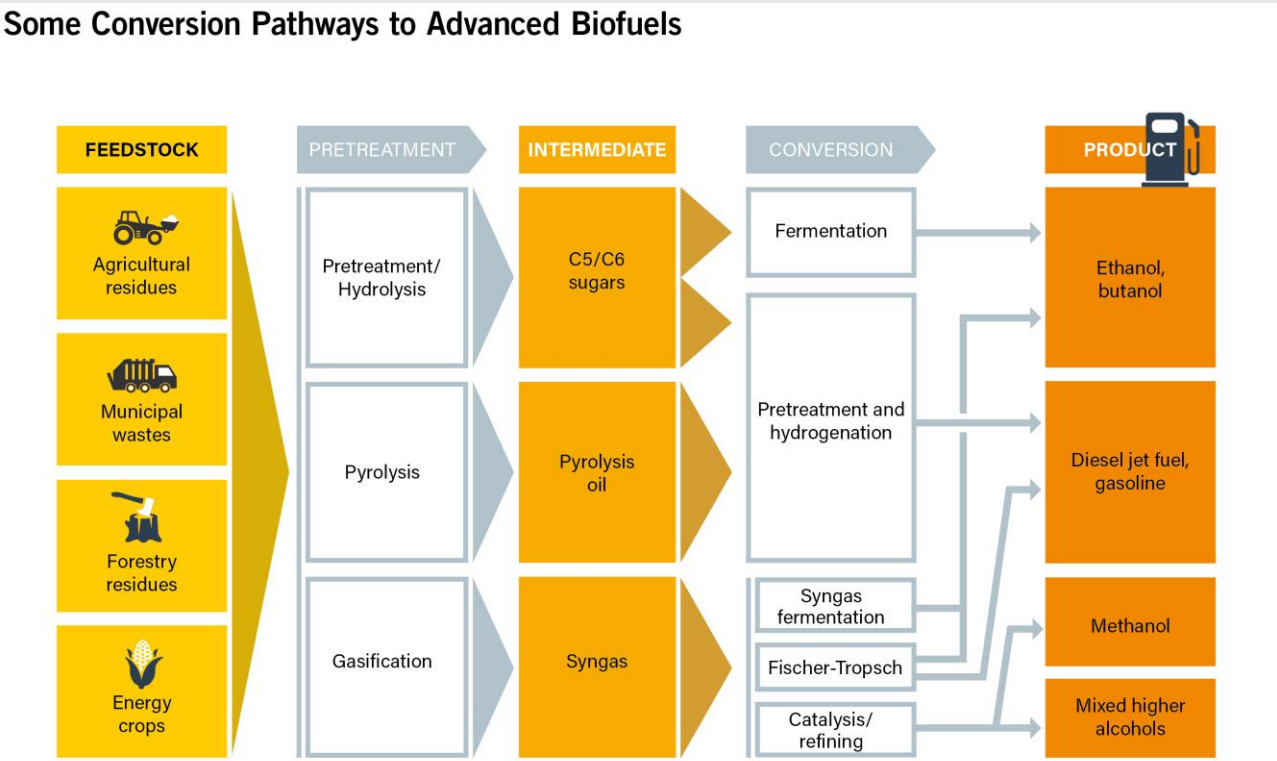
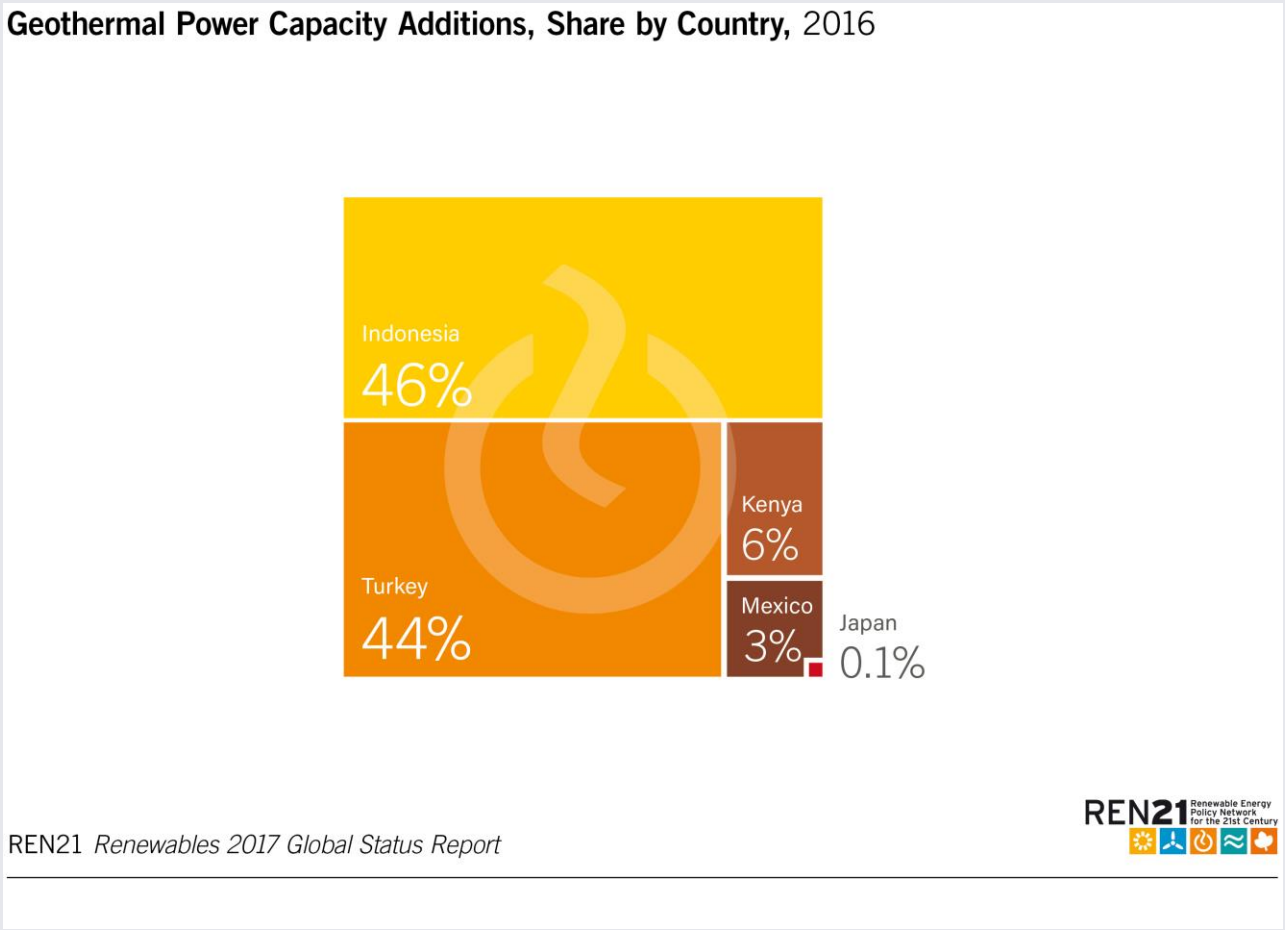
Biomass Energy



Geothermal Power and Heat

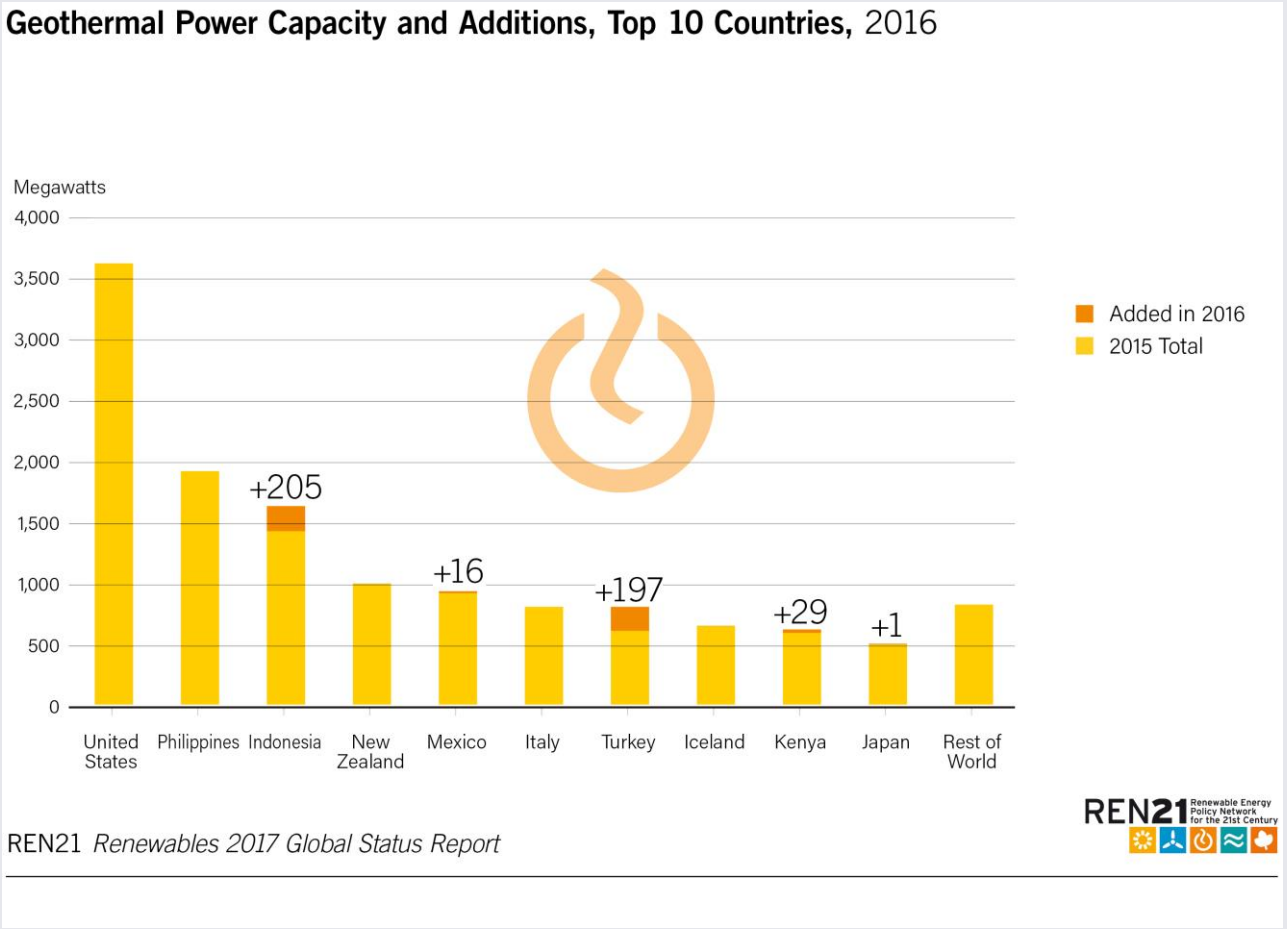
0.4 GW of new geothermal power generating capacity came online in 2016, bringing the global total to an estimated **13.5 GW**

Indonesia and **Turkey** were in the lead for new installations



Geothermal Power and Heat

The United States had the most geothermal power generating capacity at the end of 2016 with **3.6 GW**

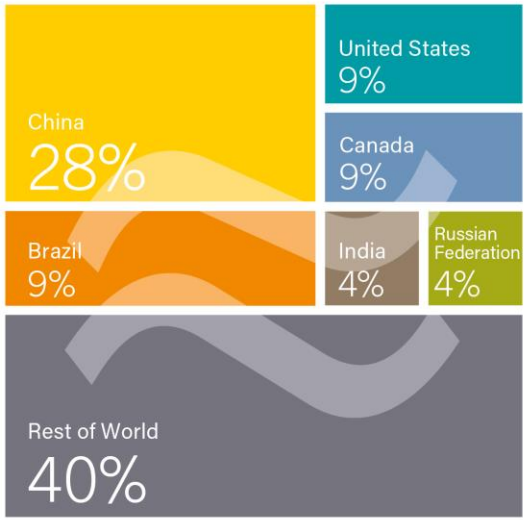


Hydropower

Total global hydropower capacity increased to **1,096 GW**

Global hydropower generation reached **4,102 TWh** – up by 3.2% over 2015

Hydropower Global Capacity, Shares of Top 6 Countries and Rest of World, 2016



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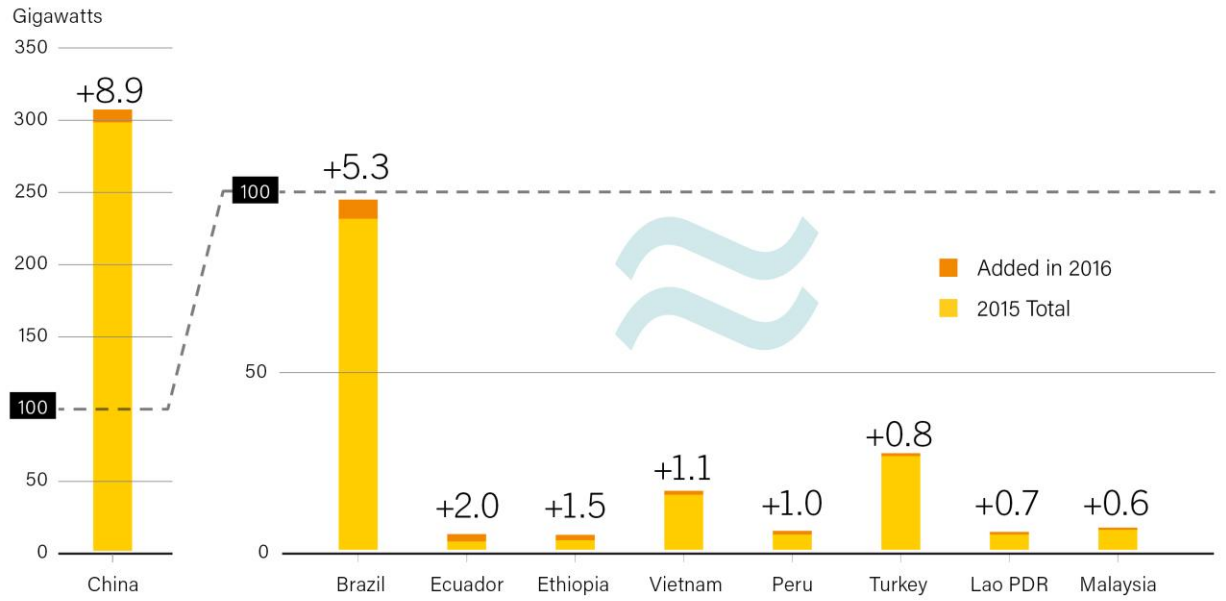
Hydropower

25 GW of new hydropower capacity was commissioned in 2016

More than **one-third** of new capacity commissioned in **China**

Hydropower Capacity and Additions, Top 9 Countries for Capacity Added, 2016



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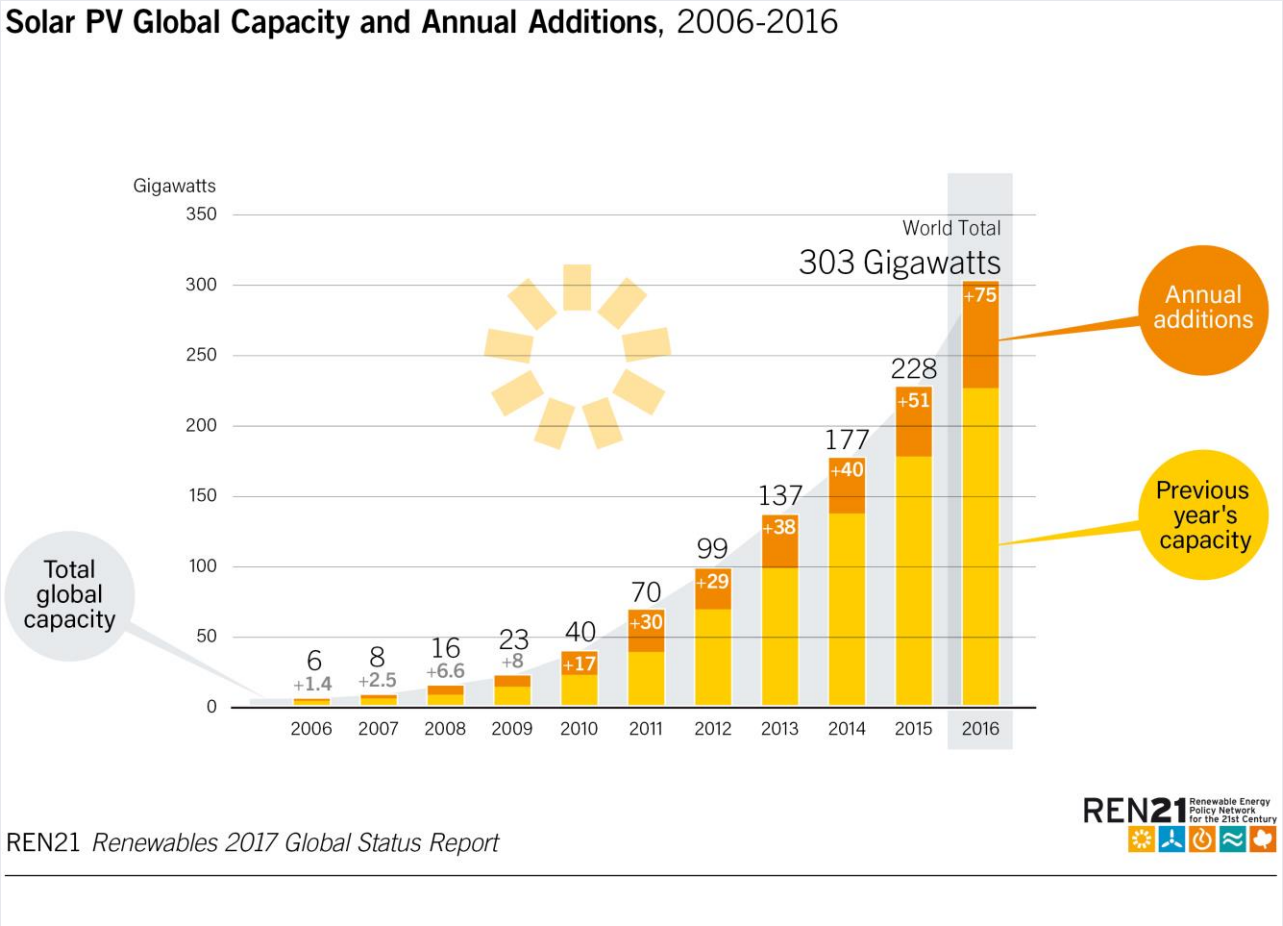
Source: IEA PVPS.

Solar PV

75 GW of solar PV capacity was added worldwide

Global solar PV capacity totaled **303 GW**

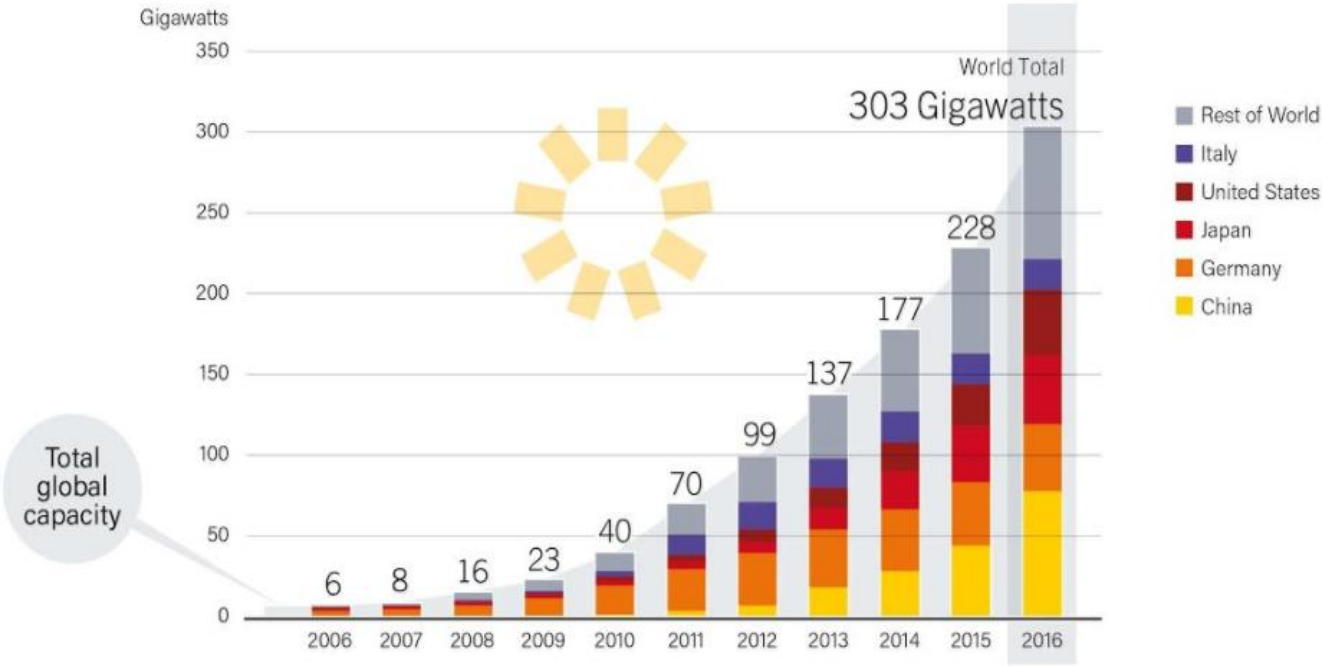


Solar PV

By end-2016:

- Every continent had installed at least **1 GW**
- At least 24 countries had **1 GW** or more of capacity
- At least 114 countries had more than **10 MW**

Solar PV Global Capacity, by Country and Region, 2006-2016



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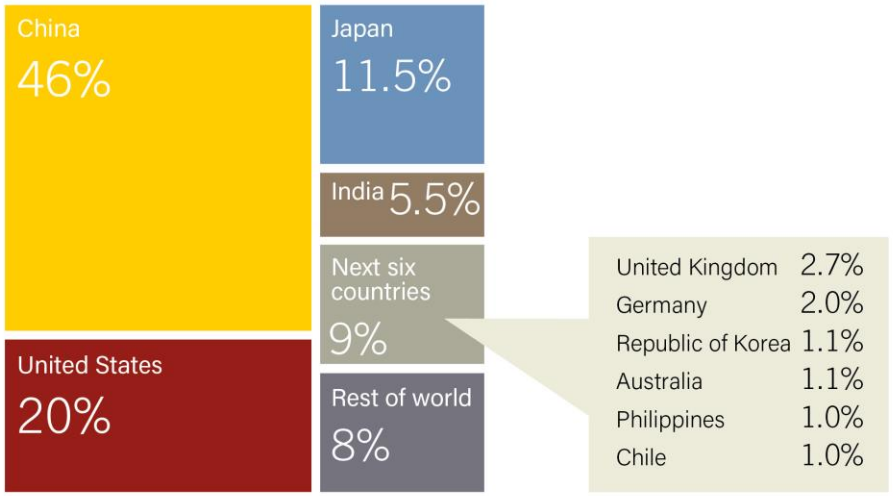
Solar PV

Top 5 markets for solar PV accounted for about **85%** of additions

- China
- United States
- Japan
- India
- United Kingdom

Solar PV Global Capacity Additions, Shares of Top 10 Countries and Rest of World, 2016



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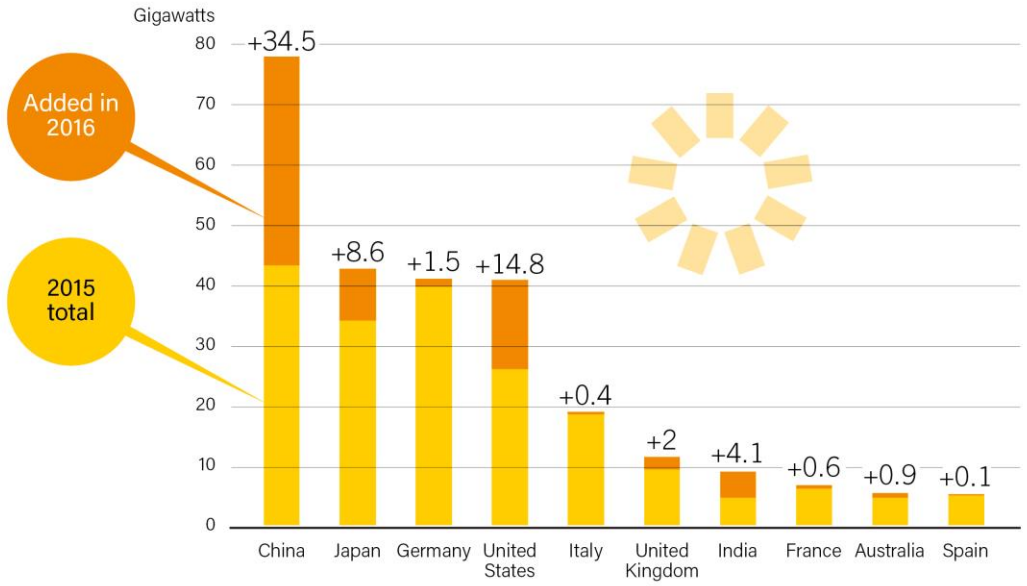
Solar PV

China added **34.5 GW** (up 126% over 2015), increasing its total solar PV capacity 45% to **77.4 GW**, far more than that of any other country

Solar PV Capacity and Additions, Top 10 Countries, 2016



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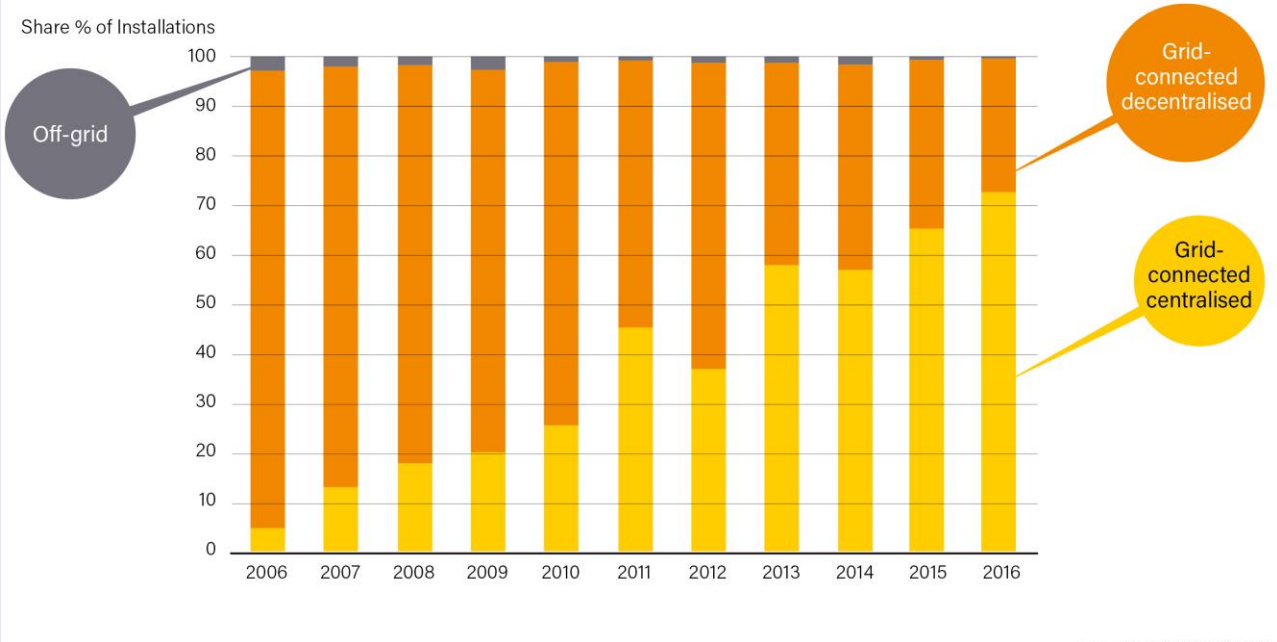
Solar PV

Demand is expanding rapidly for **off-grid solar PV**, but capacity of **grid-connected systems** is rising more quickly

Solar PV Global Additions, Shares of Grid-Connected and Off-Grid Installations, 2006-2016



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Source: IEA PVPS.

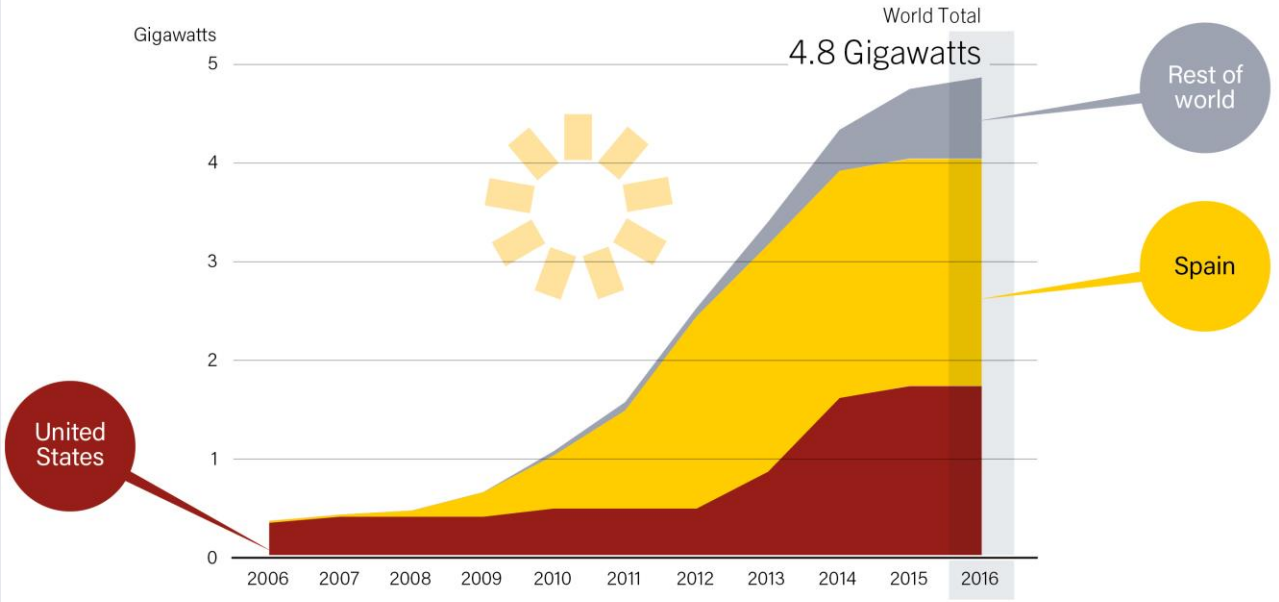
Concentrating Solar Thermal Power (CSP)

110 MW of capacity came online in 2016

Total global capacity: **4.8 GW**

900 MW expected to enter operation during the course of 2017

Concentrating Solar Thermal Power Global Capacity, by Country and Region, 2006-2016



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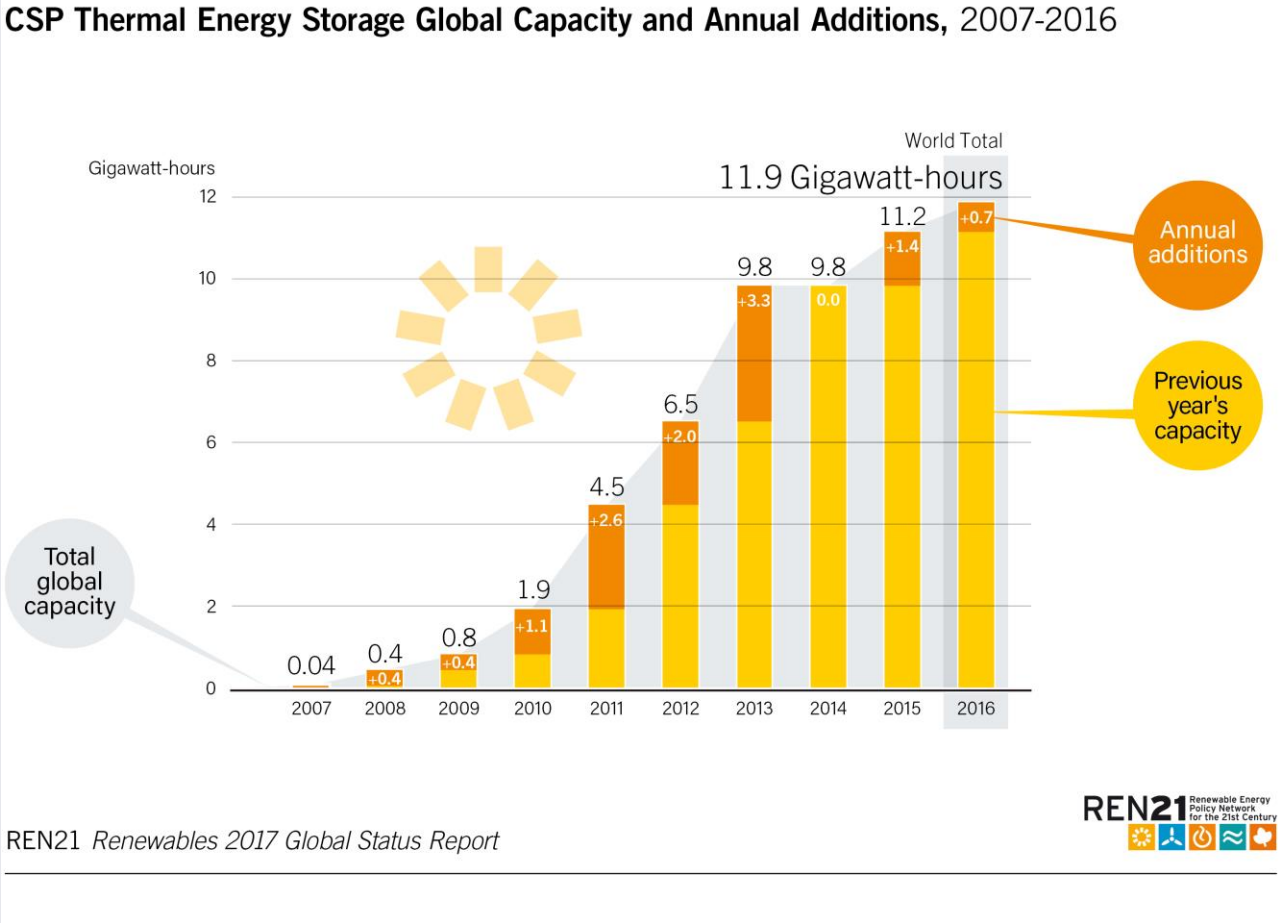
Concentrating Solar Thermal Power (CSP)

Annual additions:
0.7 GWh

World total:
11.9 GWh

All new facilities that came online **incorporated thermal energy storage**

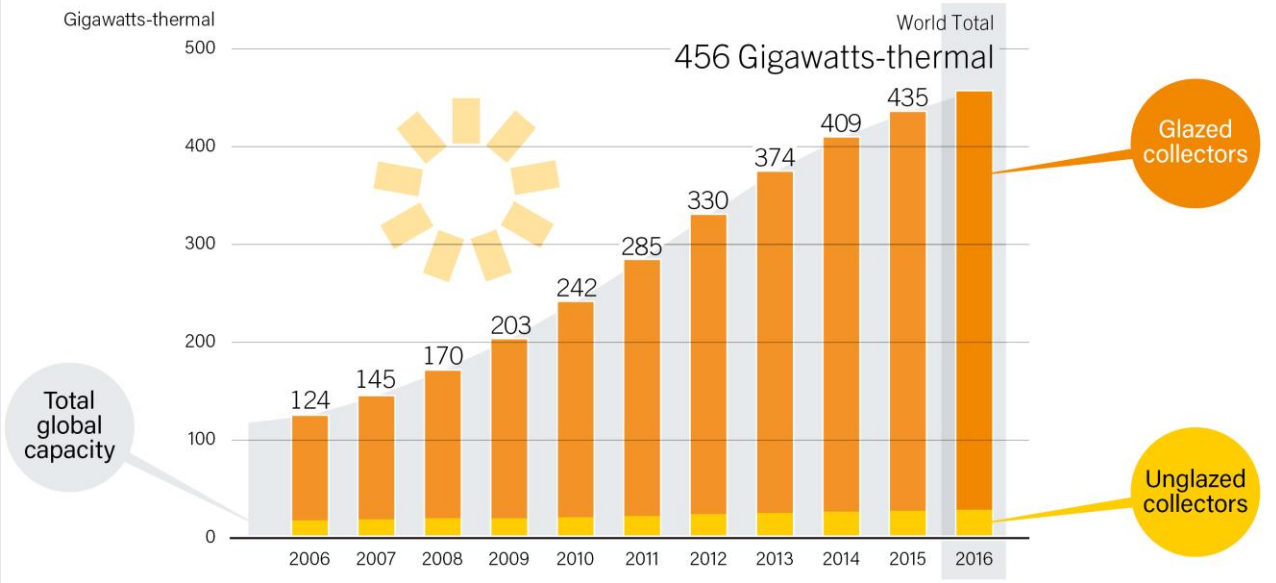


Solar Thermal Heating and Cooling

Total capacity of water collectors increased by **5%** to **456 GWth**

Solar heating and cooling technologies have been sold in at least **127 countries**

Solar Water Heating Collectors Global Capacity, 2006-2016



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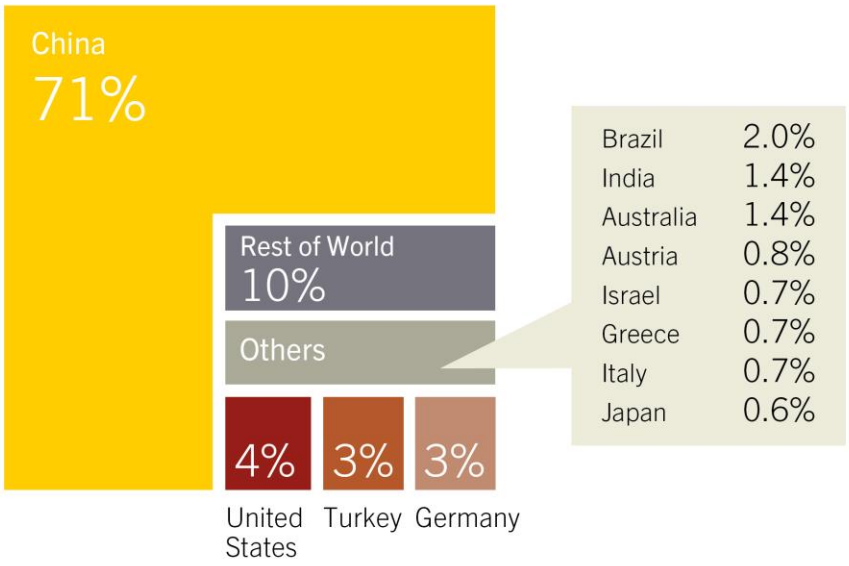
Source: IEA SHC.

Solar Thermal Heating and Cooling

Top 5 countries for cumulative capacity were:

- China
- USA
- Turkey
- Germany
- Brazil

Solar Water Heating Collectors Global Capacity, Shares of Top 12 Countries and Rest of World, 2015



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Source: IEA SHC.

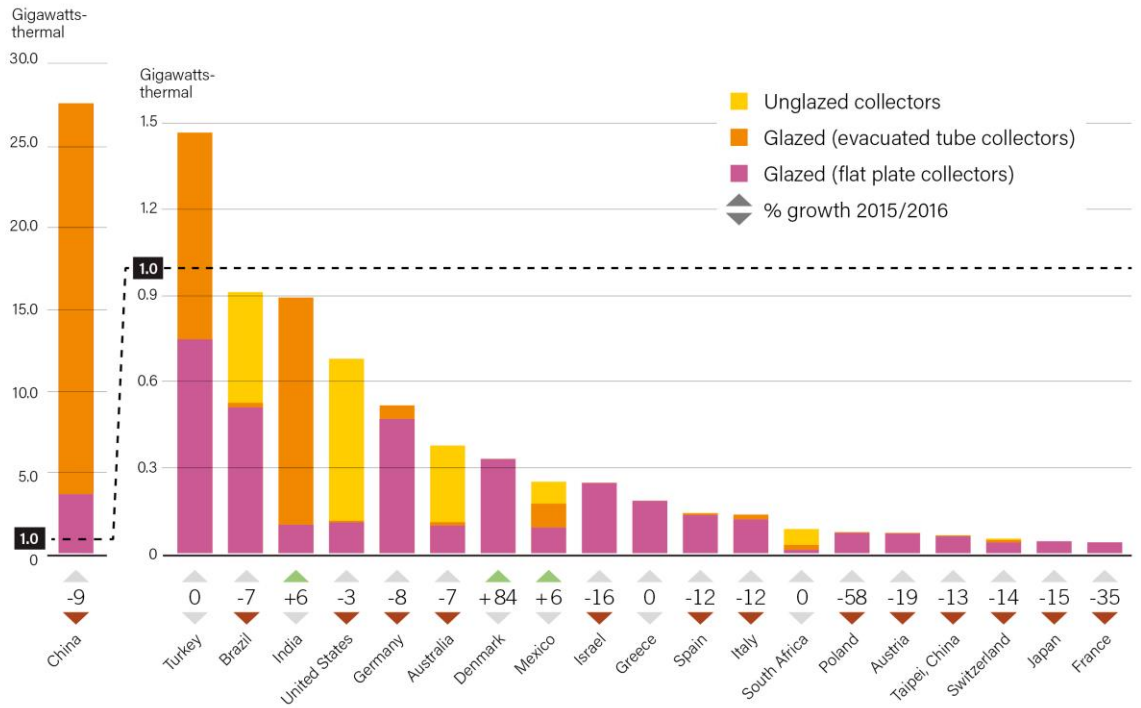
Solar Thermal Heating and Cooling

Gross additions:
36.7 GWth

Significant market growth in:

- → Denmark: 84%
- → Mexico: 6%
- → India: 6%

Solar Water Heating Collector Additions, Top 20 Countries for Capacity Added, 2016



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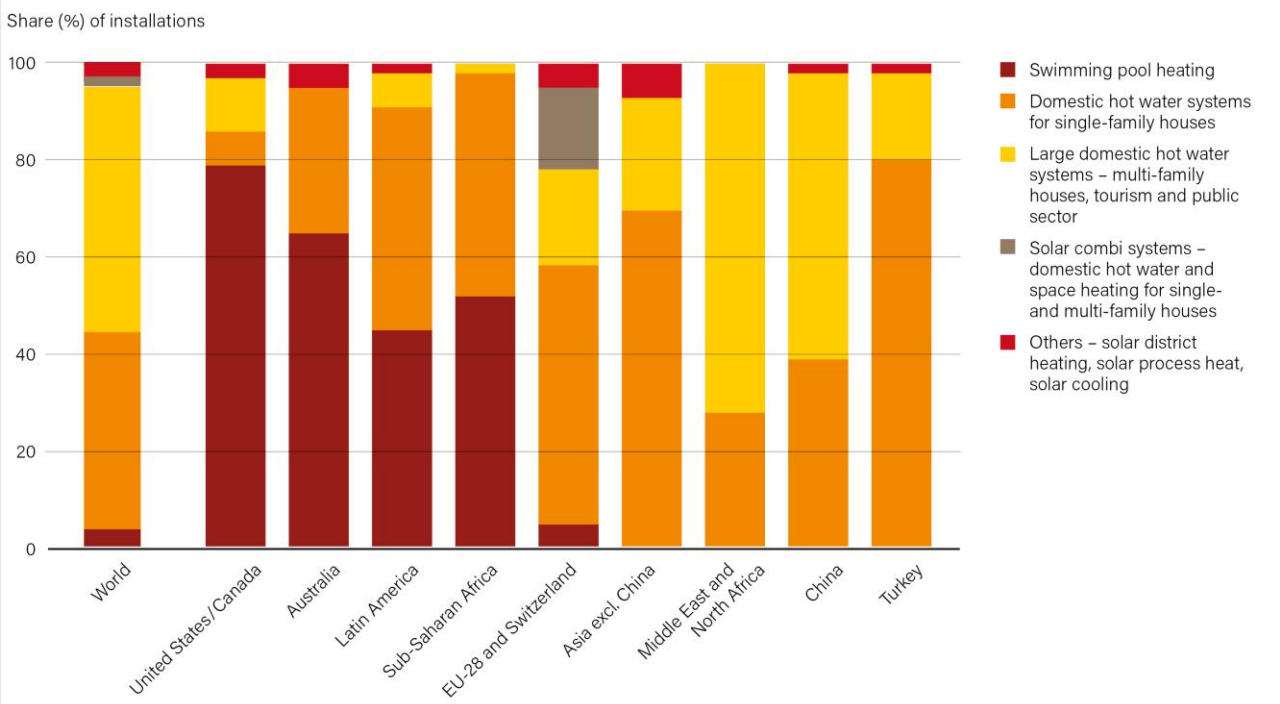
Solar Thermal Heating and Cooling

Residential sector accounted for **63%** of total installed collector capacity at the end of 2015

Markets transitioning to large-scale systems

Solar Water Heater Applications for Newly Installed Capacity, by Economic Region, 2015



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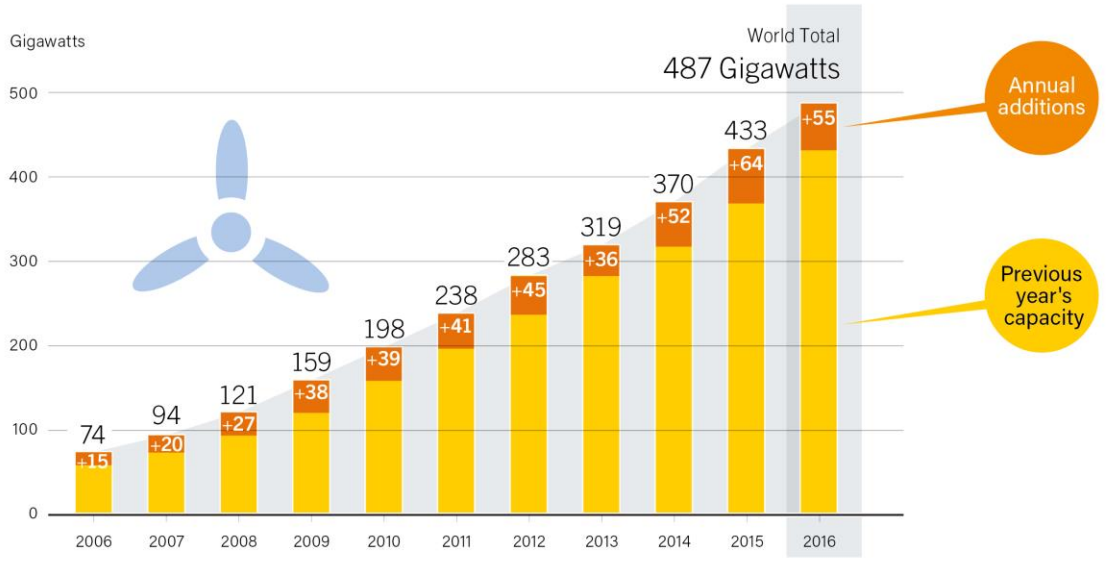
Source: IEA SHC.

Wind Power

55 GW of wind power capacity added

Global total increased 12% to **487 GW**

Wind Power Global Capacity and Annual Additions, 2006-2016



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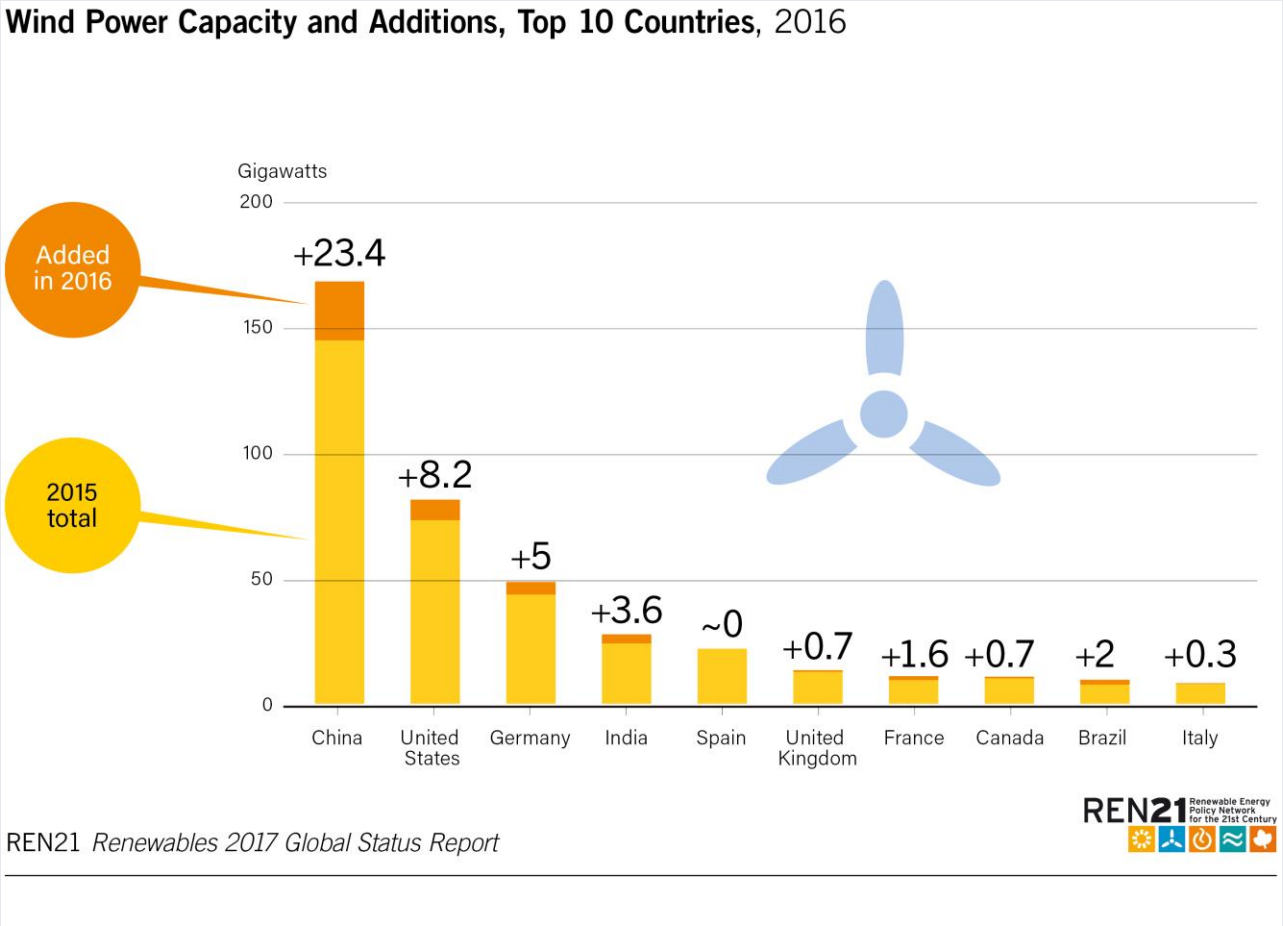
Wind Power

The global wind power market contracted in 2016

China added most new installations: **23.4 GW**



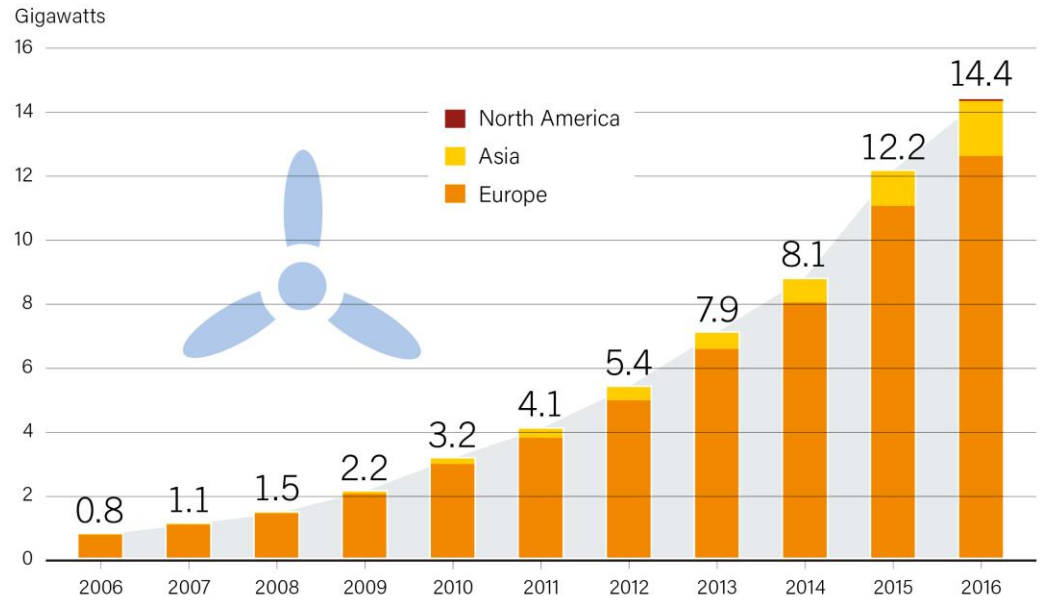
Wind Power

Global total:
4.4 GW

2.2 GW of capacity connected to grid in 2016

Europe home of **70%** of global additions

Wind Power Offshore Global Capacity, by Region, 2006-2016



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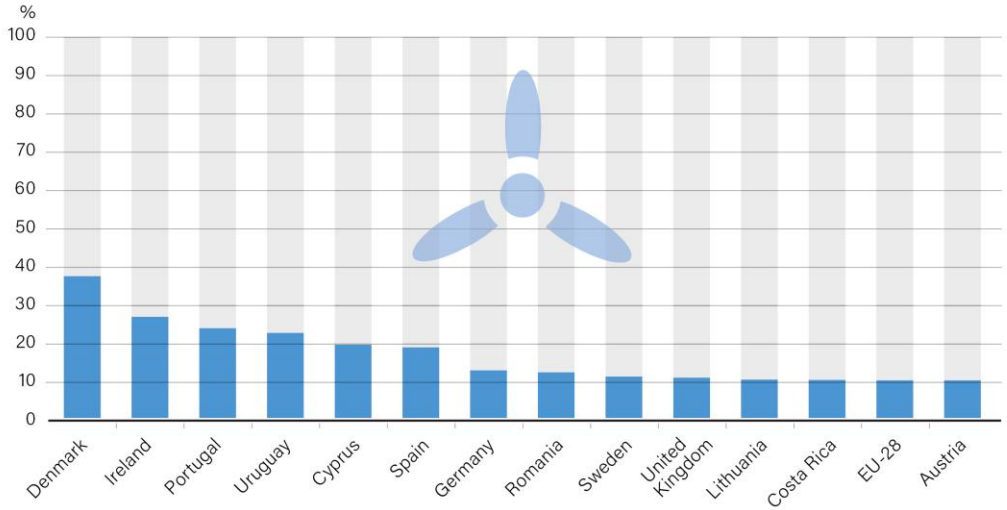
Wind Power

At least **24** countries met **5%** or more of their annual electricity demand with wind power

Enough global capacity to meet **4%** of total electricity consumption

Share of Electricity Demand Met by Wind Power, Selected Countries with over 10% and EU-28, 2016



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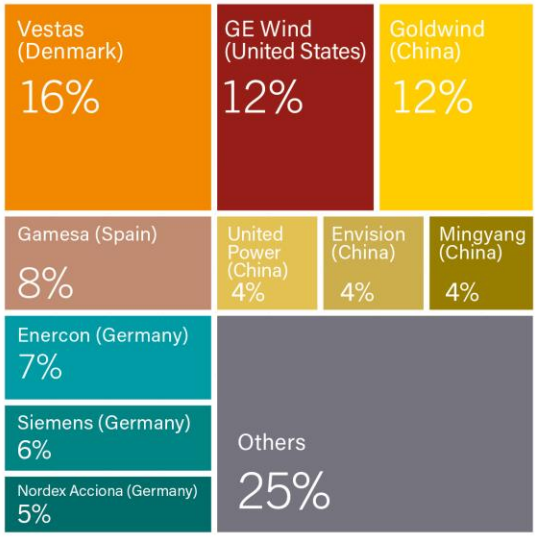
Wind Power

Most wind turbine manufacturing takes

- China
- EU
- India
- United States

Market Shares of Top 10 Wind Turbine Manufacturers, 2016



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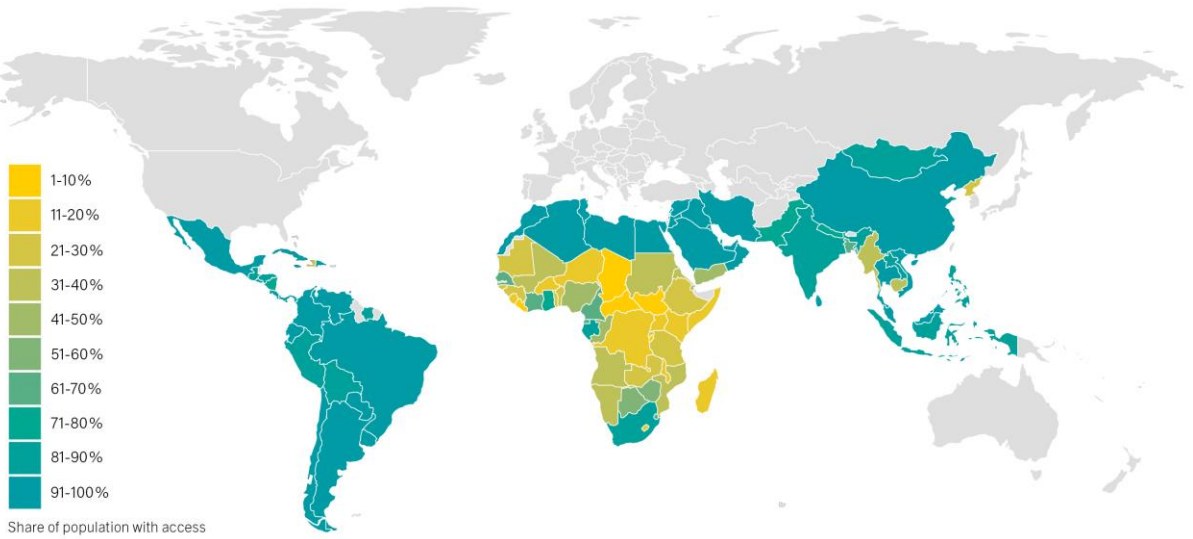
Source: FTI Consulting.

Distributed Renewable Energy for Energy Access

16% of the global population lived **without electricity** - approx. 1.19 billion people

Electricity Access in Developing Countries, 2014



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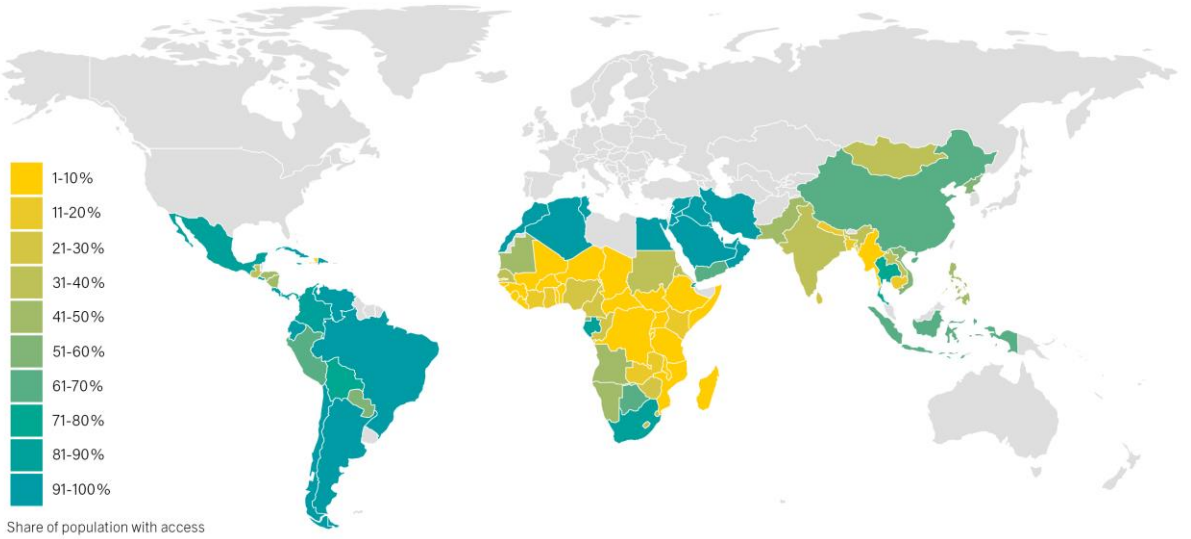
Distributed Renewable Energy for Energy Access

38% of global population are **without clean cooking** facilities - approx. 2.7 billion people

Access to Clean Cooking Facilities in Developing Countries, 2014



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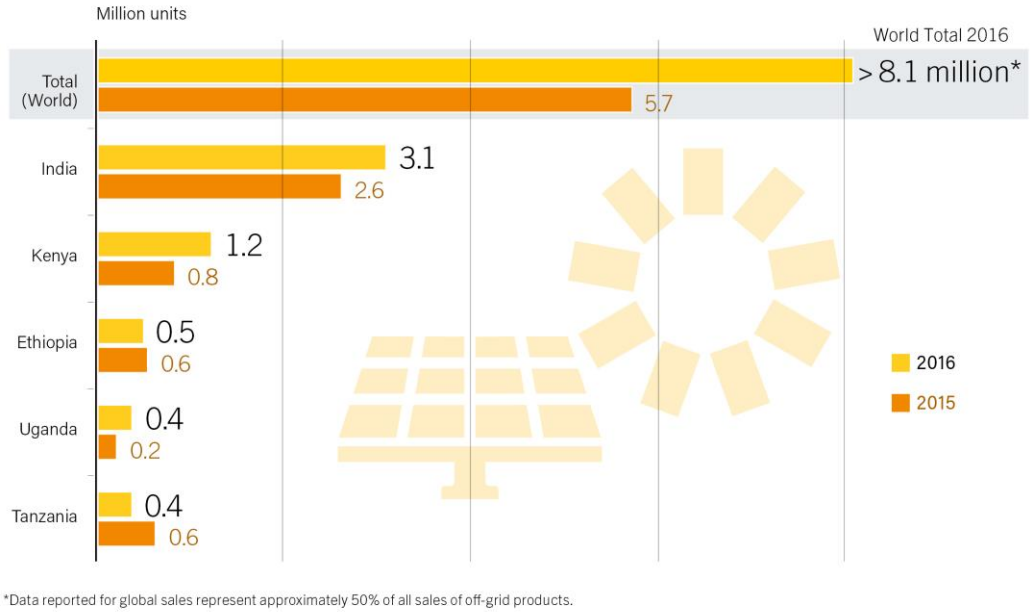
Distributed Renewable Energy for Energy Access

Sales of off-grid solar systems reach **8.1 million** units worldwide

Sales were highest in sub-Saharan Africa, in particular in East Africa

Sales of Off-Grid Solar Systems in Top 5 Countries, 2015-2016



*Data reported for global sales represent approximately 50% of all sales of off-grid products.

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Source: GOGLA/IFC.

Distributed Renewable Energy for Energy Access

Deployment of **mini-grids** accelerated in 2016

Market now exceeds **USD 200 billion** annually

Status of Renewable Energy Mini/Micro-grid Markets, by Region

■ Limited
□ Pilots
■ Emerging
■ Mature

Region	Autonomous Basic	Autonomous Full	Interconnected Community
Central America and the Caribbean	■	■	■
South America	■	■	■
Northern Africa	■	■	■
Sub-Saharan Africa	■ ■	■	■
Central and North Asia	□ ■	■	■
East and South Asia	■	□ ■ ■	■
Middle East	■	□	■
Oceania	■	■ ■	□

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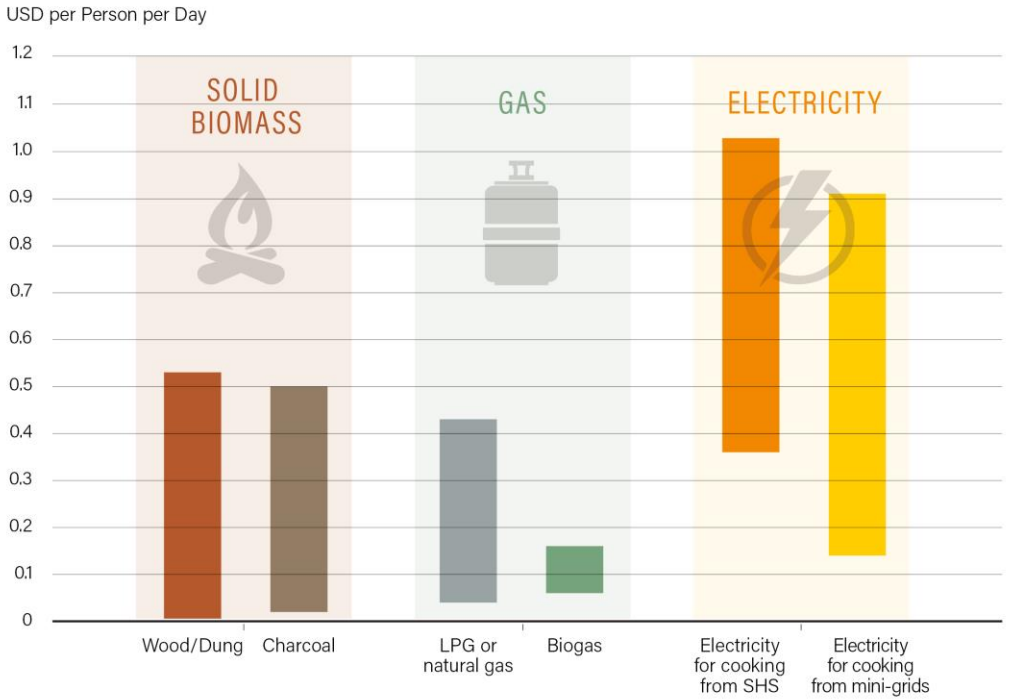
Distributed Renewable Energy for Energy Access

Reduced consumption of firewood and/or charcoal by:

- → Electric cooking: **10-40%**
- → Biogas stoves: **66-80%**

Cost of Various Cooking Technologies



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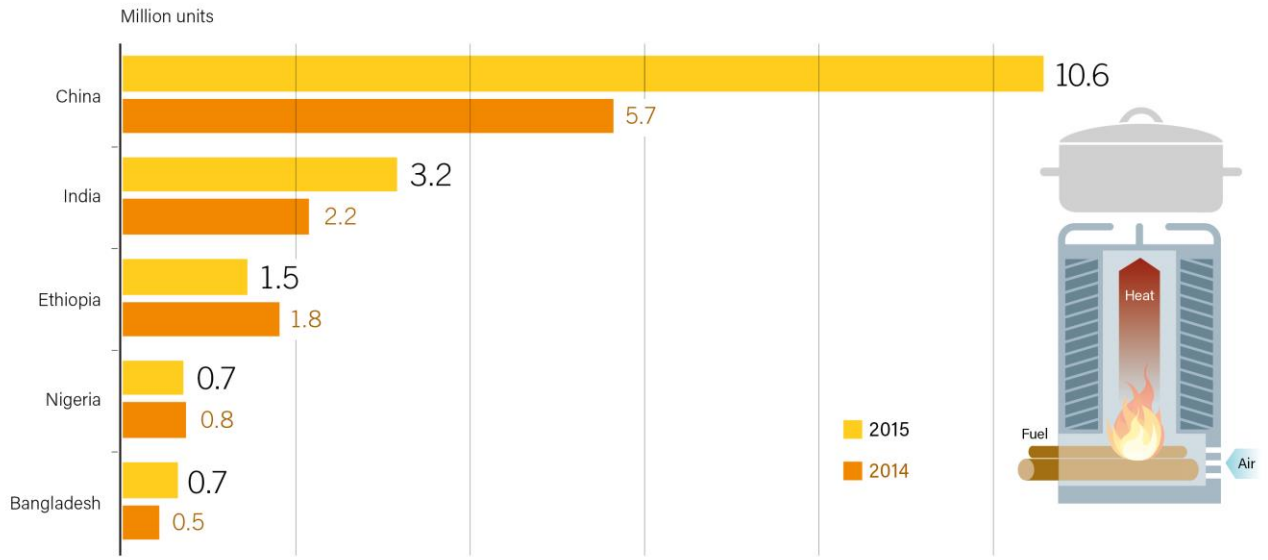
Distributed Renewable Energy for Energy Access

20 million clean cook stoves distributed in 2015, an **18%** increase

China leads in installations

Number of Clean Cook Stoves Added in Top 5 Countries, 2014 and 2015



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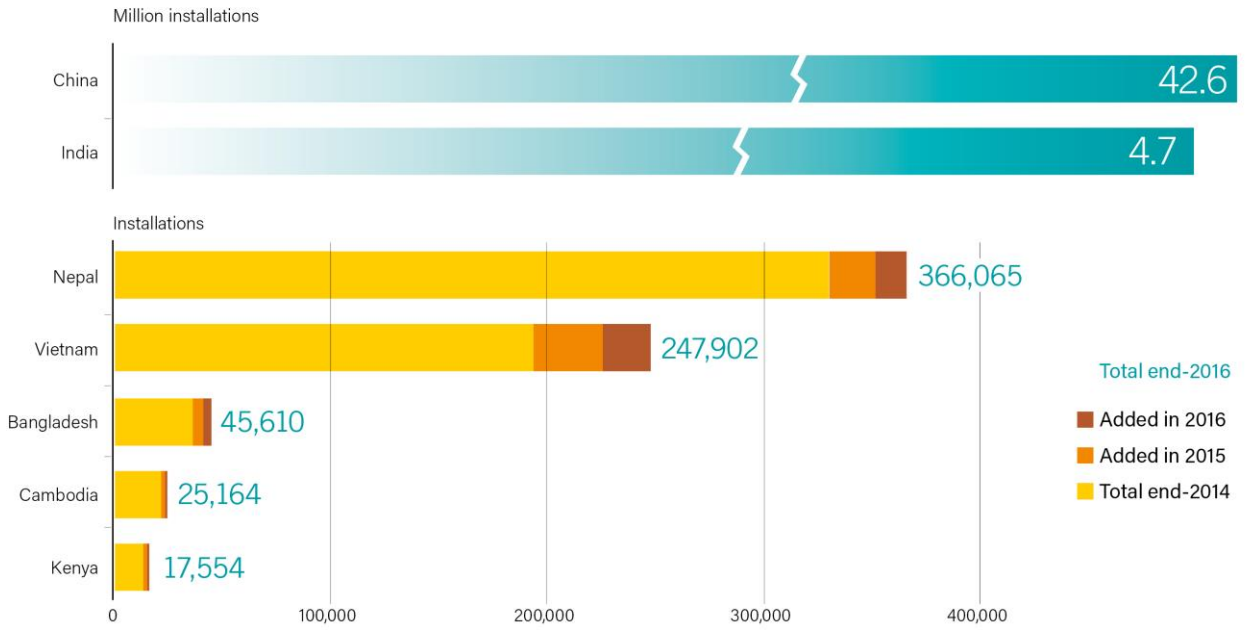
Distributed Renewable Energy for Energy Access

Asia leads in total installations of domestic biogas plants

Most are in **China** (**42.6 million** units at the end of 2016), and **India** (**4.7 million** units)

Number of Domestic Biogas Plants Installed in Top 5 Countries, Total and Annual Additions, 2014-2016



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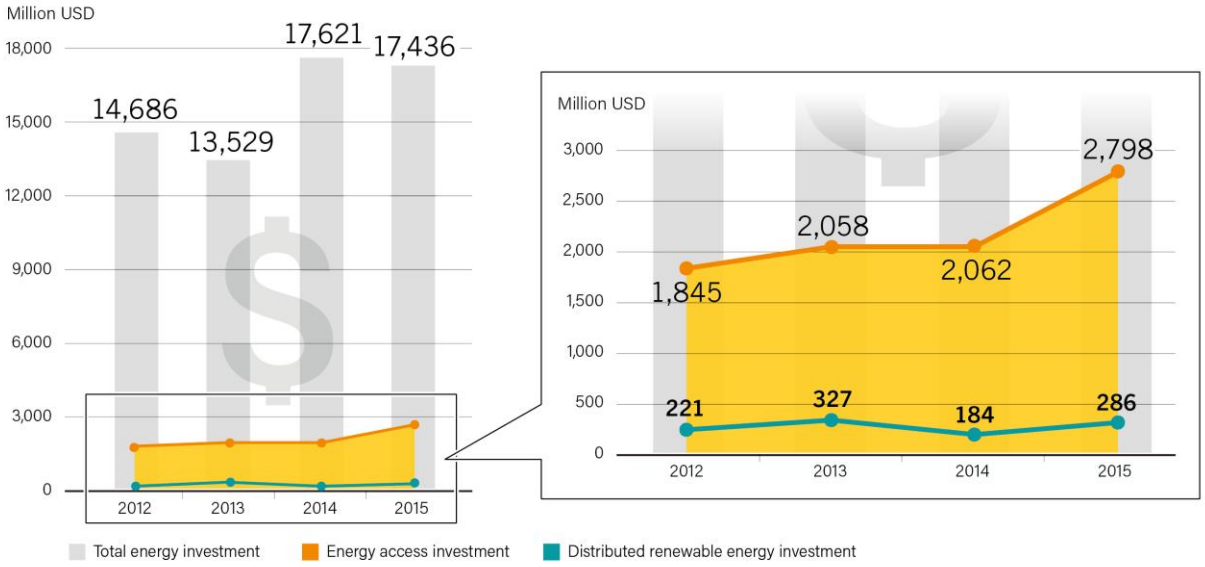
Distributed Renewable Energy for Energy Access

Funding from multilateral organisations and bilateral donors account for **55%** of energy access investments

Overview of Multilateral Funding for Energy Access and Distributed Renewable Energy, 2012-2015



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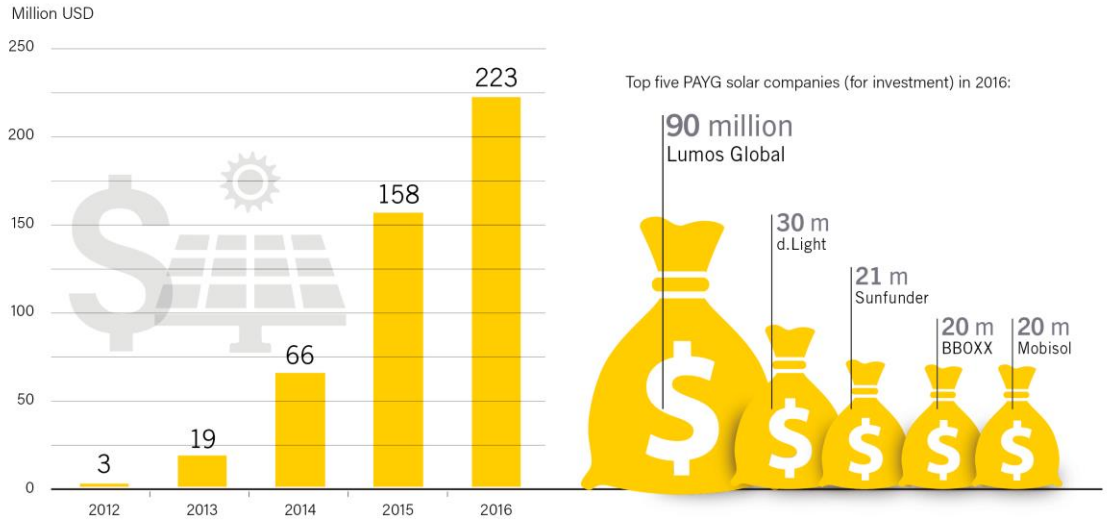
Distributed Renewable Energy for Energy Access

USD 223 million raised by PAYG solar PV companies, an increase of about **40%** from 2015

Investment in Pay-As-You-Go Solar Companies, 2012-2016



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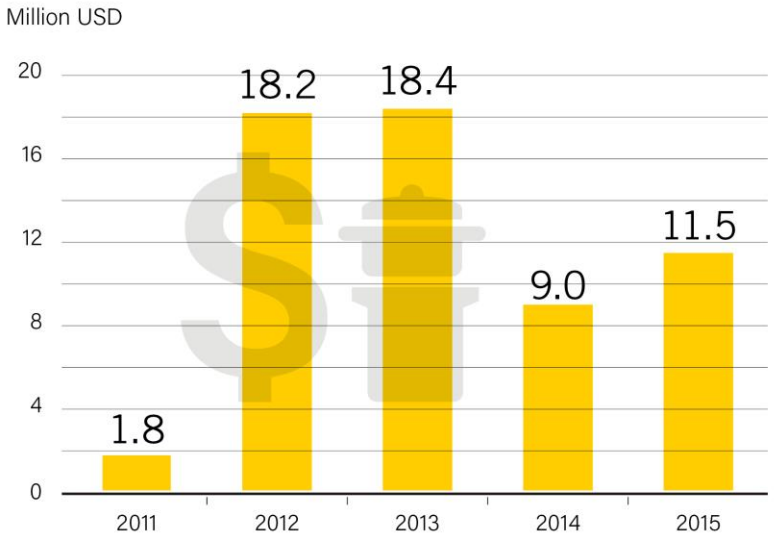
Distributed Renewable Energy for Energy Access

Investment in clean cook stoves increased **28%** (to **USD 11.5 million**) in 2015

Investment in Clean Cook Stoves, 2011-2015



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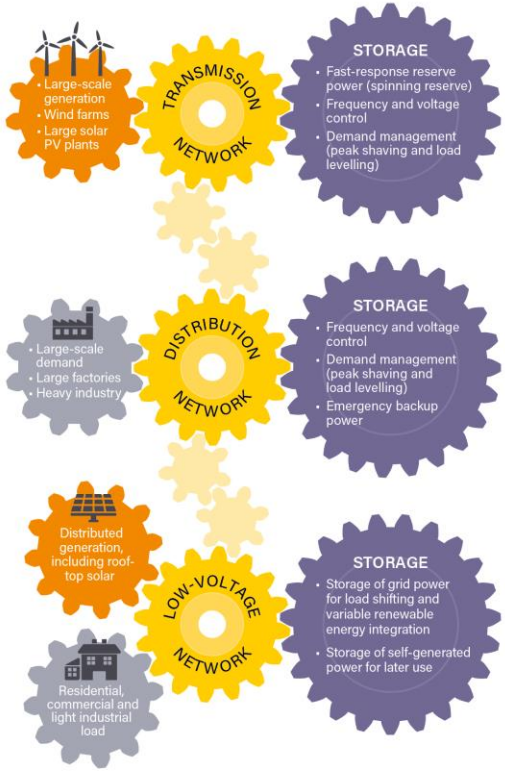
Enabling Technologies and Energy Systems Integration

Storage can provide **system benefits** and **flexibility** to customers, system managers and utilities

Can be applied from the **household level** to **utility-scale**

Storage Applications in Electric Power Systems



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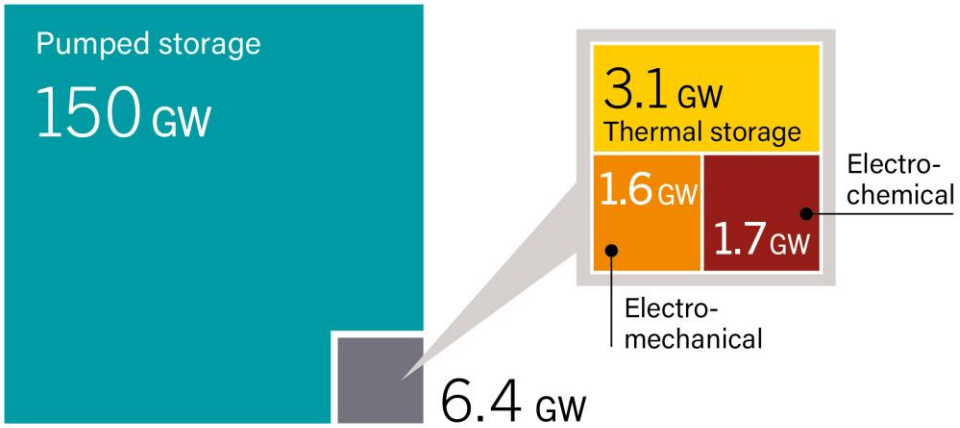
Enabling Technologies and Energy Systems Integration

Global grid-connected and stationary energy storage capacity in 2016 totalled an estimated **156 GW**

Global Grid-Connected Energy Storage Capacity, by Technology, 2016



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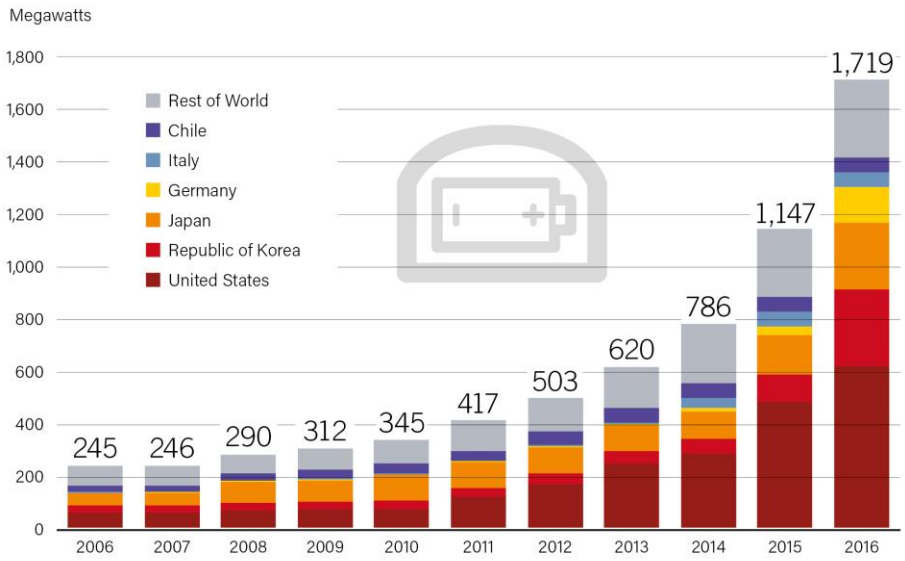
Enabling Technologies and Energy Systems Integration

Grid-connected battery storage grew by **50%** in 2016

Global Grid-Connected Stationary Battery Storage Capacity, by Country, 2006-2016



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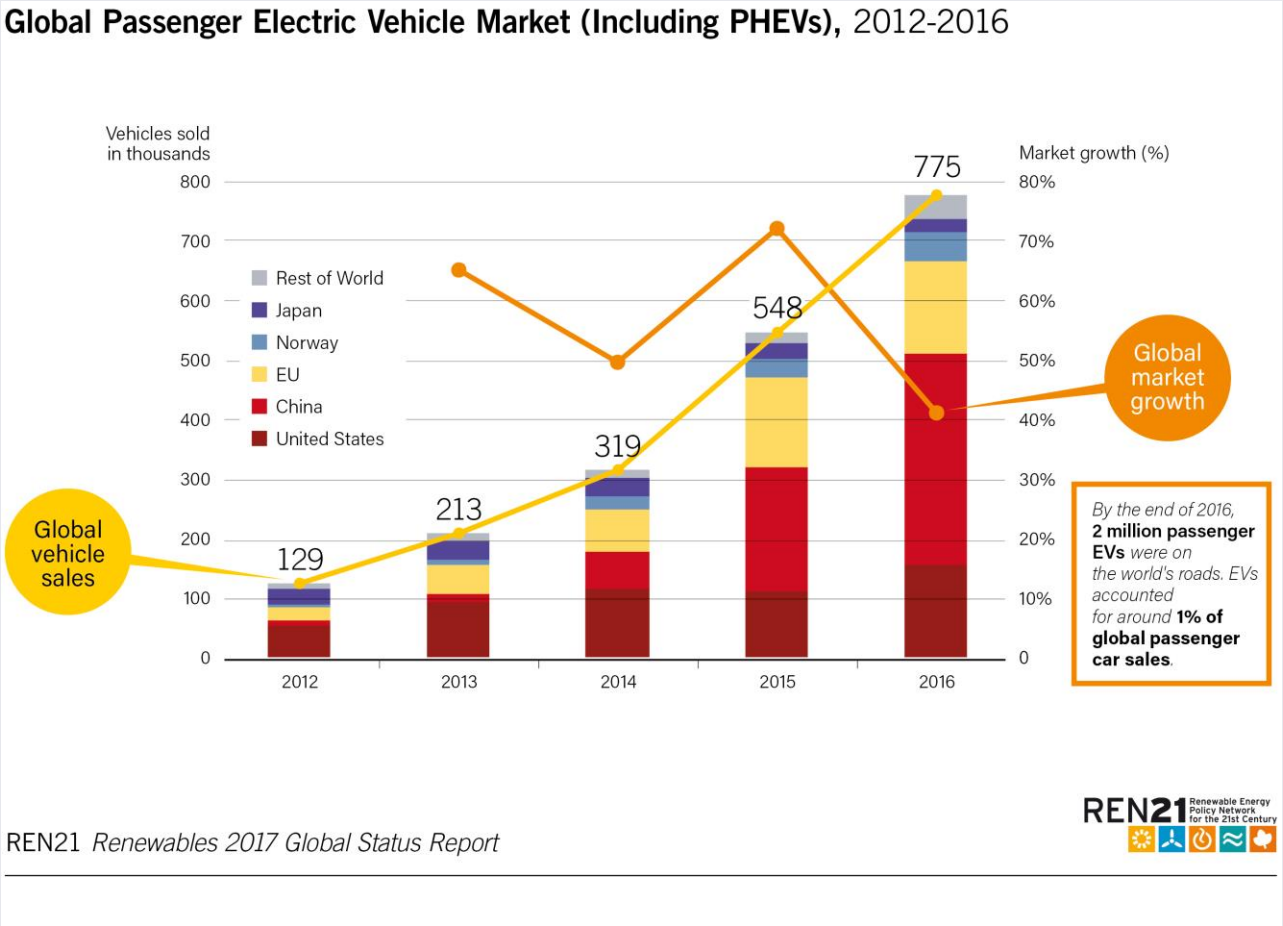
Enabling Technologies and Energy Systems Integration

Global sales of EVs reached **775,000 units**

More than **2 million passenger EVs** were on the world's roads by year's end (1% of the light vehicle market)

So far, little linking of renewable eneryg and electric mobility

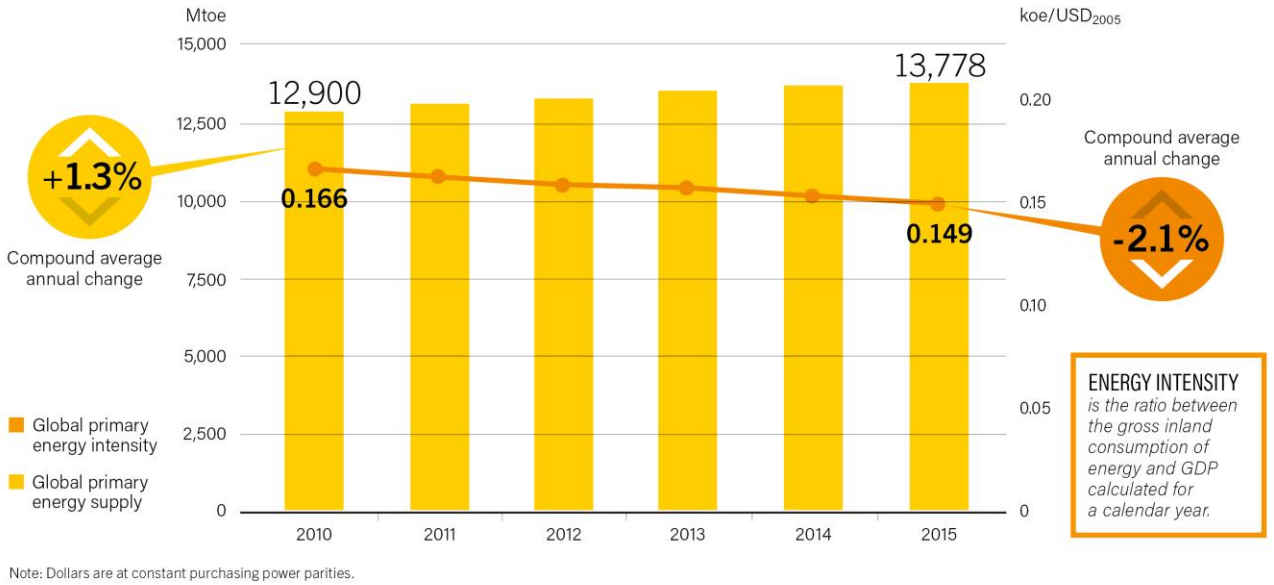


Energy Efficiency

Global primary energy intensity improved by **2.6%**

From 2010 to 2015, energy intensity declined by an average annual rate of **2.1%**

Global Primary Energy Intensity and Total Primary Energy Supply, 2010-2015



Note: Dollars are at constant purchasing power parities.

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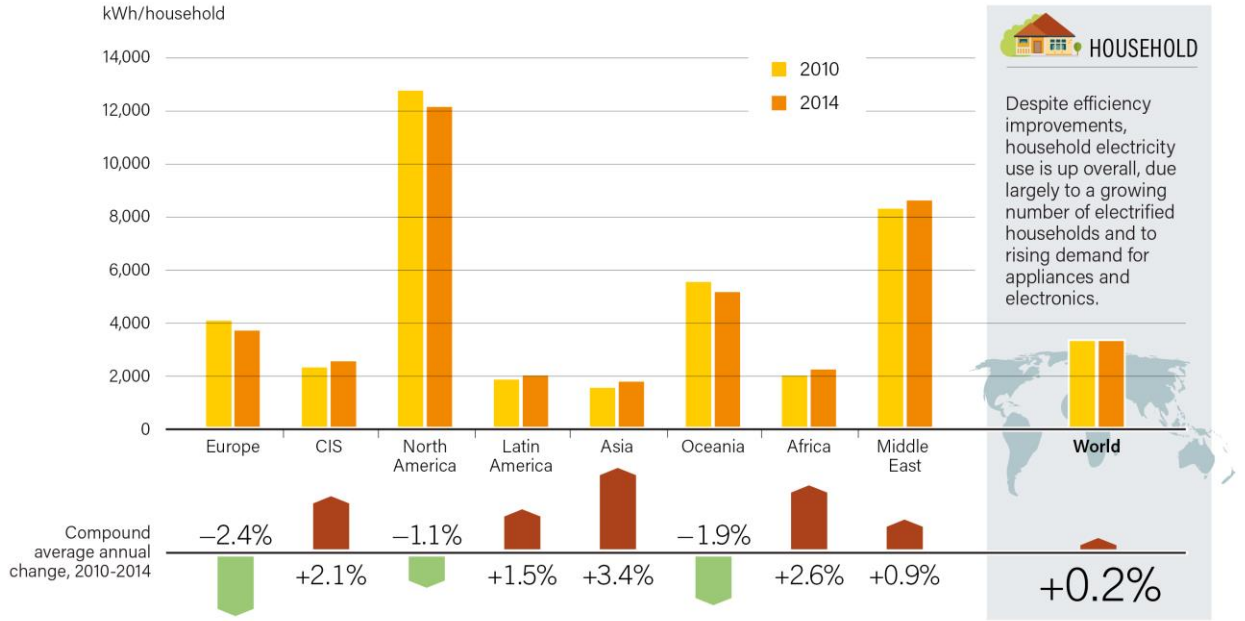
Energy Efficiency

Electricity consumption per household **declined** 2010-2014 in:

- → North America
- → Europe
- → Oceania

Average Electricity Consumption per Electrified Household, Selected Regions and World, 2010 and 2014



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Energy Efficiency

Electricity intensity of the service sector **declined in every region** except the Middle East and Latin America, from 2010 to 2014

Electricity Intensity of Service Sector, Selected Regions and World, 2010 and 2014

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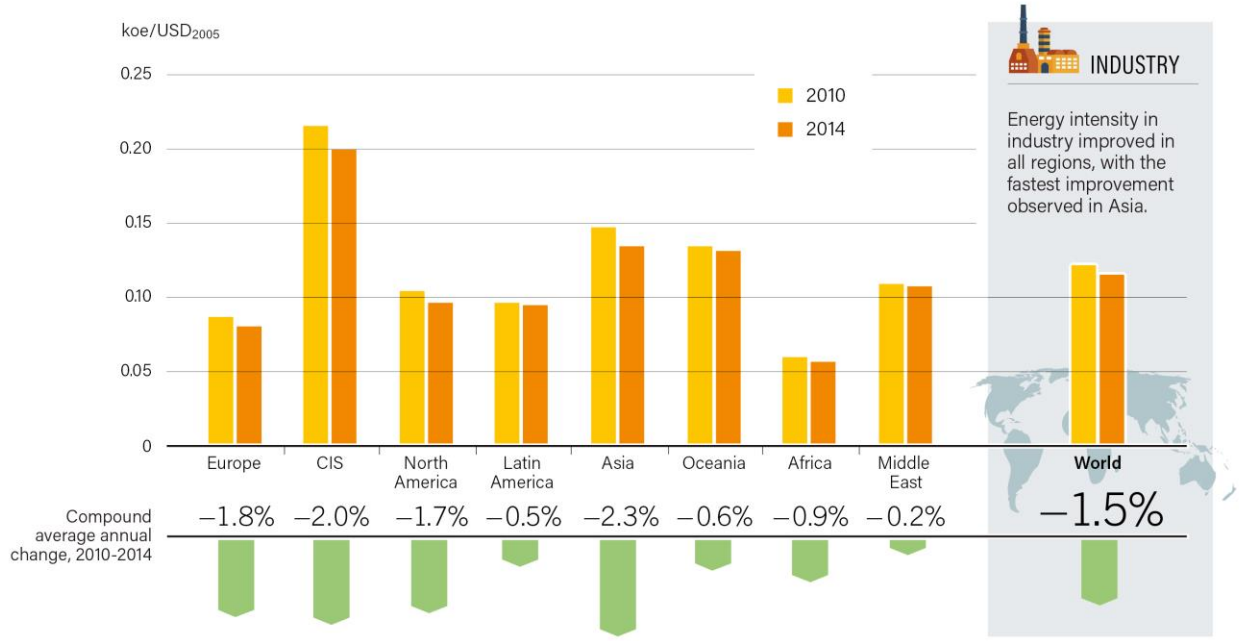
Energy Efficiency

Energy intensity in industry **decreased** by an average of **1.5%** annually and improved in all regions, from 2010 to 2014

Energy Intensity of Industry, Selected Regions and World, 2010 and 2014



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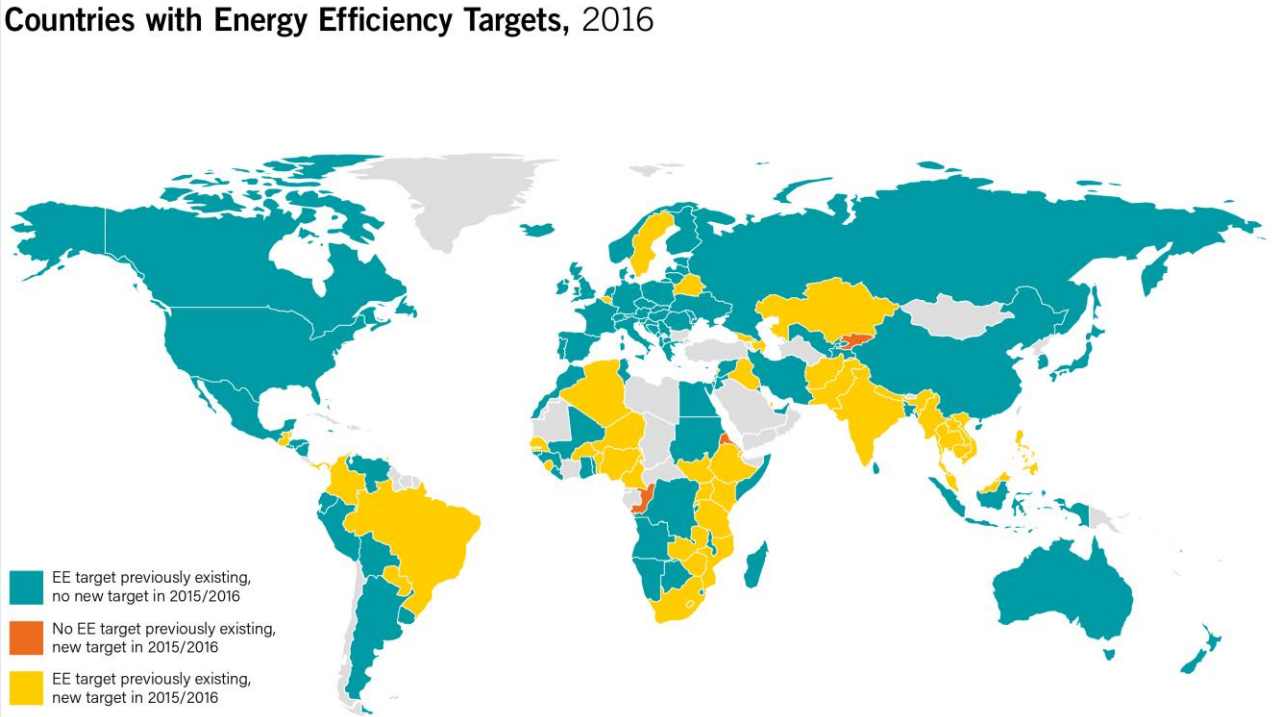
Energy Efficiency

By end-2016, at least **149** countries had enacted one or more energy efficiency targets.

Of these countries, **56** adopted a new target in 2015 or 2016



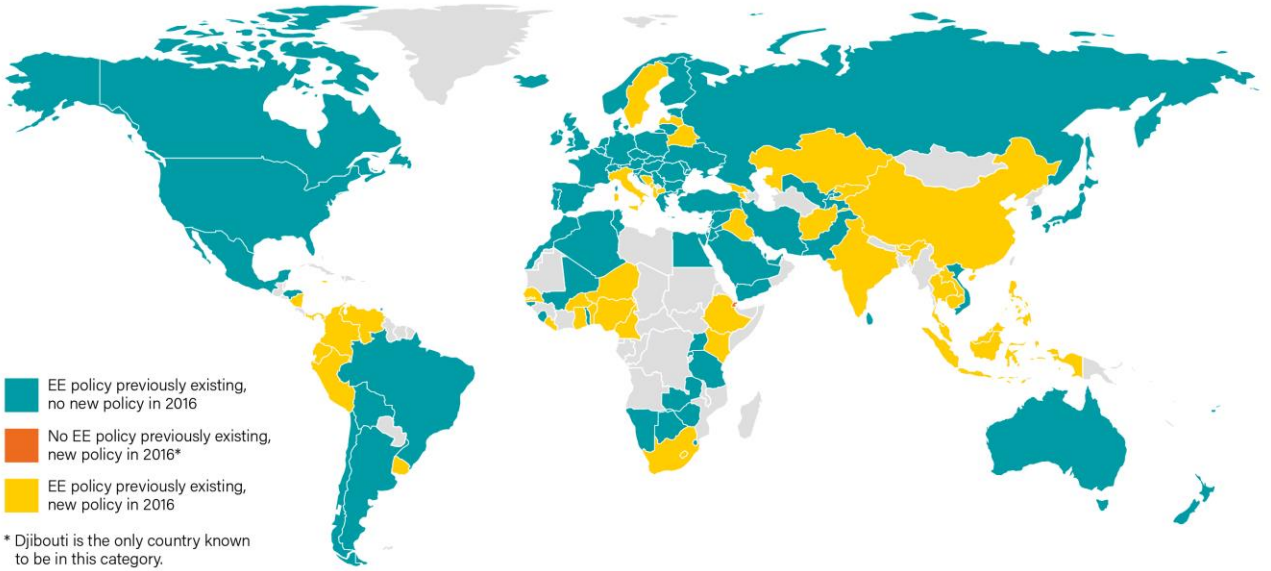
Source: REN21 Policy Database.

Energy Efficiency

By end-2016, at least **137** countries had enacted some kind of energy efficiency policy.

Of these countries, **48** enacted a new or revised policy in 2016

Countries with Energy Efficiency Policies, 2016



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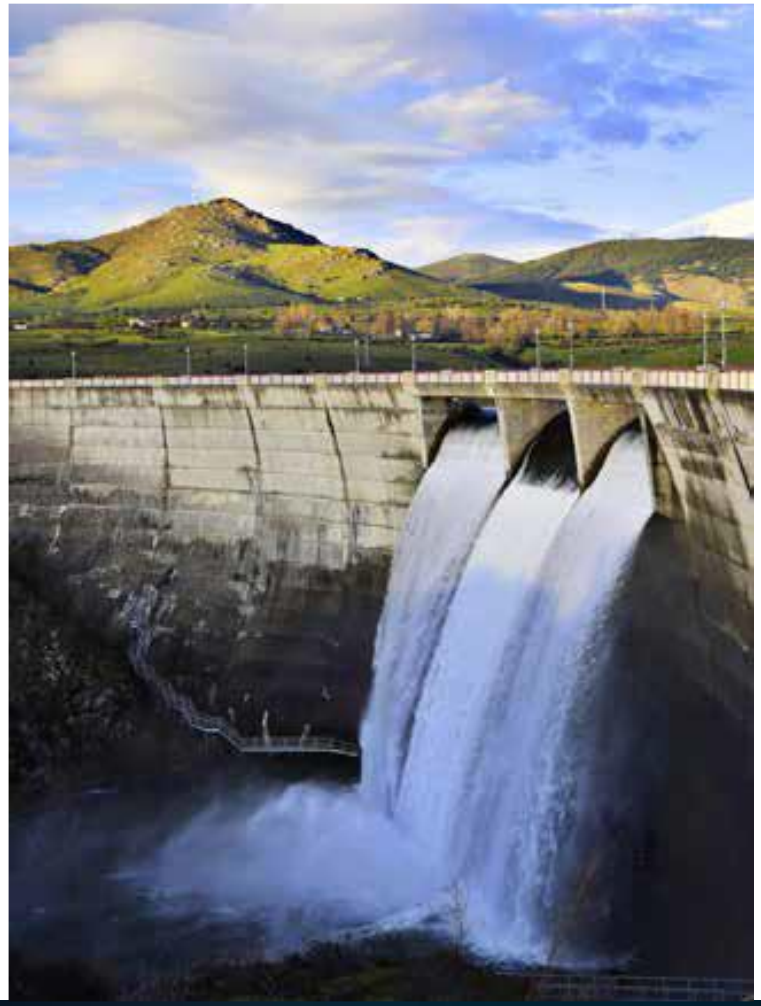
Source: REN21 Policy Database.

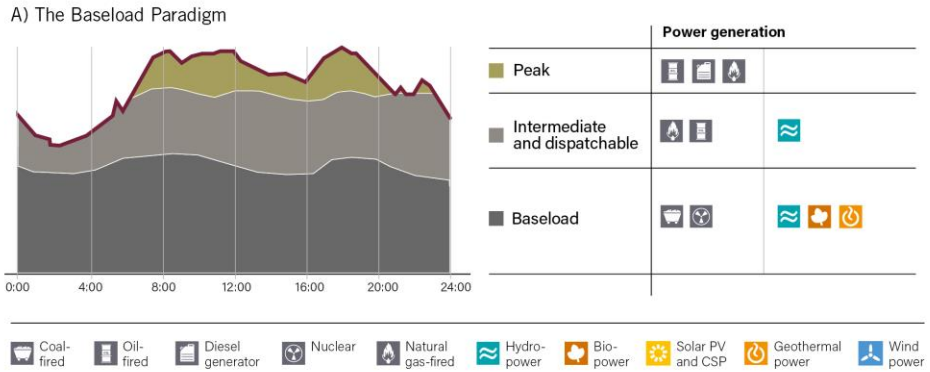
Feature: Deconstructing Baseload

- Traditional baseload generators such as coal and nuclear are beginning to lose their economic advantage and may no longer be the first to dispatch energy.
- A number of countries and regions – including **Denmark, Germany, Uruguay and Cabo Verde** – have integrated high shares (from **20-40%**) of variable renewable energy.



Feature: Deconstructing Baseload

Conceptual Progression from the Baseload Paradigm to a New Paradigm of 100% Renewable Electricity



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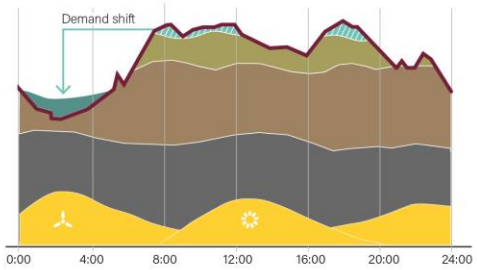
Feature: Deconstructing Baseload

Conceptual Progression from the Baseload Paradigm to a New Paradigm of 100% Renewable Electricity

In the early stages of progression to larger shares of variable renewable generation, power systems make some adjustments in their grid operations, develop forecasting systems for renewable energy production, and introduce improved control technology and operating procedures for efficient scheduling and dispatch.

B) The Early Transition



	Power generation	
Demand shift	→ to early morning lows	
Peak		
Intermediate and dispatchable		
Baseload		
Variable renewable energy		

Coal-fired · Oil-fired · Diesel generator · Nuclear · Natural gas-fired · Hydro-power · Bio-power · Solar PV and CSP · Geothermal power · Wind power

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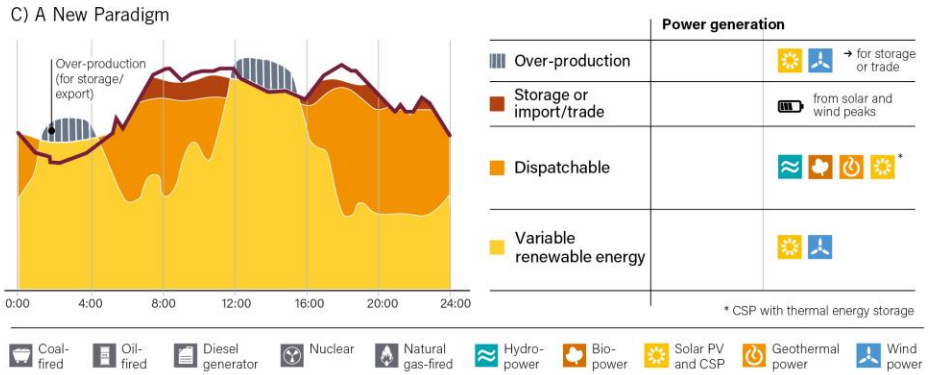
Feature: Deconstructing Baseload

Conceptual Progression from the Baseload Paradigm to a New Paradigm of 100% Renewable Electricity

In the late stages of progression towards fully renewable power systems, variable renewable power will be integrated through advanced resource forecasting, grid reinforcements and strengthened interconnections, improved information and control technologies for grid operations, widespread deployment of storage technologies, greater efficiency and scope of demand response, and coupling of electricity, heating and cooling, and transport sectors.



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Conclusions

- Global renewable energy transition advancing with record capacity additions and rapidly falling costs – more capacity installed for less money
- 2016 was the third year in a row where decoupling of economic growth and energy-related CO_2 emissions occurred
- **However, progress not fast enough to reach Paris Agreement goals**
- Better-integrated sectoral planning
- Smarter, more flexible systems integrating variable renewables
- More use of enabling technologies

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