REN21 Renewable Energy Policy Network for the 21st Century

ADVANCING THE GLOBAL RENEWABLE ENERGY TRANSITION

HIGHLIGHTS

of the REN21 Renewables 2018 Global Status Report in perspective

2018

REN21 MEMBERS

INDUSTRY ASSOCIATIONS

Alliance for Rural Electrification (ARE)
American Council on Renewable Energy (ACORE)
Associação Portuguesa de Energias Renováveis (APREN)
Association for Renewable Energy of Lusophone Countries (ALER)
Chinese Renewable Energy Industries Association (CREIA)
Clean Energy Council (CEC)
European Renewable Energies Federation (EREF)
Global Off-Grid Lighting Association (GOGLA)
Global Solar Council (GSC)
Global Wind Energy Council (GWEC)
Indian Renewable Energy Federation (IREF)
International Geothermal Association (IGA)
International Hydropower Association (IHA)
Renewable Energy Solutions for the Mediterranean (RES4MED)
World Bioenergy Association (WBA)
World Wind Energy Association (WWEA)

INTERNATIONAL ORGANISATIONS

Asian Development Bank (ADB)
Asia Pacific Energy Research Centre (APERC)
ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE)
European Commission (EC)
Global Environment Facility (GEF)
International Energy Agency (IEA)
International Renewable Energy Agency (IRENA)
Regional Center for Renewable Energy and Energy Efficiency (RCREEE)
United Nations Development Programme (UNDP)
United Nations Environment Programme (UN Environment)
United Nations Industrial Development Organization (UNIDO)
World Bank (WB)

NGOS

Climate Action Network International (CAN-I)
Council on Energy, Environment and Water (CEEW)
Fundación Energías Renovables (FER)
Global Alliance for Clean Cookstoves (GACC)
Global Forum on Sustainable Energy (GFSE)
Greenpeace International
ICLEI – Local Governments for Sustainability, South Asia
International Electrotechnical Commission (IEC)
Institute for Sustainable Energy Policies (ISEP)
Mali Folkecenter (MFC)
Partnership for Sustainable Low Carbon Transport (SLoCaT)
Renewable Energy Institute (REI)
World Council for Renewable Energy (WCRE)
World Future Council (WFC)
World Resources Institute (WRI)
World Wildlife Fund (WWF)

MEMBERS AT LARGE

Michael Eckhart
Mohamed El-Ashry
David Hales
Kirsty Hamilton
Peter Rae

NATIONAL GOVERNMENTS

Afghanistan
Brazil
Denmark
Germany
India
Norway
South Africa
Spain
United Arab Emirates
United States of America

SCIENCE AND ACADEMIA

Fundación Bariloche (FB)
International Institute for Applied Systems Analysis (IIASA)
International Solar Energy Society (ISES)
National Renewable Energy Laboratory (NREL)
South African National Energy Development Institute (SANEDI)
The Energy and Resources Institute (TERI)

CHAIR

Arthouros Zervos
National Technical University of Athens (NTUA)

EXECUTIVE SECRETARY

Rana Adib
REN21

REN21 COMMUNITY

REN21 is a multi-stakeholder network that is built on an international community of over 900 experts from governments, inter-governmental organisations, industry associations, non-governmental organisations, and science and academia. It grows from year to year and represents an increasing diversity of sectors. REN21 provides a platform for this wide-ranging community to exchange information and ideas, to learn from each other and to collectively build the renewable energy future.

This network enables the REN21 Secretariat, among other things, to produce its annual flagship publication, the *Renewables Global Status Report (GSR)*. The report is a truly collaborative effort where the contributors and peer reviewers work alongside an international authoring team and the REN21 Secretariat.

REN21 COMMUNITY INVOLVEMENT IN GSR:

60% new experts in the community every year

40% have been involved at least twice

Over **900** experts internationally

400 experts actively involved in 2018 edition

RENEWABLE ENERGY POLICY NETWORK FOR THE 21st CENTURY

REN21 is the global renewable energy policy multi-stakeholder network that connects a wide range of key actors. REN21's goal is to facilitate knowledge exchange, policy development and joint action towards a rapid global transition to renewable energy.

REN21 brings together governments, non-governmental organisations, research and academic institutions, international organisations and industry to learn from one another and build on successes that advance renewable energy. To assist policy decision-making, REN21 provides high-quality information, catalyses discussion and debate, and supports the development of thematic networks.

Bridging and building the energy future.

www.ren21.net

REN21 facilitates the collection of comprehensive and timely information on renewable energy. This information reflects diverse viewpoints from both private and public sector actors, serving to dispel myths about renewable energy and to catalyse policy change. It does this through six product lines:

REN21 PRODUCTS

Global Status Report: yearly publication since 2005

RENEWABLES GLOBAL STATUS REPORT (GSR)

First released in 2005, REN21's *Renewables Global Status Report* (GSR) has grown to become a truly collaborative effort, drawing on an international network of over 900 authors, contributors and reviewers. Today it is the most frequently referenced report on renewable energy market, industry and policy trends.

	2004	2005	2006	2007	2008	2009	2010	2011	2012
REN21 publications:		First GSR published				Chinese Renewable Energy Status Report	Indian Renewable Energy Status Report Renewables Interactive Map	Global Status Report on Local Renewable Energy Policies	
REN21 events:	Renewables 2004, Bonn	BIREC, Beijing International Renewable Energy Conference			WIREC, Washington International Renewable Energy Conference		DIREC, Delhi International Renewable Energy Conference		

Regional Status Reports

Global Futures Reports

Thematic Reports

REN21
Renewables Academy

REN21 Renewables Academy

International Renewable Energy Conferences

REGIONAL STATUS REPORTS

These reports detail the renewable energy developments of a particular region; their production also supports regional data collection processes and informed decision making.

GLOBAL FUTURES REPORTS (GFR)

REN21 produces reports that illustrate the credible possibilities for the future of renewables within particular thematic areas.

THEMATIC REPORTS

Each report covers a specific topic related to renewable energy in detail. Examples of reports covered in this series include the *Mini-grid Policy Toolkit, Renewable Energy Tenders and Community [Em]power[ment]* and *Renewables Energy Policies in a Time of Transition.*

RENEWABLES ACADEMY

The REN21 Renewables Academy provides an opportunity for lively exchange among the growing community of REN21 contributors. It offers a venue to brainstorm on future-orientated policy solutions and allows participants to actively contribute on issues central to a renewable energy transition.

INTERNATIONAL RENEWABLE ENERGY CONFERENCES (IREC)

The International Renewable Energy Conference (IREC) is a high-level political conference series. Dedicated exclusively to the renewable energy sector, the biennial IREC is hosted by a national government and convened by REN21.

2013

Global Futures Report

MENA Renewable Energy Status Report

ADIREC, Abu Dhabi International Renewable Energy Conference

2014

Mini-grid Policy Toolkit

ECOWAS Renewable Energy and Energy Efficiency Status Report

First REN21 Renewables Academy, Bonn

2015

SADC and UNECE Renewable Energy and Energy Efficiency Status Reports

Renewables Interactive Map revamp

SAIREC, South Africa International Renewable Energy Conference

2016

EAC Renewable Energy and Energy Efficiency Status Report

First GSR Microsite

2017

100% Renewables Global Futures Report

UNECE Renewable Energy Status Report

Renewable Energy Tenders and Community [Em]Power[ment]

MEXIREC, Mexico International Renewable Energy Conference

2018

Renewable Energy Policies in a Time of Transition

SADC Renewable Energy and Energy Efficiency Status Report

Second REN21 Renewables Academy, Bonn

THE STATE OF THE GLOBAL RENEWABLE ENERGY TRANSITION

Highlights of the REN21 Renewables 2018 Global Status Report in Perspective

REN21 Renewable Energy Policy Network for the 21st Century

This document presents the overarching trends and development from 2018 so that policy makers and others can more easily understand the significance of the latest renewable energy development. It outlines what is happening to drive the energy transition and details why it is not happening fast enough or as fast as possible. It draws on the meticulously documented data found in ***REN21's Renewables 2018 Global Status Report***. See the endnotes and methodological notes in the full report for further details.

The REN21 *Renewables 2018 Global Status Report* (GSR) portrays a dynamic renewable power sector characterised by falling costs, increased investment, record-setting installation and new, innovative business models that are creating rapid change. Thanks to years of active policy support and driven by technology advances, rapid growth and dramatic reductions in costs of solar photovoltaics (PV) and wind, renewable electricity is now less expensive than newly installed fossil and nuclear energy generation in many parts of the world; in some places it is less expensive even than operating existing conventional power plants.

But these positive developments tell only part of the story. The global energy transition is only fully underway for the power sector; for other sectors it has barely begun. The power sector on its own will not deliver the emissions reductions demanded by the Paris climate agreement or the aspirations of Sustainable Development Goal 7 (SDG 7) to ensure access to affordable, reliable, sustainable and modern energy for all. The heating and cooling and transport sectors, which together account for about 80% of global total final energy demand, are lagging behind.

+5.4 %

the average growth rate of modern renewables over the past decade

In 2017, China, Europe and the United States accounted for nearly 75% of the global investment in renewable power and fuels. While investment in these major markets is impressive and needs to continue, there are also examples of significant investment in developing country markets. China had a high level of investment – an increase of 30.7% from the previous year. However, when measured per unit of gross domestic product (GDP), the Marshall Islands, Rwanda, the Solomon Islands, Guinea-Bissau, and many other developing countries are investing as much as or more in renewables than developed and emerging economies. These positive trends need to be scaled up for a global energy transition.

Furthermore, a booming global economy combined with weaker improvements in energy intensity led to an increase in energy demand of an estimated 2.1% in 2017 (more than twice the average increase over the previous five years). Energy-related carbon dioxide (CO_2) emissions rose – by an estimated 1.4% – for the first time in four years, at a time when climate scientists say that emissions need to be in steep decline.

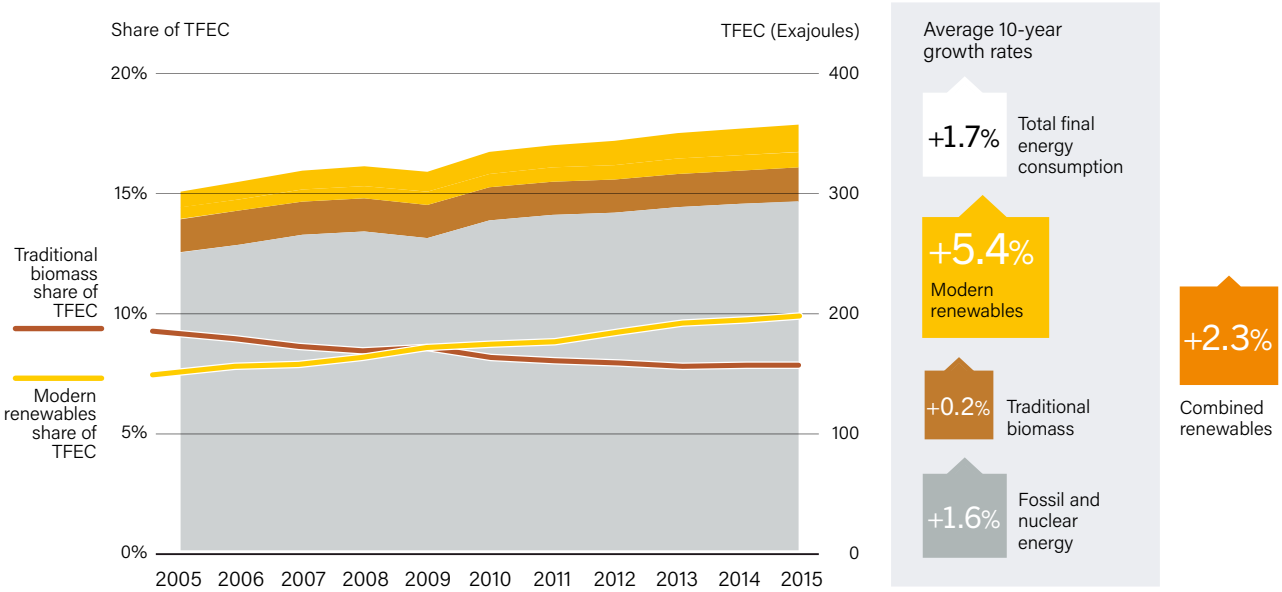
There is uneven progress between the sectors and between the different geographical regions, and a fundamental disconnect between commitments and real action on the ground. Simply put, the global renewable energy transition is progressing far too slowly.

POSITIVE DEVELOPMENTS DEMONSTRATE THE CENTRAL ROLE THAT RENEWABLES CAN PLAY IN THE OVERALL ENERGY SYSTEM:

The share of modern renewable energy in the total global energy supply is on the rise.

The share of renewables in final energy consumption continues to grow globally with some technologies growing very rapidly. Despite impressive uptake in sources such as PV and wind, growth in renewables had difficulty keeping up with rapidly rising demand. In addition, in some countries traditional biomass use has fallen, which, although a positive development, is slowing down the growth of the total renewable energy share globally. Because of this, many countries have seen the share of renewable energy in their total final demand fall since 2010. (→ *See Figure 1.*)

FIGURE 1. GROWTH IN RENEWABLE ENERGY COMPARED TO TOTAL FINAL ENERGY CONSUMPTION (TFEC), 2005-2015



Note: The renewable energy share of final consumption shown in this figure has changed significantly relative to previous years because of a downward revision of data for traditional uses of biomass in China (IEA, World Energy Statistics and Balances 2017). Data should not be compared with prior versions of this figure to obtain year-by-year changes, as some revisions are due to improved or adjusted data or methodology.

Renewable electricity saw record global growth in solar PV and continued acceleration of wind power.

Solar PV was the star performer for the second year in a row, with newly installed capacity increasing by about 33% (at least 98 gigawatts, GW) over the record-setting additions in 2016. Approximately 402 GW of solar PV was up and running worldwide by the end of 2017.

About 52 GW of wind power was added globally in 2017, bringing the cumulative total installed capacity to around 539 GW – an increase of nearly 11% over 2016. The global offshore wind market grew 30%.

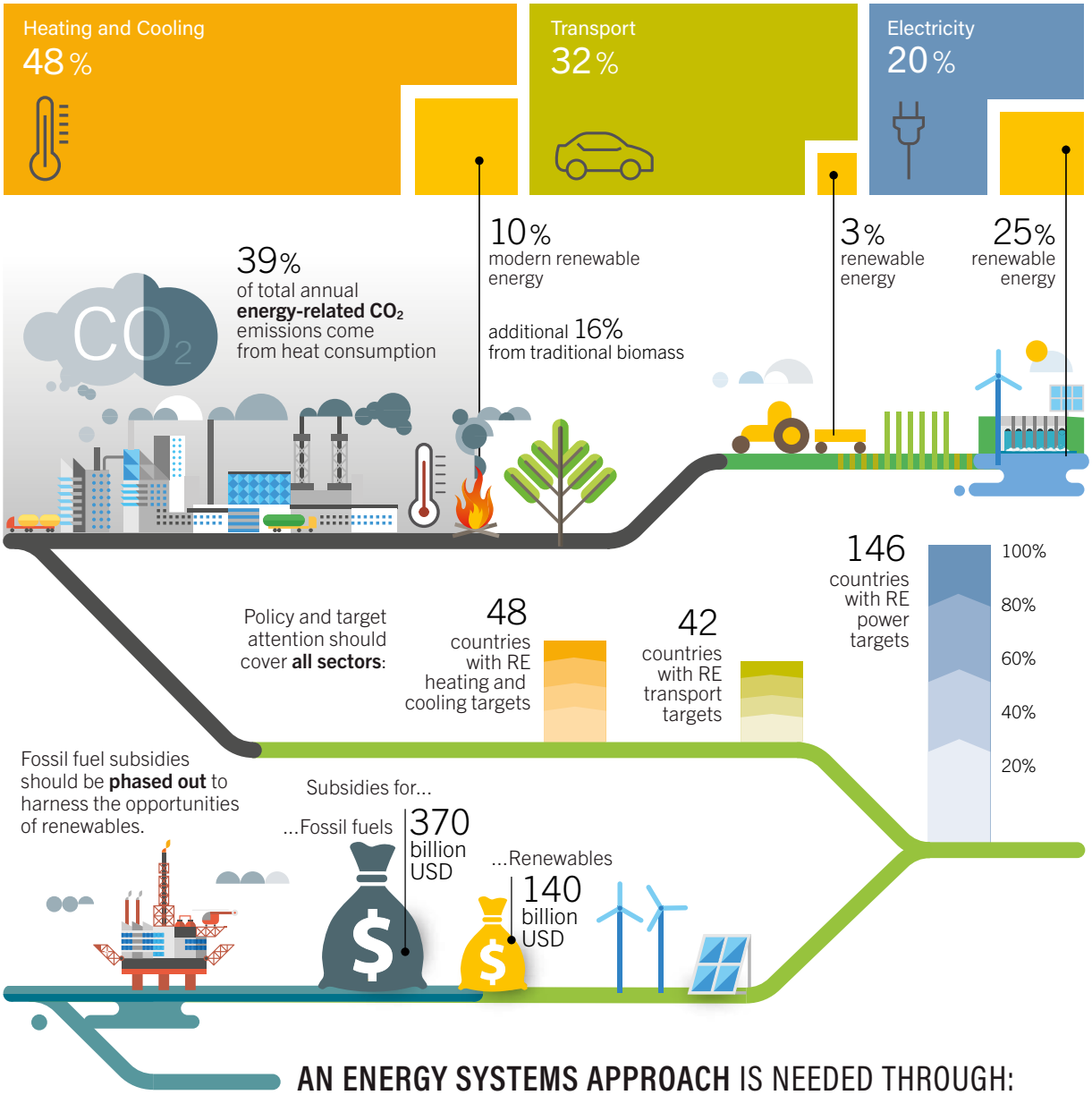
Taken together, renewables accounted for an estimated 70% of net additions to global power generation capacity, up from 63% in 2016.

RENEWABLE ENERGY TRANSITION

WE MUST MOVE FROM AN ELECTRICITY TRANSITION **TO AN ENERGY TRANSITION**

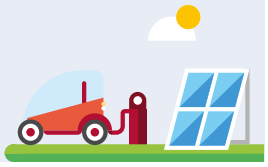
WE CONSUME THE MOST ENERGY FOR **HEATING, COOLING, AND TRANSPORT**

Modern Renewable Energy in Final Energy Use by Sector, 2015

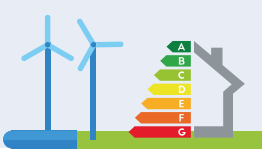


AN ENERGY SYSTEMS APPROACH IS NEEDED THROUGH:

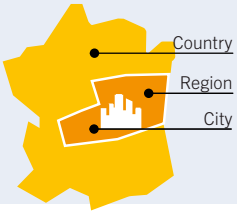
SECTOR COUPLING AMONG POWER, HEATING, COOLING AND TRANSPORT



LINKING **RENEWABLE ENERGY** AND **ENERGY EFFICIENCY**



ALIGNING **NATIONAL, SUBNATIONAL** AND **LOCAL POLICIES**



POLITICAL WILL AND GOOD GOVERNANCE MUST BE FRONT AND CENTER

to remove fossil fuel and nuclear subsidies, introduce carbon pricing and create a level playing field

Defying sceptics, higher shares of variable renewable energy (VRE) are being successfully integrated into electricity systems across the globe, without affecting grid stability. Penetration reached significant levels in many regions in 2017.

As shown in Figure 2, the countries leading in wind and solar PV penetration are Denmark (52.9%), Uruguay (28.1%), Germany (26%) and Ireland (25.2%).

Several countries and regions integrated even higher shares of VRE into their power systems over short periods in 2017. South Australia generated more than 100% of its electricity demand (load) from wind power alone on one occasion, and 44% from solar PV alone on another. Other examples include Germany (66% of load; wind and solar combined), the US state of Texas (54% of load; wind alone) and Ireland (60% of load; wind alone).

Integrating high shares of VRE into the power system requires a conceptual shift: policy makers and planners are increasingly looking beyond the confines of a single grid, a single country, a single city or a single sector and are integrating both supply- and demand-side solutions across sectors and across borders.

China, for example, is specifically encouraging the electrification of heating, manufacturing and transport in parts of the country where large renewable power capacity exists, as it helps to reduce curtailment (the powering down of generation to maintain the balance between supply and demand).

The European Union (EU) is providing funding to support the construction of four major transmission lines across Europe, enabling surpluses in one area to be used or stored in another. Having this flexibility will reduce costs and allow for greater shares of VRE in the total mix.

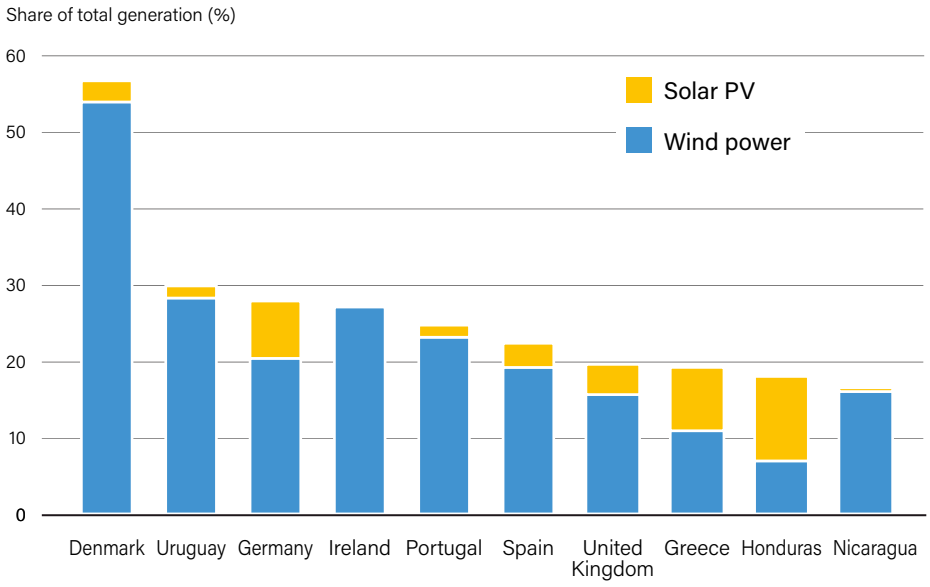
The costs of solar PV and wind continued to fall due to technological innovations, changes in markets, effective policies and new business models.

Solar PV tenders resulted in record-low bids in a number of countries. In Germany, for example, winning bids were on average nearly 50% lower than those over the last two years, to below EUR 50 per megawatt-hour (MWh) (USD 60 per MWh). In the United States, the country's least expensive ever solar power purchase agreement was awarded for a 150 megawatt (MW) project in Texas, with prices potentially as low as USD 21 per MWh.

In markets as diverse as Canada, India, Mexico and Morocco, the prices bid for onshore wind power came down to about USD 30 per MWh. A Mexican tender late in the year saw prices below USD 20 per MWh – a world record low and down 40-50% relative to Mexico's tenders in 2016. Germany also saw a national record low of EUR 38 per MWh (around USD 45 per MWh).

For offshore wind, tenders in Germany and the Netherlands attracted zero-subsidy bids (that is, producers will be paid market prices only, although governments will provide grid connection and other support) for projects due to come online in 2024 and 2022, respectively. This would have been unthinkable even just a few years ago.

FIGURE 2. SHARE OF ELECTRICITY GENERATION FROM VARIABLE RENEWABLE ENERGY, TOP 10 COUNTRIES, 2017



Note: This figure includes the top 10 countries according to the best available data at the time of publication

RENEWABLE ENERGY **INDICATORS 2017**

		2016	2017
INVESTMENT			
New investment (annual) in renewable power and fuels[1]	billion USD	274	**279.8**
POWER			
Renewable power capacity (including hydro)	GW	2,017	**2,195**
Renewable power capacity (not including hydro)	GW	922	**1,081**
Hydropower capacity[2]	GW	1,095	**1,114**
Bio-power capacity	GW	114	**122**
Bio-power generation (annual)	TWh	501	**555**
Geothermal power capacity	GW	12.1	**12.8**
Solar PV capacity[3]	GW	303	**402**
Concentrating solar thermal power (CSP) capacity	GW	4.8	**4.9**
Wind power capacity	GW	487	**539**
Ocean energy capacity	GW	0.5	**0.5**
HEAT			
Solar hot water capacity[4]	GW_{th}	456	**472**
TRANSPORT			
Ethanol production (annual)	billion litres	103	**106**
FAME biodiesel production (annual)	billion litres	31	**31**
HVO production (annual)	billion litres	5.9	**6.5**
POLICIES[5]			
Countries with national/state/provincial renewable energy targets	#	176	**179**
Countries with 100% renewable electricity targets	#	57	**57**
Countries with 100% renewable heating and cooling targets	#	1	**1**
Countries with 100% renewable transport targets	#	1	**1**
Countries with 100% renewable energy in primary or final energy targets	#	1	**1**
States/provinces/countries with heat obligations/mandates	#	21	**22**
States/provinces/countries with biofuel mandates[6]	#	68	**70**
States/provinces/countries with feed-in policies	#	110	**113**
States/provinces/countries with RPS/quota policies	#	33	**33**
Countries with tendering (held in 2017)	#	34	**29**
Countries with tendering (cumulative)[7]	#	73	**84**

[1] Investment data are from Bloomberg New Energy Finance and include all biomass, geothermal and wind power projects of more than 1 MW; all hydropower projects of between 1 and 50 MW; all solar power projects, with those less than 1 MW estimated separately; all ocean energy projects; and all biofuel projects with an annual production capacity of 1 million litres or more.

[2] The GSR strives to exclude pure pumped storage capacity from hydropower capacity data.

[3] Solar PV data are provided in direct current (DC). See Methodological Notes in *Renewables 2018 Global Status Report* for more information.

[4] Solar hot water capacity data include water collectors only. The number for 2017 is a preliminary estimate.

[5] A country is counted a single time if it has at least one national or state/provincial target.

[6] Biofuel policies include policies listed both under the biofuel obligation/mandate column in Table 3 (Renewable Energy Support Policies Overview) and in Table R7 (Renewable Transportation Mandates: National/State/Provincial, end 2017).

[7] Data for tendering reflect all countries that have held tenders at any time up through the year of focus.

Note: All values are rounded to whole numbers except for numbers <15, biofuels and investment, which are rounded to one decimal point. Where totals do not add up, the difference is due to rounding.

FAME = fatty acid methyl esters; HVO = hydrotreated vegetable oil.

New market players emerged as costs decreased, but traditional utilities also are changing their business models.

By early 2018, more than 130 leading global corporations had joined the RE100 initiative, a network of corporations committed to using 100% renewable power, up from 87 corporations in 2016. Corporate sourcing of renewable power has spread from the United States and Europe to regions around the world, in countries as diverse as Burkina Faso, Chile, China, Egypt, Ghana, India, Japan, Mexico, Namibia and Thailand.

Some utilities have announced that they will disengage from fossil fuel generation and move into large-scale renewable energy generation. Examples include utilities in Africa, Australia, China, Europe, India and the United States. The French utility company Engie, for example, sold off coal and gas assets worth EUR 15 billion (USD 18 billion) during 2016 and 2017 and will reinvest EUR 22 billion (USD 26 billion) by the end of 2018 in energy efficiency and renewables.

Distributed small-scale generation is also gaining ground, and digitalisation is helping to convert consumers to prosumers.[i] Peer-to-peer micro-trading among solar power prosumers in virtual marketplaces has started to occur in Australia, Denmark, France, Japan, the Republic of Korea and the United States.

Distributed renewables for energy access systems served approximately

300 million

people by end-2016

Progress, albeit slow, continued towards increasing energy access in developing countries, particularly those in sub-Saharan Africa.

Approximately 1.06 billion people (about 14% of the global population) lived without electricity in 2016, about 125 million fewer people than in 2014. In the developing and emerging countries of Asia, the number of people without access to electricity decreased from over 1 billion in 2000 to 0.44 billion in 2016, with significant progress particularly in Bangladesh, China, India and Indonesia.

Distributed renewables for energy access (DREA) systems play a very important role in improving energy access. They continue to provide cost-effective alternatives to extending or improving the grid and were serving an estimated 300 million people by the end of 2016. Off-grid solar devices such as solar lanterns and solar home systems experienced 60% annual growth rates between 2010 and 2017. The pay-as-you-go (PAYG) model, enabled by the emergence of mobile technology, has become the dominant means of rolling out DREA systems around the world. In East and West Africa, PAYG companies raised about USD 263 million in capital – up 19% from 2016 – and served more than 700,000 customers.

The market for clean cooking solutions continued to thrive in 2016 (latest data available), with clean cook stoves making up 83% (30.8 million) of the 37 million cook stoves distributed. The number of clean cook stoves distributed more than tripled in 2016 compared to 2015. However, most of the 30.8 million clean cook stoves distributed in 2016 use liquified petroleum gas; only an estimated 5.9% use modern renewable fuels. Furthermore, the overall number of people without access to clean cooking facilities has increased due to population growth. About 2.8 billion people (38% of the global population, and about 50% of the population in developing countries) live without clean cooking facilities.

Pledges to phase out coal power are on the rise.

In 2017, more than 20 countries launched the Powering Past Coal Alliance that is committed to phasing out coal power by 2030, with new pledges from Angola, Denmark, Italy, Mexico, New Zealand and the United Kingdom. An increasing number of companies that owned, developed or operated coal-fired power plants moved away from the coal business. And utilities in 26 out of 28 EU member states signed an agreement not to build any more coal-fired power plants from 2020 onwards.

i Individuals are not just consumers but also have the potential to be energy producers, particularly of renewable energy, playing an active role in the generation of energy, in energy storage and in demand-side management.

TOP 5 COUNTRIES 2017

Annual Investment / Net Capacity Additions / Production in 2017

	1	2	3	4	5
Investment in renewable power and fuels (not including hydro over 50 MW)	**China**	United States	Japan	India	Germany
Investment in renewable power and fuels per unit GDP[1]	**Marshall Islands**	Rwanda	Solomon Islands	Guinea-Bissau	Serbia
Geothermal power capacity	**Indonesia**	Turkey	Chile	Iceland	Honduras
Hydropower capacity	**China**	Brazil	India	Angola	Turkey
Solar PV capacity	**China**	United States	India	Japan	Turkey
Concentrating solar thermal power (CSP) capacity[2]	**South Africa**	-	-	-	-
Wind power capacity	**China**	United States	Germany	United Kingdom	India
Solar water heating capacity	**China**	Turkey	India	Brazil	United States
Biodiesel production	**United States**	Brazil	Germany	Argentina	Indonesia
Ethanol production	**United States**	Brazil	China	Canada	Thailand

Total Capacity or Generation as of End-2017

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

[1] Countries considered include only those covered by Bloomberg New Energy Finance (BNEF); GDP (at purchasers' prices) data for 2016 from World Bank. BNEF data include the following: all biomass, geothermal and wind power projects of more than 1 MW; all hydropower projects of between 1 and 50 MW; all solar power projects with those less than 1 MW (small-scale capacity) estimated separately; all ocean energy projects; and all biofuel projects with an annual production capacity of 1 million litres or more. Small-scale capacity data used to help calculate investment per unit of GDP cover only those countries investing USD 200 million or more.

[2] Only one country brought CSP capacity online in 2017, which is why no countries are listed in places 2, 3, 4 and 5.

[3] Per capita renewable power capacity (not including hydropower) ranking based on data gathered from various sources for more than 70 countries and on 2016 population data from the World Bank.

[4] Country rankings for hydropower capacity and generation differ because some countries rely on hydropower for baseload supply whereas others use it more to follow the electric load to match peaks in demand.

[5] Solar water heating collector rankings for total capacity and per capita are for year-end 2016 and are based on capacity of water (glazed and unglazed) collectors only. Data from International Energy Agency Solar Heating and Cooling Programme. Total capacity rankings are estimated to remain unchanged for year-end 2017.

[6] Not including heat pumps.

Note: Most rankings are based on absolute amounts of investment, power generation capacity or output, or biofuels production; if done on a basis of per capita, national GDP or other, the rankings would be different for many categories (as seen with per capita rankings for renewable power not including hydropower, solar PV, wind power and solar water heating collector capacity).

THE PACE OF CHANGE REMAINS TOO SLOW

Despite these positive trends, the current pace of the energy transition will not allow us to keep global temperature rise below 2°C compared with pre-industrial levels, let alone the safer limit of 1.5°C. We also are falling behind on meeting the global energy targets for 2030 as set out in SDG 7. Progress in the heating, cooling and transport sectors needs to be increased.

SOME CHALLENGES INCLUDE:

Energy intensity improvements were weaker.

Energy intensity (the amount of energy per unit of economic activity) has been on a long-term downward trajectory, with substantial progress in the last decade compared to preceding decades. This has been good news for climate change mitigation. Energy intensity improved by 1.7% in 2017, compared to an annual average of 2.1% over the period 2011-2016. Given that SDG 7 calls for doubling the global rate of improvement in energy efficiency by 2030 (over 2010 levels), as measured by primary energy consumption in relation to gross domestic product (GDP), more action is clearly necessary.

There has been slow progress in renewable energy uptake in heating and cooling.

Energy use for heating and cooling is estimated to account for about half of total world final energy consumption in 2015 (with about half of that used for industrial process heat). Slow progress in this sector is therefore problematic. (→ *See page 16.*)

Modern renewable energy supplied approximately 10.3% of total global energy consumption for heat in 2017. Another 16.4% was supplied by traditional biomass, predominantly for cooking in the developing world where it is burned in simple, highly inefficient systems, causing significant adverse health impacts and air pollution.

Deploying renewable energy technologies for heating and cooling requires higher upfront investments than equivalent fossil fuel systems. Despite the urgent need for enabling policy to transform this sector, policy development appears to be a much lower priority for renewable heating and cooling than for renewable electricity.

Challenges in the transport sector continued to impede progress.

Despite a number of positive developments in the transport sector (→ *see page 17*), the vast majority (92%) of transport needs worldwide continued to be met by oil, with only small proportions met by biofuels (2.8%) and electricity (1.3%, of which about one-fourth is renewable). That said, countries with targets for both EVs and renewable energy in power implicitly encourage the use of renewable deployment for transport.

Even with improvements in the fuel efficiency of passenger vehicles over the last 15 years, a reduction in the number of passengers per vehicle and other factors resulted in a net 4% increase in passenger transport energy use in International Energy Agency (IEA) member countries since 2000. Major emerging economies saw net passenger transport triple during that same period.

Freight transport (by road) also continued to increase. A net increase of 9% of freight transport occurred in IEA member countries, while in major emerging economies freight transport by road increased more than 250% during 2000-2016.

The use of biofuels in transport is growing slowly – held back by continuing policy uncertainty stemming from debates about the sustainability of first-generation biofuels – and is still concentrated in a small number of regions: the United States, Brazil, the EU and China. Progress is being made in developing advanced biofuels, but their use is growing only slowly. Apart from road transport, strong interest continued in the development of aviation biofuels; however, the quantities produced in 2017 remained relatively small and mostly for demonstration use. Biofuel use in the maritime sector is also in its infancy.

Renewable energy makes up about

3.1%

of total global energy consumption for transport

HEATING AND COOLING

Although the renewable energy transition in the heating and cooling sector is slow, developments in some countries over the course of 2017 indicate that transforming the energy system is possible here too.

- **China** announced its "Clean winter heating plan for Northern China (2017-2021)," which included renewable energy. China also planned for 2% of the cooling loads of buildings to be met with solar thermal energy by 2020, with two cooling plants announced towards the end of 2017.

- In **Sweden**, which is rich in biomass, the total renewable energy share in heating and cooling in 2016 was 68.6%, the highest in the EU-28. The country's share of renewable energy (including recycled heat) in district heating reached 90% in 2017.

- In **Denmark**, a majority of the heat supplied to district heating systems was generated from biomass and waste in 2016, but the country also has made significant strides in incorporating solar thermal into its district heating systems. The renewable energy share of Denmark's heating in 2016 was 42%, twice as high as in 2004.

- **Brazil** used bioenergy to meet around 50% of its industrial heat demand in 2017, the highest share in the world. The country also was the fourth largest market for solar thermal collectors that year.

- **India** has a strong market for solar thermal applications, with installations of thermal collectors in 2017 up approximately 26% from 2016. Solar process heating supply for India's silk industry gained ground, with 1,500 units converted from wood or briquettes to solar thermal.

- In the **Middle East**, solar thermal cooling demonstration plants were commissioned in Dubai and Kuwait in 2017, with a demonstration plant announced for Saudi Arabia as of early 2018.

- **Carbon pricing policies** can spur renewable energy uptake in heating and cooling. 2017 saw significant developments with the launch of the world's largest emissions trading scheme in China, and the the Carbon Pricing in the Americas co-operative framework.

- **Building energy codes** are one of the most common policy tools used to promote both renewable energy and energy efficiency in the sector. New policies that integrated both renewable heat and energy efficiency in the buildings sector were seen in Hungary, India and Macedonia in 2017.

Modern renewable energy accounted for

10.3 %

of total global energy consumption for heat in 2017

TRANSPORT

Despite the slow pace of progress in the transport sector, several positive developments are worth highlighting:

- Despite providing only 2.8% of transport energy needs, biofuels provide by far the greatest contribution to renewable transport. The contribution from well-established biofuels such as ethanol and biodiesel has been slowly growing. Progress also is being made in developing more **advanced and sustainable biofuels**.

- **Electrification of the transport sector** is another way to increase the share of renewables while also offering opportunities for integrating VRE into the grid. This electrification generally has been limited to trains and light rail, but there is increasing potential for the entire sector to open up to electrification. Fully electric passenger cars, scooters and bicycles are no longer a novelty and are increasingly commonplace in markets such as Norway and China. More than 200 million two- and three-wheeled EVs were on the world's roads in 2016, and more than 30 million are being added each year. Electric passenger cars passed the 3 million mark in 2017 (up by an estimated 1.2 million since 2016). Prototypes for heavy-duty trucks, planes and ships also were released in 2017.

- Although **rail** accounts for only around 2% of the total energy used in transport, it is the most highly electrified transport sector. Just over one-third of the electricity used is estimated to be renewable, and the renewable share is expected to grow. The Dutch railway commitment to power all electric trains with 100% renewable electricity was achieved in 2017 – ahead of schedule – and other initiatives have been announced elsewhere.

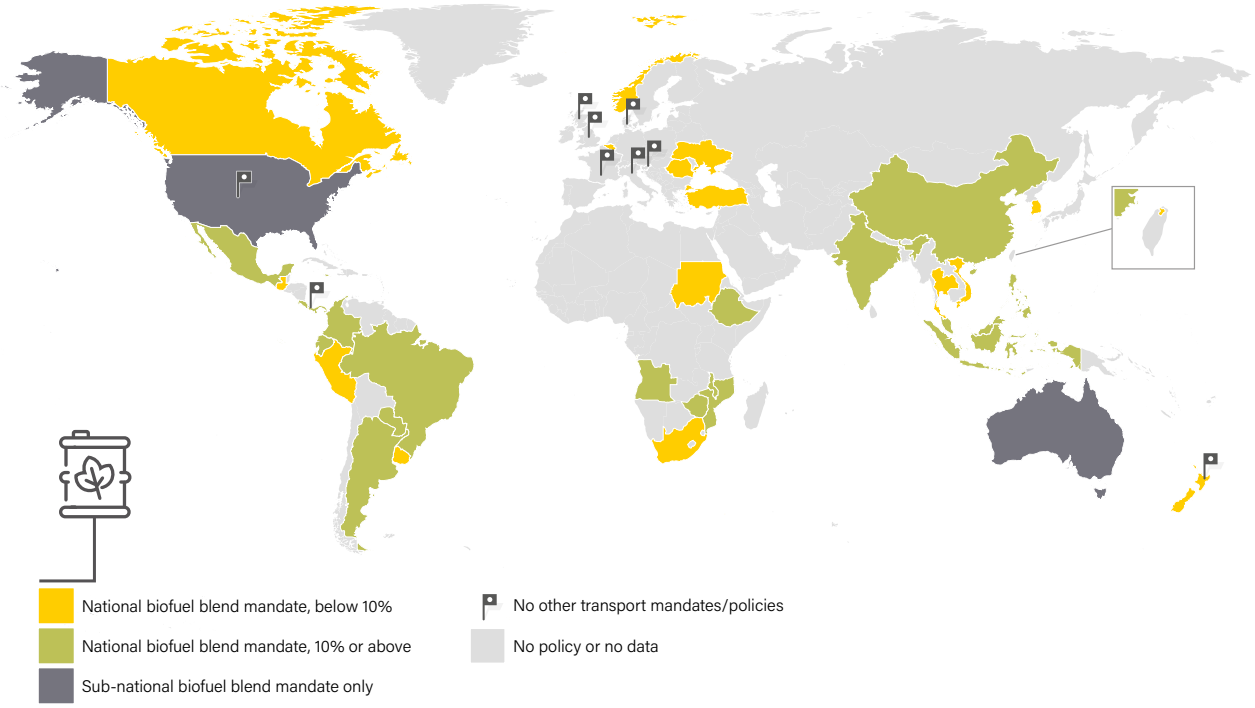
- In 2017, five countries announced their intention to **ban sales of new diesel and petrol cars** as of 2030 (India, the Netherlands and Slovenia) and from 2040 (France and the United Kingdom). By the end of 2017, a coalition of 16 global corporations from China, Europe and the United States had joined EV100, a new campaign to accelerate the uptake of EVs and associated infrastructure.

- Renewable energy plays only a minor role in **aviation**, which accounts for around 11% of the total energy used in transport and is one of the fastest growing sources of greenhouse gas emissions. In October 2016, however, the International Civil Aviation Organization announced a landmark agreement to mitigate greenhouse gas emissions in the aviation sector that might lead to increased support of renewables deployment in this sector. By early 2018, 107 countries representing 91.8% of air traffic had submitted State Action Plans under this agreement. As of year-end, five renewable jet fuels were certified for blending with traditional petroleum jet fuels.

- **Maritime transport** consumes around 9% of the global energy used in transport and produces about 2% of global greenhouse gas emissions – a figure that is expected to grow. In 2017, the International Maritime Organisation's Marine Environment Protection Committee approved a roadmap (2017-2023) which develops a strategy for reducing greenhouse gas emissions from ships and foresees initial steps being adopted in 2018. China saw the launch of the world's first all-electric cargo ship in 2017, while in Sweden two large ferries were converted from diesel to electricity.

RENEWABLE ENERGY AND TRANSPORT

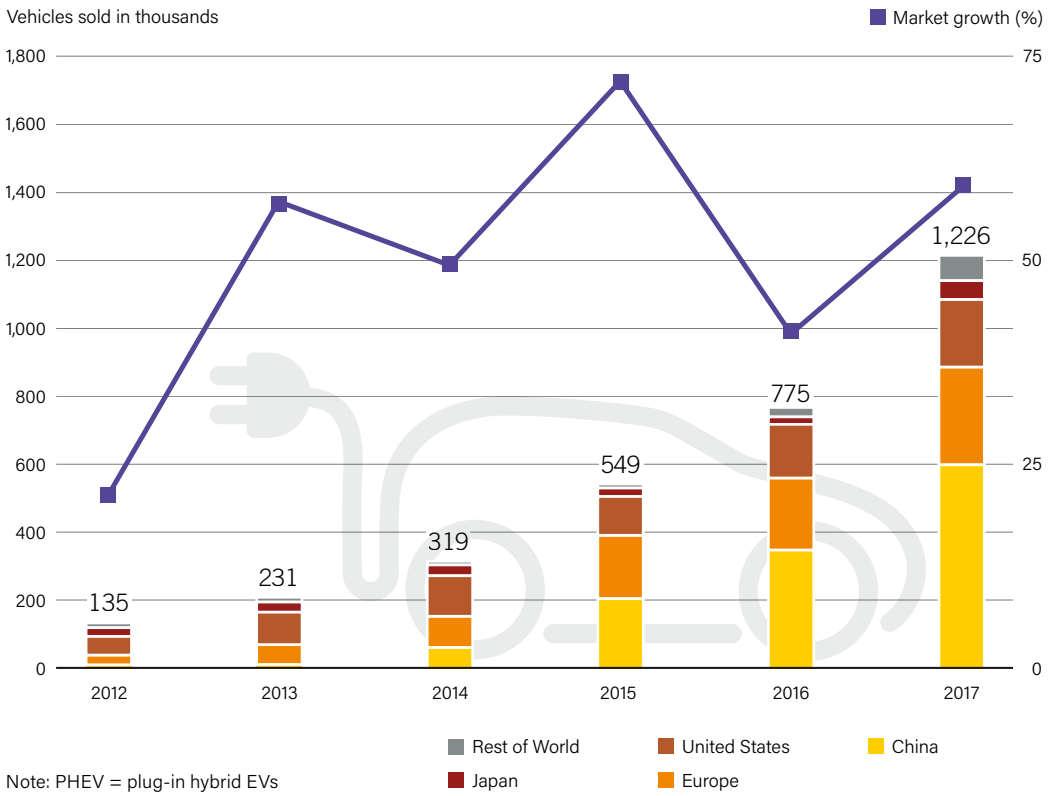
NATIONAL AND SUB-NATIONAL RENEWABLE TRANSPORT MANDATES, END-2017



GLOBAL PASSENGER ELECTRIC VEHICLE MARKET (INCLUDING PHEVS), 2012-2017

Over **3 million** electric passenger vehicles are now on the world's roads.

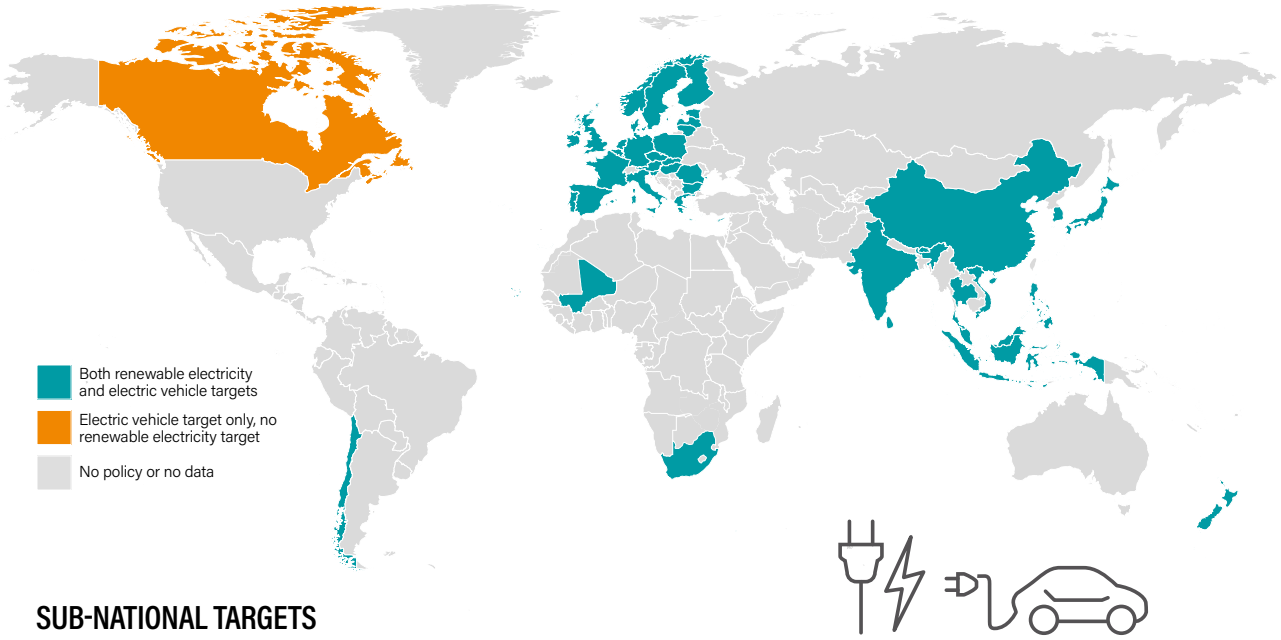
23 % of electricity used for transport is renewable



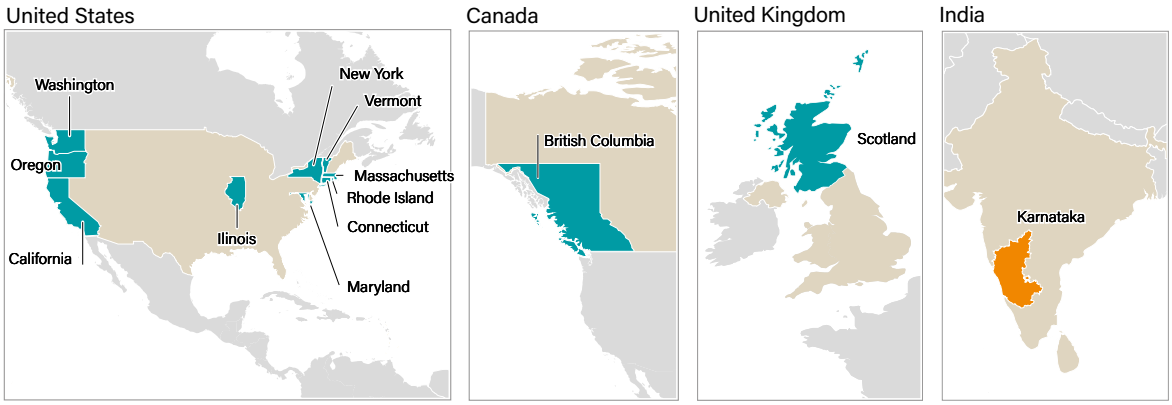
Note: PHEV = plug-in hybrid EVs

TARGETS FOR RENEWABLE POWER AND/OR ELECTRIC VEHICLES, END-2017

NATIONAL TARGETS



SUB-NATIONAL TARGETS



CITY TARGETS

Note: Targets for Norway and the United Kingdom are national-level final energy targets. The United States does not have a renewable electricity target at the national level. The figure provides a sample of local renewable energy commitments worldwide. It does not aim to present a comprehensive picture of all municipal electric vehicle or renewable electricity goals.

WE COULD EASILY BE DOING SO MUCH MORE

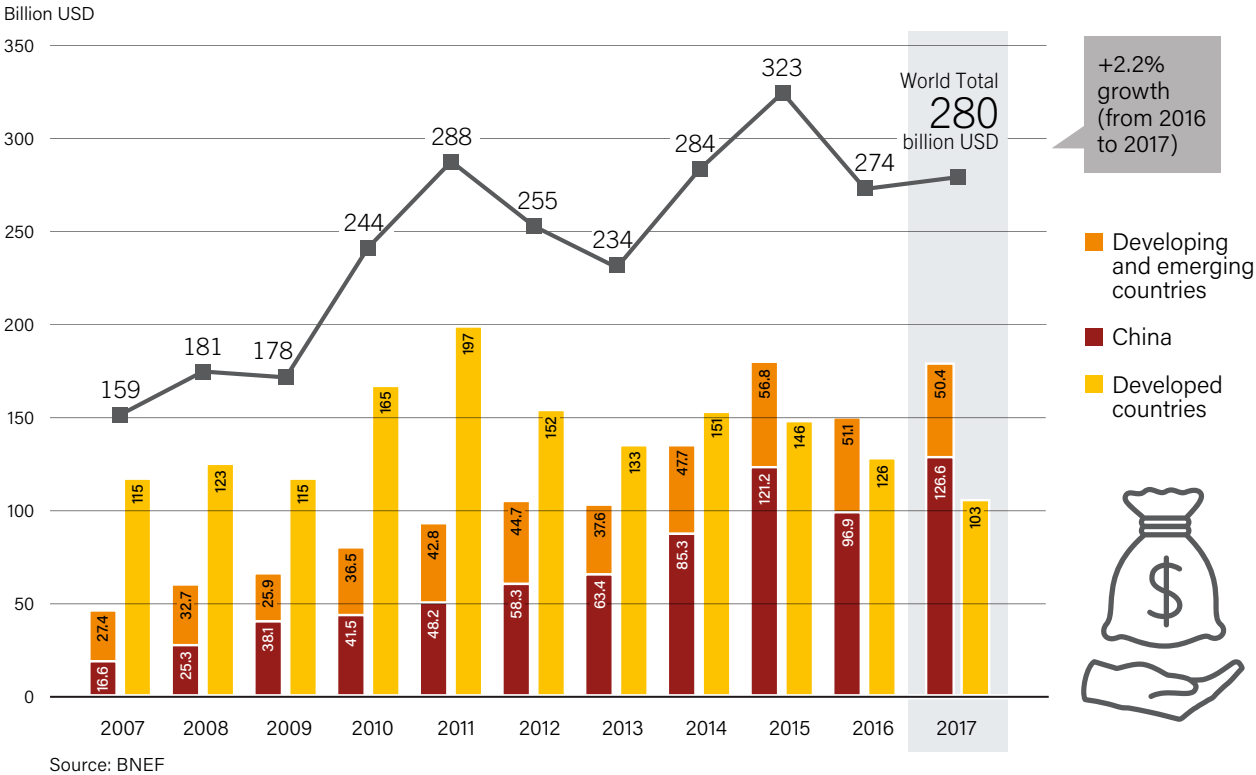
While research, development and deployment (RD&D) are crucial to address the remaining technical challenges to be overcome in deploying renewables in some areas – for example, in aviation, maritime transport and high-temperature industrial process heat – more policy support and investment would go a long way towards advancing the energy transition in heating, cooling, transport and power. The following trends show where much more needs to be done if we are to have any hope of achieving the renewable energy transition in time to meet climate and sustainable development objectives.

Investments in renewable energy, while higher than in 2016, were not on the scale necessary to meet the goals of the Paris climate agreement.

According to the IEA's *World Energy Outlook 2017* ("Sustainable Development Scenario"), keeping global temperature rise well below 2°C would require a USD 12 trillion investment in renewable power supply alone from now to 2040. This translates to investment levels on the order of USD 500 billion per year.

In 2017, global new investment in renewable power and fuels, not including hydropower projects larger than 50 MW, was USD 279.8 billion, representing a 2% increase over 2016, but investment in 2016 was down 23% compared to 2015 (from USD 323 billion to USD 274 billion). (→ *See Figure 3.*) Investment in large hydropower projects contributed an estimated additional USD 45 billion in 2017.

FIGURE 3 . GLOBAL NEW INVESTMENT IN RENEWABLE POWER AND FUELS IN DEVELOPED, EMERGING AND DEVELOPING COUNTRIES, 2007



Source: BNEF

Investors can now acquire more renewable energy capacity for less money as a result of significant cost reductions in solar PV and wind power. More ambition, however, will be necessary to achieve the energy transition.

Focussing on the power sector alone is not sufficient for a full energy transition, and available data suggests there is far less investment in renewables for heating and cooling. An IEA analysis found that global investment in solar thermal heating technologies increased steadily until 2013 but then fell each year through 2016.

Investment in achieving universal energy access remains inadequate.

Likewise, in order to meet the universal energy access targets in SDG 7, it is estimated that USD 45-56 billion will need to be invested annually until 2030, including both public and private investment.

A recent analysis suggests that 90% of the population currently without access to electricity will obtain this access thanks to renewables. Although a part of the population will be connected to the grid, distributed renewable energy systems will play a key role in reaching global electricity access. According to the IEA, nearly 75% of those gaining access will be electrified by stand-alone systems or mini-grids. Despite increasing capital flows, investments in DREA are far below the required annual investment to achieve worldwide access to electricity. In addition, further efforts are necessary to increase access to clean cooking facilities.

Investment in renewable energy by the traditional leading countries has declined.

Renewable energy investment in developed countries, as a group, fell 18.3% in 2017, despite the deployment of substantial amounts of renewable energy capacity. Investment decreased in developed-country front-runners such as the United States (down 6% or down USD 2.6 billion) and Japan (down 28% or down USD 5.2 billion) and in the leading European countries of Germany (down 35% or down USD 5.6 billion) and the United Kingdom (down 65% or down USD 14.1 billion).

Unlike developing and emerging countries, many developed countries are experiencing slow or declining growth in electricity demand, have significant amounts of existing power generation capacity and, in some cases, are intentionally slowing renewables deployment to focus more on integration of renewables with the grid. However, there is still a need for policies to encourage increased investment in renewables, enabling technologies and necessary infrastructure in line with the new reality of renewable energy (e.g., falling costs, rising shares of VRE, need for increased flexibility and sector coupling, etc.).

Investment

levels are not high enough to reach international climate goals

Investment needs to increase in the regions that need it most.

In terms of global new investment in renewable power and fuels (excluding hydropower larger than 50 MW), China, as a fast-growing economy with underserved market segments, accounted for 45% of the global total, up from 35% in 2016. Europe as a whole came in a distant second with 15%, and the United States followed at 14%. Other countries held single-digit investment shares, although in most cases overall energy use, economic activity and related indicators were lower in these countries.

In investment per GDP, developing countries topped the list in 2017. Many developing countries are investing as much as or more than developed and emerging countries on a per GDP basis. Also, in many of these and other countries, more capacity and infrastructure development are needed, particularly where rates of energy access and renewable energy shares remain low. Institutional support is necessary to help finance renewable energy projects and infrastructure. Furthermore, development banks must prioritise projects using renewable energy over those using fossil fuels.

A wide range of additional countries and development banks could, and should, substantially raise their levels of investment in renewables and energy efficiency and broaden the regional spread of renewables where renewable energy shares and energy access remain low. Investment in these areas also should encompass all sectors.

Little progress has been made in the elimination of outdated fossil fuel subsidies.

In 2017, the Group of Twenty (G20) countries reaffirmed their 2009 commitment to phase out inefficient fossil fuel subsidies, although the G20 has never defined "inefficient" and no deadlines have been set. The commitment is not only limited to the G20: by the end of 2016, more than 50 countries had pledged to phase out fossil fuel subsidies. Nonetheless, governments have continued to allow such subsidies to distort the market and impede the transition to renewable energy. In 2016, global fossil fuel production and consumption subsidies were estimated to total some USD 370 billion, only a 15% reduction since 2015.

And while renewables continue to be perceived as "too expensive" in some quarters, subsidies for fossil fuels were nearly double the estimated subsidies for renewable power generation (USD 140 billion). If externalities such as health, pollution and climate mitigation were factored in, the value of fossil fuel subsidies would be considered higher by an order of magnitude.

Investment in new fossil fuel- and nuclear-based power is still significant.

Despite renewables increasingly being the least-cost option, investments in fossil fuel and nuclear power generating capacity remained high in 2017, at an estimated USD 103 billion and USD 42 billion, respectively – together accounting for 32% of global investment in new power capacity. Global coal consumption increased 1% in 2017, reversing a three-year decline, almost entirely because of higher coal-fired power generation, much of that in China. Within the EU, Poland remains heavily invested in coal with plans under way to build 10 GW of new coal-fired power plants. Other countries constructing new coal plants include Indonesia, Japan, the Philippines and Turkey.

Greater political ambition is needed to accelerate the energy transition across all sectors.

As discussed above, progress in deploying renewables in the heating and cooling sector (for buildings, cooking and industry) and in the transport sector remains very slow. However, policy makers have not given them the same level of attention as the power sector, which accounted for only 20% of total final energy consumption.

In the heating, cooling and transport sectors, renewable energy still must compete with fossil fuels that often remain heavily subsidised. A major barrier to progress is the lack of political will, as manifested by continuing fossil fuel subsidies, and by the lack of effective renewable energy targets and policy support across sectors. Out of 197 countries, targets (i.e., indication of a government's intention) for increasing the use of renewables in heating and cooling exist in only 48 countries, and for transport this falls to only 42 countries, compared to targets in 146 countries for renewable energy use in the power sector. Targets for the share of final energy from renewable sources are in place in 64 countries, while Denmark is the only country with a 100% target for total final energy from renewables.

When looking at policies and regulations (i.e., the process of implementation), only 24 countries having regulatory policies that support the uptake of renewable energy in heating; however, a total of 29 countries have other heating and cooling incentives at the national level.

Likewise, renewable fuels in the transport sector are still at an early stage and are not seen as a priority in most countries. As of 2017, 70 countries had regulations in place to support the transition to renewable transport, an increase of only 7 countries since 2014.

Electricity system transformation and system flexibility are lacking, leading to curtailment of renewables.

In some countries and regions around the world, power generation has been scaled back (curtailed) due to bottlenecks in transmission capacity at times of excess supply. Curtailment impedes the advancement of renewables, increases overall system costs and is a sign of the need for greater flexibility in power systems.

There have been some challenges in China in particular, but curtailment there is in decline due to a number of government policies and investment in new transmission infrastructure. The average curtailment in China in 2017 was down for both solar PV and wind power compared to 2016. All provinces saw significant reductions relative to 2016 in response to new or adjusted policies, including those to expand electrification (especially for industrial heating), to encourage direct trade of renewable energy among large consumers and to construct new transmission lines.

Germany also is a particular case, with about 3.7 TWh of renewable electricity (about 2.3% of annual renewable generation) curtailed in 2016. Germany has experienced congestion on its grids due to rising VRE output and increased electricity trade with its neighbours; this is limiting the flow of wind power from turbines in the north to high-demand regions in the south, leading to curtailment.

Targets for the share of final energy from renewable sources are in place in

64 countries

MARKET AND INDUSTRY DEVELOPMENT **AT A GLANCE**

In 2017, the growth of renewable energy worldwide continued to be spurred by a combination of targeted public policy and advances in energy technologies.

Biomass Energy

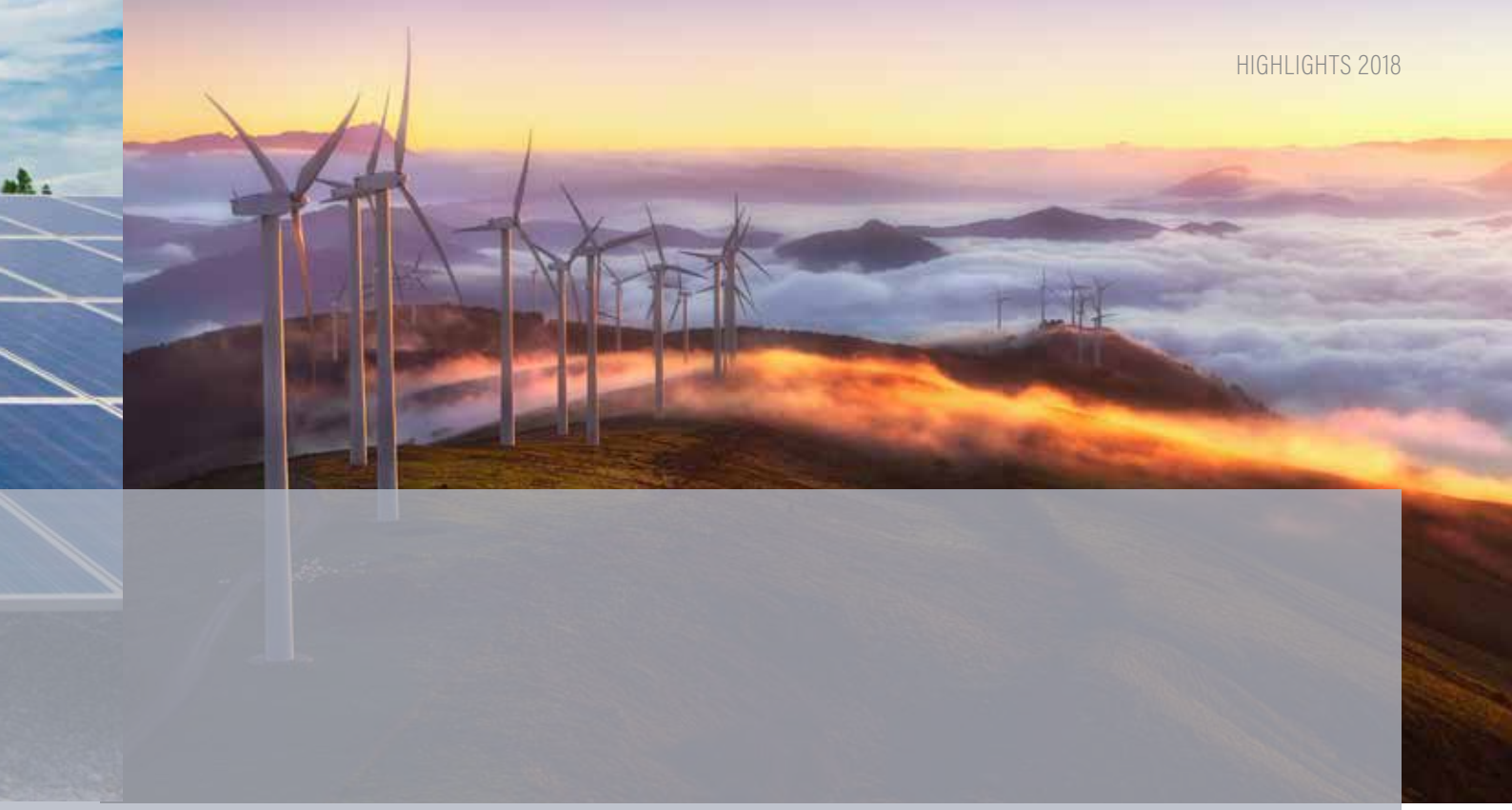
Excluding traditional biomass, bioenergy accounted for the greatest share of renewable heat in 2017, providing about two-thirds. Global bioelectricity capacity (electricity generation from bioenergy) increased an estimated 7% in 2017, to 122 GW, and bioelectricity generation rose some 11% to an estimated 555 TWh. Global biofuels production increased around 2% to some 143 billion litres (equivalent to 3.5 exajoules). Several initiatives in 2017 aimed to promote sustainable bioenergy development. These include the establishment of the BioFuture Platform involving 20 countries, and the Sustainable Biofuels Innovation Challenge with 22 participant countries.

Geothermal

An estimated 0.7 GW of new geothermal power generating capacity came online in 2017, bringing the global total to an estimated 12.8 GW. Indonesia and Turkey continued to lead for new installations and accounted for about half of the new capacity during the year. The countries with the largest amounts of geothermal power generating capacity at the end of 2017 (in order of scale) were the United States, the Philippines, Indonesia, Turkey, New Zealand, Mexico, Italy, Iceland, Kenya and Japan.

Hydropower

Hydropower capacity grew by an estimated 19 GW in 2017, with total capacity reaching some 1,114 GW. While significant, this is the smallest annual increment in the last five years. The leading countries for cumulative capacity – China, Brazil, the United States, Canada, the Russian Federation, India and Norway – remained the same as in the past several years and together represented about 63% of installed capacity at year's end.



Ocean Energy

Ocean energy remains a largely untapped renewable energy source, despite decades of development efforts. Of the approximately 529 MW of operating capacity at the end of 2017, more than 90% was represented by two tidal barrage facilities (in France and the Republic of Korea). Ocean energy technologies deployed in open waters had a notably good year, as new capacity came online from both tidal stream and wave energy projects, much of this launched in the waters off Scotland. The year ended with net capacity additions of at least 4 MW, for a year-end total of 17 MW of tidal stream and 8 MW of wave energy capacity.

Solar PV

Solar PV had another landmark year in 2017. The world added more capacity from solar PV than from any other type of power generating technology, and more solar PV was installed than the net capacity additions of fossil fuels and nuclear power combined. Solar PV was the top source of new power capacity in several countries, including China, India, Japan and the United States. Globally, about 98 GW (in direct current) of solar PV capacity was installed both on and off the grid – up about 29% from the record additions in 2016 – for a cumulative total of some 402 GW at the end of 2017. On average, the equivalent of more than 40,000 solar panels was installed each hour of the year.

Concentrating Solar Thermal Power (CSP)

In 2017, 100 MW of CSP capacity came online, about the same as in 2016, bringing global capacity to around 4.9 GW. Several projects that were due to enter operation during the year were delayed until 2018 or later. Although global capacity increased by only just over 2%, the CSP industry was active, with a pipeline of more than 2 GW of projects under construction around the world, particularly in China, the Middle East and North Africa.

Solar Thermal Heating and Cooling

Solar heating and cooling systems with glazed and unglazed collectors provided approximately 388 TWh (1,397 petajoules) of heat annually by the end of 2017, equivalent to the energy content of 228 million barrels of oil. Globally, 35 gigawatts-thermal (GW_{th}) of capacity of glazed and unglazed collectors was newly commissioned in 2017, bringing total capacity to an estimated 472 GW_{th} by year's end. Gross additions for the year were down 3% – from 36.2 GW_{th} in 2016 – due to increasing competition with other renewable energy technologies in the residential sector and to low fossil fuel prices, which negatively affected solar thermal use in the commercial sector.

Wind Power

Wind power had a relatively modest year compared with 2015 and 2016, but still saw its third strongest 12-month period, with about 52 GW added globally in 2017. Cumulative capacity increased nearly 11% to around 539 GW. As in 2016, a decline in Chinese installations accounted for much of the contraction, while several other markets, including Europe and India, had record years. For the first time in at least a decade, however, the trend towards greater diversification of markets reversed in 2017, with a concentration of new wind power capacity in a smaller number of markets.

Although onshore wind power continues to account for the bulk of global installed capacity (more than 96%), nine countries connected a total 4.3 GW of offshore capacity during 2017, increasing total world offshore wind power capacity 30%, to 18.8 GW. The top countries for offshore additions were the United Kingdom, Germany, China and Belgium.

INNOVATION: THE HALLMARK OF AN ACCELERATED ENERGY TRANSITION

Technological advances

Technology advances in power generation equipment are unlocking efficiencies in manufacturing, reducing costs and improving performance. Innovations such as large wind turbines with greater swept areas allow more energy to be harvested from the same resource, while designs of new solar PV cells offer greater efficiency. A significant innovation in the offshore wind sector is the deployment of floating turbines that offer the potential to expand the areas where offshore wind power is viable and economically attractive.

Use of solar thermal expanded in district heating systems and for industrial process heat in the low- to medium-temperature range. Installations of solar heat capacity for industrial processes had a record year in 2017.

Digitalisation

The digitalisation of grid networks and ultra-high-speed telecommunications networks (along with improvements in cybersecurity) is rapidly and fundamentally changing the way that energy is produced and consumed. On the supply side, the use of sensors and analytics is helping to reduce operation and maintenance costs and planned outages and is improving power plant and network efficiencies. On the demand side, an increasing number of utilities are relying on wireless communication with smart appliances, such as thermostats, to reduce consumer demand when needed. Thus, vehicles and buildings are becoming more connected, and process controls are contributing to cost-effective energy savings in industry.

Virtual power plants and blockchain

Traditional utilities, network operators and third parties are developing joint platforms for decentralised energy that include installing rooftop solar PV and batteries "behind the meter" (i.e., at the customer side of the interface with the distribution grid) and operating them as virtual power plants (in many cases, as pilot projects). These virtual power plants are aggregated through a cloud-connected intelligent control system, enabling the utility, for example, to discharge the batteries at a time of greatest benefit for customers and the community, and to enable high penetration of VRE in the grid while ensuring grid stability.

Blockchain represents a new way of sharing information. It is a public distributed ledger where digital transactions are recorded and confirmed anonymously. In energy sectors, blockchain offers opportunities for new types of customer market projects and micro-trading among, for example, solar power prosumers. The number of projects testing blockchain in the energy sector has increased significantly over the last two years.

Increasing energy access

The mini-grid sector is evolving rapidly. Driven in large part by the falling costs of solar PV, an increasing number of private mini-grid developers are actively testing a range of business models and helping to move the sector to maturity. In 2017, over 100 renewable energy-based mini-grid projects were completed in developing countries primarily in Africa and South Asia.

Technological innovation is transforming off-grid systems into viable commercial propositions. Key system components such as batteries, light-emitting diodes, controllers and meters have undergone major cost reductions and efficiency improvements. These developments are complemented by the emergence and proliferation of solutions for remote monitoring, data analytics, and customer management and payments. Appliance manufacturers have started marketing highly efficient low-voltage direct current appliances such as televisions, fans, refrigerators and small machines designed specifically to be powered by off-grid solar systems. By using high-efficiency products, the energy system size can be reduced significantly so that consumers receive more energy services for less money.

Sector coupling with electric vehicles

Rising numbers of EVs present both opportunities and challenges. Several actors, including utilities, car manufacturers and distribution grid operators, are experimenting with vehicle-to-grid technologies that could enable utilities to manage EV charging while allowing vehicle batteries to store grid electricity for reinjection when needed.

Battery and thermal storage

The battery storage industry is coming into its own. Battery prices continue to decline, particularly for lithium-ion batteries. Global battery manufacturing capacity passed 100 gigawatt-hours in 2016 and continued to expand in 2017.

Thermal energy storage is playing an increasingly important role as well. Stored thermal energy can be converted into electricity or used directly for heating and cooling. Likewise, surplus solar PV and wind power can be stored as, for example, hot or chilled water (or ice).

HOW TO SPEED THE TRANSITION

The transition to a renewable energy future is unstoppable, but not necessarily within the time frame needed to ensure a stable climate, or to meet the SDG 7.

Governments have a key role to play in accelerating momentum in the energy transition – by what they tax, what they subsidise, what they require and what they prohibit. It has been more than 25 years since the adoption of the United Nations Framework Convention on Climate Change, yet renewables are still disadvantaged. Fossil fuels continue to enjoy the lion's share of subsidies, tax relief and other kinds of support. The following are key actions that governments and other actors should take to level the playing field, although their implementation might differ depending on local conditions.

Fossil fuel subsidies were more than

double

the estimated subsidies for renewable power generation

1 SET PRIORITIES THROUGH TAX AND OTHER FINANCIAL INCENTIVES

As noted before, continuing to subsidise fossil fuels and nuclear power distorts the market and slows the renewable energy transition. These subsidies need to be phased out as quickly as possible, and every country should set a deadline (sooner rather than later) to do so.

Carbon pricing and other policies should be implemented to reflect the true cost of fossil fuels: increasing CO_2 emissions, air pollution and their related impacts on health, quality of life, etc.

Carbon pricing policies, which include carbon taxes and emission trading schemes, were in place in 64 jurisdictions worldwide in 2017, up from 61 in 2016. *(→ See Figure 4.)* In 2017, China launched the world's largest emissions trading scheme, with the first phase of a new cap-and-trade programme focusing on the country's power sector. The Carbon Pricing in the Americas co-operative framework also was launched, with participants spanning North, Central and South America aiming to align their carbon pricing systems and to develop a harmonised carbon market.

These are positive examples, but they must be scaled-up.

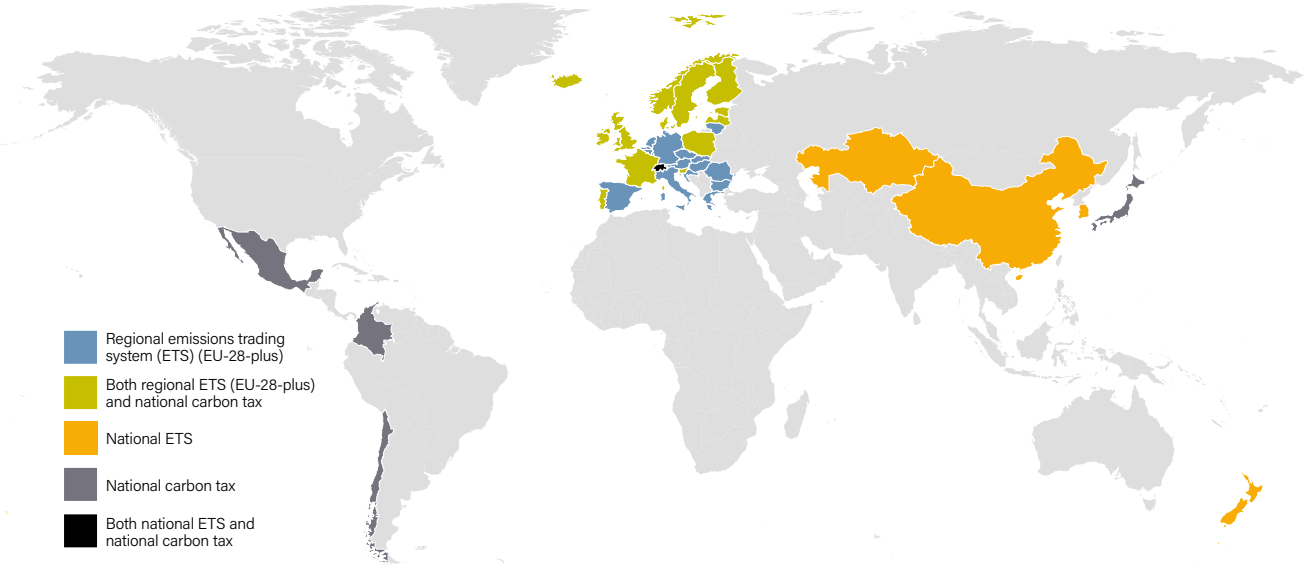
2 SET TARGETS FOR THE ENERGY SYSTEM AS A WHOLE, INCLUDING FOR ALL MAJOR END-USE SECTORS

Targets take many forms, including goals for achieving a specified contribution of renewable generation (or capacity), and for shares of renewable energy overall and in specific sectors.

Many sub-national governments are leading with ambitious targets. In 2017, more than 250 US mayors committed to the US Conference of Mayors' goal of 100% renewable energy by 2035. Municipal leaders in Japan released the Nagano Declaration committing to work towards 100% renewable energy for cities and regions across the country. In Germany, over 150 districts, municipalities, regional associations and cities had committed by the end of 2017 to pursue 100% renewable energy through the network of 100% Renewable Energy Regions.

FIGURE 4 . CARBON PRICING POLICIES, 2017

NATIONAL POLICIES



3 THINK OUTSIDE THE BOX: APPROACH CHALLENGES SYSTEMICALLY

While these are good examples of the kind of ambitious targets that are needed, in many cases the 100% targets are for renewable electricity alone rather than being system-wide. Similarly, many national targets have been set for 100% renewable energy in the power sector, but 100% renewable energy targets are needed i.e., not just for power. These could then be expanded into sector-specific targets for 100% renewable energy in heating, cooling and transport.

Targets for renewable transport, heating and cooling should be instituted as a high priority.

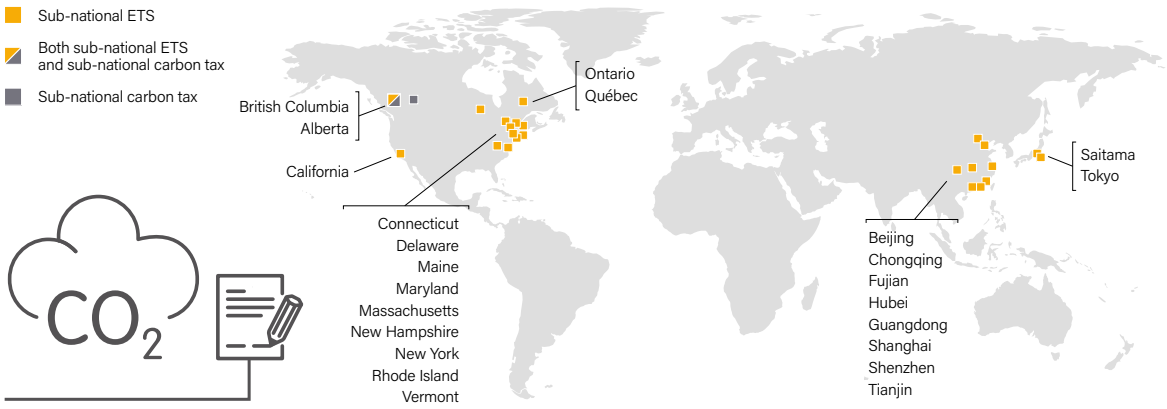
A faster transition to a renewable energy future requires a **holistic, system-wide approach**

A faster transition to a renewable energy future requires a holistic, system-wide approach, including increasing energy efficiency measures to reduce overall energy demand. It is not enough to simply build more wind farms or put solar panels on every rooftop. Nor is it enough to substitute electricity for natural gas used for heating if the source of the electricity is not renewable. Put simply, renewables need to be used to meet the energy needs of all sectors. This means that renewable energy providers need to better understand the thinking, challenges and opportunities in every end-use sector. Local involvement of all stakeholders and local ownership (e.g., prosumers, community energy) is also critical.

Developing renewable energy has broader implications than for the energy sector alone, and policies must be integrated into an overall framework connecting economic policy, industry, jobs and trade, facilitated by education and capacity building.

Finally, aligning policies to support sustainable deployment of renewables at the national, sub-national and local levels is key.

SUB-NATIONAL POLICIES



4 DESIGN FOR FLEXIBILITY

An energy system designed for the maximum uptake of variable renewables must be flexible enough to accommodate the variable nature of wind and sun, by: incorporating sufficient flexible generation and maximising the use of demand management; managing shorter trading times; being "smarter" (including through digitalisation and automation technologies) about matching demand with supply; and other systemic solutions as described above.

An increasing number of countries are planning for flexibility to facilitate integration of higher shares of VRE. To date, most flexibility in power systems has been provided by transmission interconnections with neighbouring systems and by flexible generation capacity (particularly hydropower and natural gas-fired power plants).

Many more options are available for ensuring reliability while integrating high proportions of VRE, such as improved resource forecasting and combining different types of variable resources with appropriate geographical distribution. Other measures to improve the flexibility and resilience of energy systems include improving energy system operations and performance through changes in market design and regulatory frameworks; improved planning and deployment of grid infrastructure, flexible generation and information and control technology; energy storage; demand-response capability; and coupling of the electricity, thermal and transport sectors.

In developing countries, effective energy planning means designing for maximum flexibility at the outset to have an energy system that is decentralised and designed to use high shares of renewable energy. This approach is fundamental to avoid the risk of getting locked into non-flexible fossil fuels and nuclear power.

Designing for
flexibility
is key to avoid the risk of getting locked into fossil fuels and nuclear power

5 ADOPT POLICIES THAT ENABLE THE RAPID UPTAKE OF RENEWABLES

The following are needed to create a more enabling environment for renewable energy uptake:

Further measures to integrate renewables and energy efficiency, already under way to some extent in the building, heating and cooling sectors

For example, mandatory and voluntary energy codes for buildings exist in more than 60 countries worldwide. Where codes already exist, they should be updated to optimise the uptake of renewables. For example, building codes could expand on energy efficiency standards so that new building stock can use renewable heat and power, largely sourced on site, to serve the (reduced) energy needs of the buildings. Where building codes do not exist, they should be developed as part of a holistic approach to decarbonisation.

Measures to increase the uptake of renewable energy in transport

To take advantage of the momentum in e-mobility, integrated policies to increase the share of renewable energy supplying electricity for the transport sector must be developed, ensuring that charging patterns are effectively harmonised with the requirements of the electricity system. In this way, increasing electrification of the transport sector can aid in the integration of VRE rather than placing additional burdens on the system. Grid regulations should allow for the development of EV-to-grid services (e.g., storage and possibly other ancillary services) by allowing the EV to act as a storage unit when connected to the grid. While examples of direct policy linkages between EVs and renewable electricity are limited, a number of jurisdictions have adopted policies to encourage or mandate the use of renewable energy in EVs, such as in Austria and Germany.

Biofuel blend mandates remain one of the most widely adopted mechanisms for increasing the use of renewable fuel use in transport. Ensuring continuous policy support is key to developing sustainable biofuels. This is important since sustainable biofuels likely will play a significant role in emissions reduction in transport. In the EU for example, the proposed 2017 Renewable Energy Directive for 2030 included a target of 3% for advanced biofuels and a cap of 7% on first-generation biofuels. Similar policies for advanced biofuels have already been adopted at the national level in the EU as was seen in Italy.

Most policies to promote renewable energy in the transport sector have focused on road transport. Policy makers are slowly supporting the integration of

renewable energy into rail transport systems, particularly at the municipal level. Other sub-sectors such as aviation and maritime transport need greater attention. While few direct support policies target the use of renewable fuels in aviation, Indonesia introduced a 2% renewable jet fuel mandate in 2017 and is set to increase to 5% by 2025. Developing support mechanisms for advanced renewable fuels is fundamental across transport sectors.

Measures to increase energy access

Grid-connected and off-grid renewable energy play key roles in addressing prevalent electricity access challenges (renewable power is less expensive and can be made available more quickly than fossil fuel-based power). The least electrified countries, most of which are in Africa, have not yet established an appropriate enabling environment, including the right policies, institutions, strategic planning, regulations and incentives to support energy access in general, and distributed energy access and renewables in particular. Reaching energy access goals requires:

- Establishing energy access targets and national commitments in the form of specific support, promotion instruments and favourable regulation and permitting.
- Allocating public funds to DREA projects and/or for grid extensions or capacity expansion (rather than exclusively for the latter), for example through well-designed subsidies, concessional equity and debt, depending on local conditions and needs.
- Thinking outside the "grid versus off-grid" dichotomy and embracing new technologies, business models and implementation strategies. Grid extension alone should not be seen as the only option for expanding energy access.
- Providing a level playing field for renewable energy and distributed renewable energy systems to encourage their deployment.
- Opening up electricity markets to independent power producers (including mini-grids) and increasing co-operation between public and private sectors.
- Involving local financial institutions in investments (e.g., through equity and debt) aimed at improving energy access. Security for investors also needs to be provided.
- Increasing deployment of clean cook stoves that use renewable energy.

Measures to encourage innovation

Driving innovation requires innovative policy measures, which are needed to help increase the number of new players, both producers and consumers. This includes: harnessing the potential of digitalisation; promoting integrated planning and policy design at the city and regional levels; and finding new viable business models and ways to support investments in developing countries.

Policy support also should aim at building capacity, including raising awareness about the different technologies, building know-how and expertise in relation to installation, etc. Innovation can be encouraged by:

- Supporting research and development for technological advances

  Continued RD&D is necessary to further bring down costs for less mature renewable energy technologies, as well as for enabling technologies, which play an increasingly important role for sector coupling and integration of higher shares of variable renewables. Further RD&D is needed especially in the heating and cooling and transport sectors.

- Establishing long-term policy certainty to facilitate increased investment across sectors

  Policy certainty is crucial for ensuring further renewable energy deployment. Energy policies also should be integrated with environmental, economic, industrial, trade and education policies to harness the co-benefits of renewables, including the development of local value chains, job creation, etc.

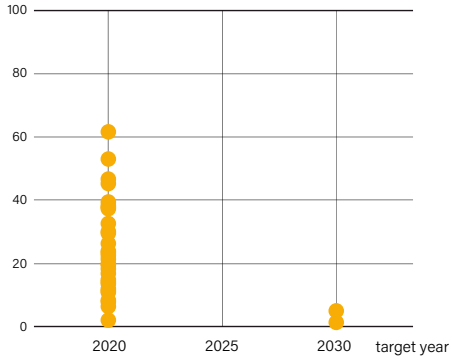
POLICY LANDSCAPE 2017

NATIONAL SECTOR-SPECIFIC TARGETS FOR SHARE OF RENEWABLE ENERGY BY A SPECIFIC YEAR, BY SECTOR, IN PLACE AT END-2017

HEATING AND COOLING

= one target

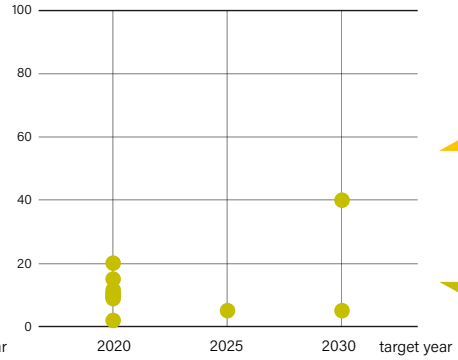
Targets for share of heating and cooling from renewable sources in %



TRANSPORT

= one target

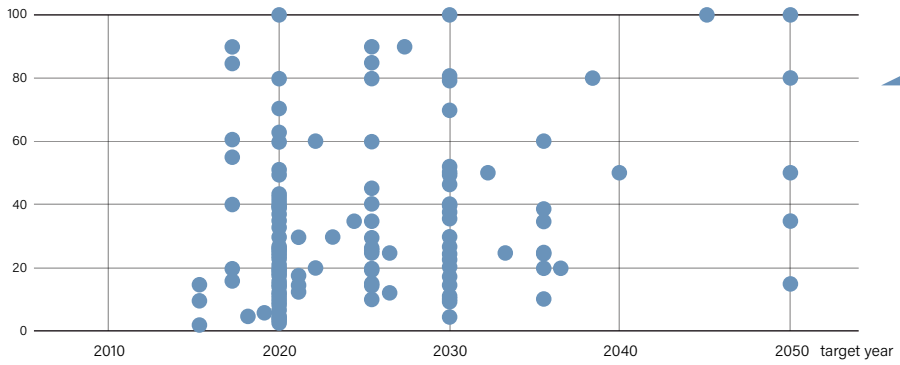
Targets for share of transport energy from renewable sources in %



POWER

= one target

Targets for share of electricity generation from renewable sources in %



Most national targets focus on the power sector, where the level of ambition is typically higher than for heating and cooling and for transport.

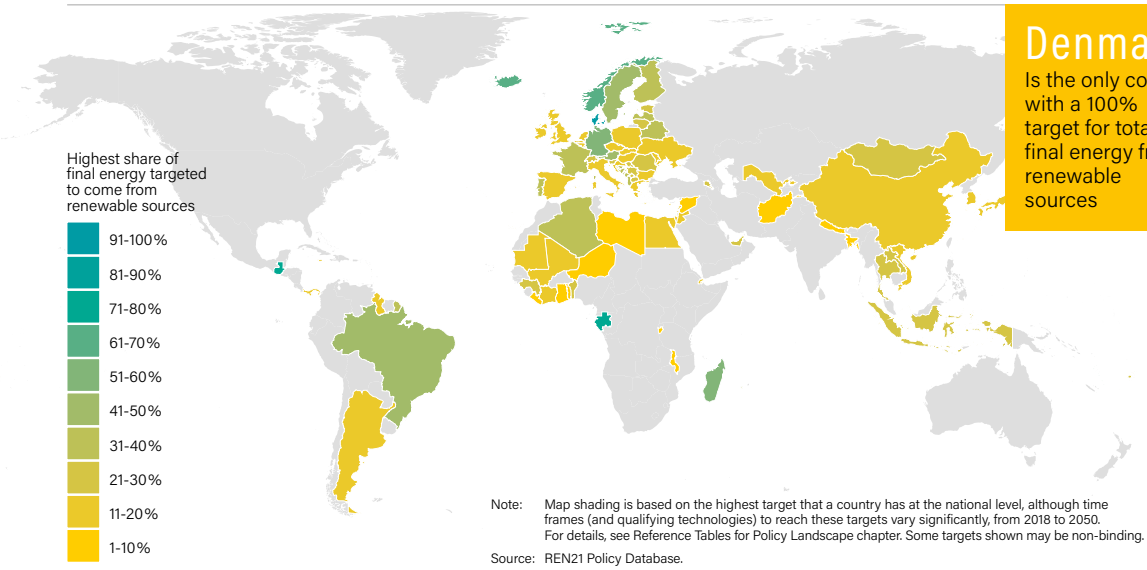
48 countries have national targets for renewable energy in heating and cooling.

42 countries have national targets for renewable energy in transport.

146 countries have national targets for renewable energy in power.

Note: Each dot can represent more than one country and is based on the highest target that a country has set at the national level. Figure includes only countries with targets in these sectors that are for a specific share from renewable sources by a specific year, and does not include countries with other types of targets in these sectors. The total number of countries with any type of target for renewable energy (not specific to shares by a certain year) is shown in the boxes. Some targets shown may be non-binding.

NATIONAL TARGETS FOR SHARE OF RENEWABLE ENERGY IN FINAL ENERGY BY A SPECIFIC YEAR, IN PLACE AT END-2017

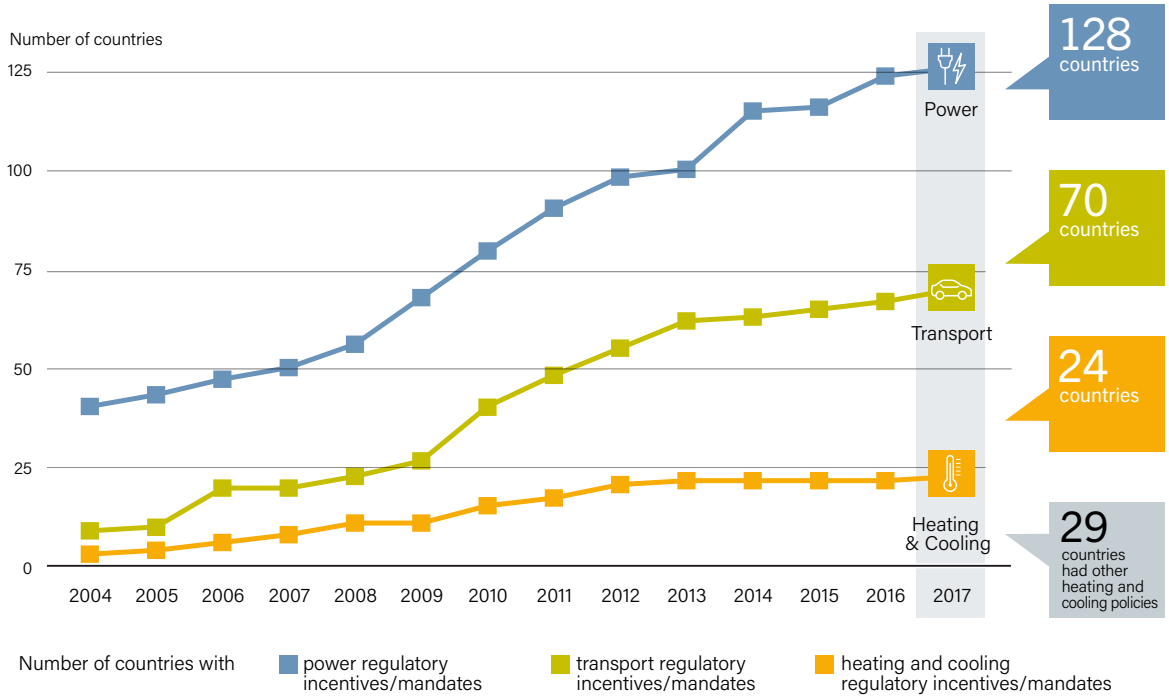


Denmark
Is the only country with a 100% target for total final energy from renewable sources

Note: Map shading is based on the highest target that a country has at the national level, although time frames (and qualifying technologies) to reach these targets vary significantly, from 2018 to 2050. For details, see Reference Tables for Policy Landscape chapter. Some targets shown may be non-binding.

Source: REN21 Policy Database.

NUMBER OF COUNTRIES WITH RENEWABLE ENERGY REGULATORY POLICIES, BY SECTOR, 2004-2017



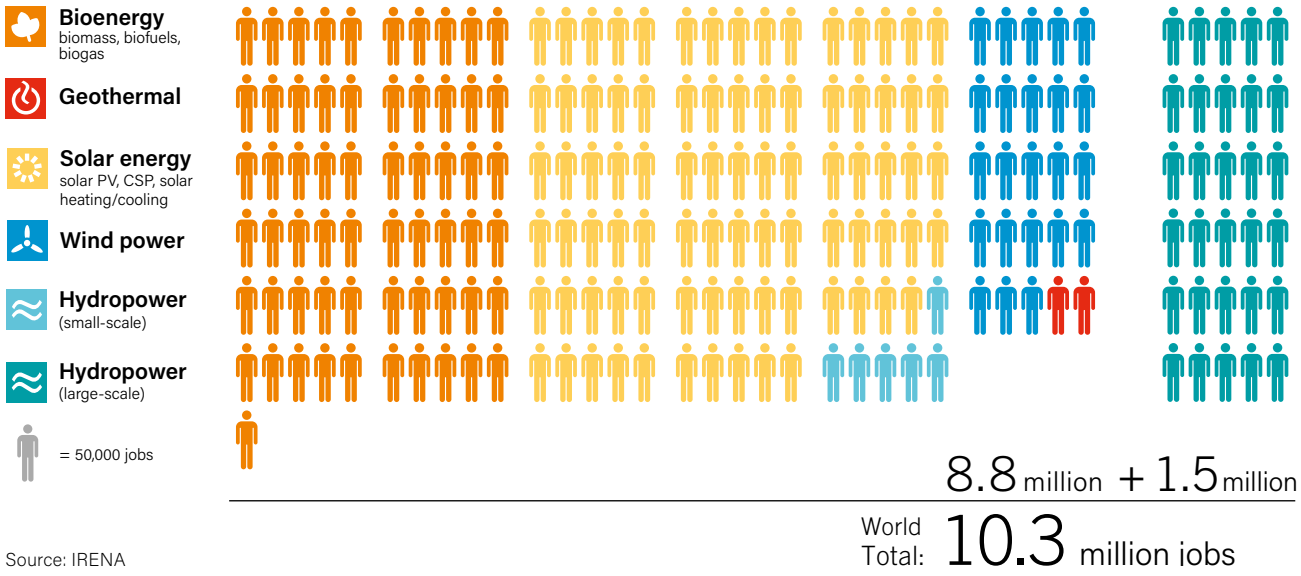
Source: REN21 Policy Database

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. A country is considered to have a policy (and is counted a single time) when it has at least one national or state/provincial-level policy in place. Power policies include feed-in tariffs/premiums, tendering, net metering and renewable portfolio standards. Tendering is counted cumulatively. Heating and cooling policies include solar heat obligations, technology neutral heat obligations and renewable heat feed-in tariffs. Some countries with regulatory policies for heating and cooling also have other heating and cooling policies. Transport policies include biodiesel obligations/mandates, ethanol obligations/mandates and non-blend mandates.

Insufficient
policy support
for renewables in heating, cooling and transport

JOBS IN RENEWABLE ENERGY

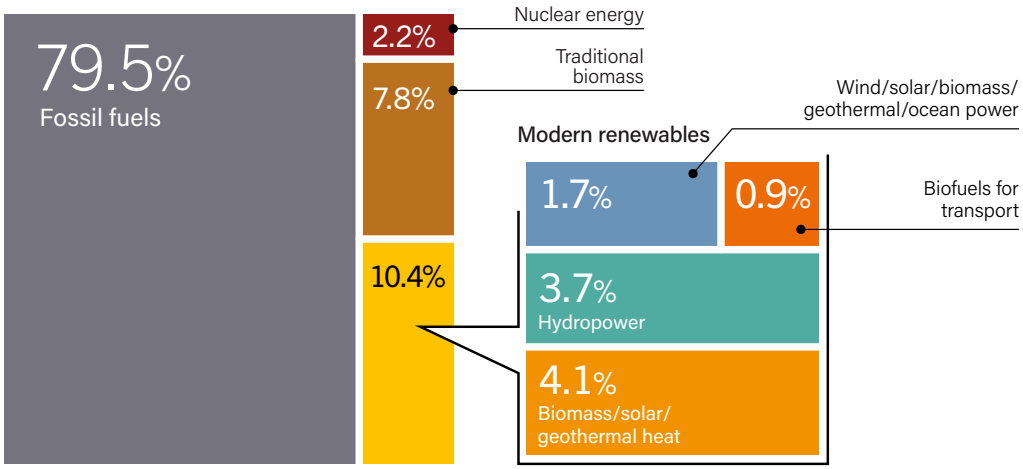
JOBS IN RENEWABLE ENERGY



Source: IRENA

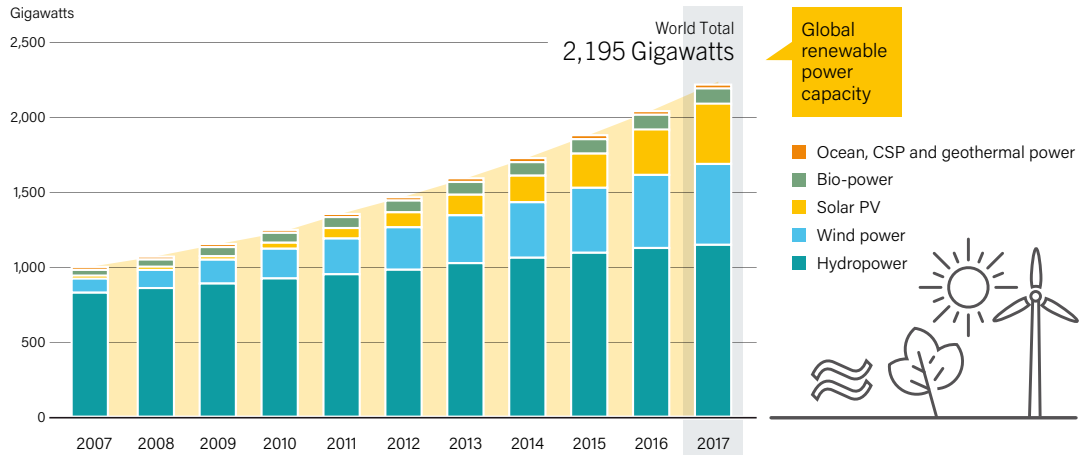
GSR 2018 KEY FIGURES

ESTIMATED RENEWABLE ENERGY SHARE OF TOTAL FINAL ENERGY CONSUMPTION, 2016

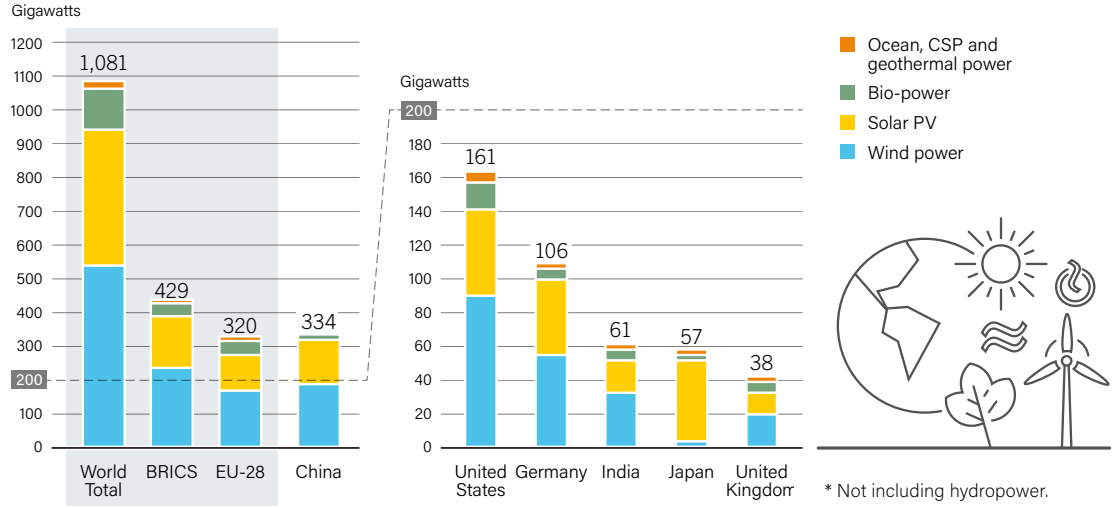


Note: Data should not be compared with previous years because of revisions due to improved or adjusted data or methodology. See full report for details. Totals may not add up due to rounding.

ESTIMATED RENEWABLE ENERGY SHARE OF TOTAL GLOBAL ELECTRICITY PRODUCTION, END-2017



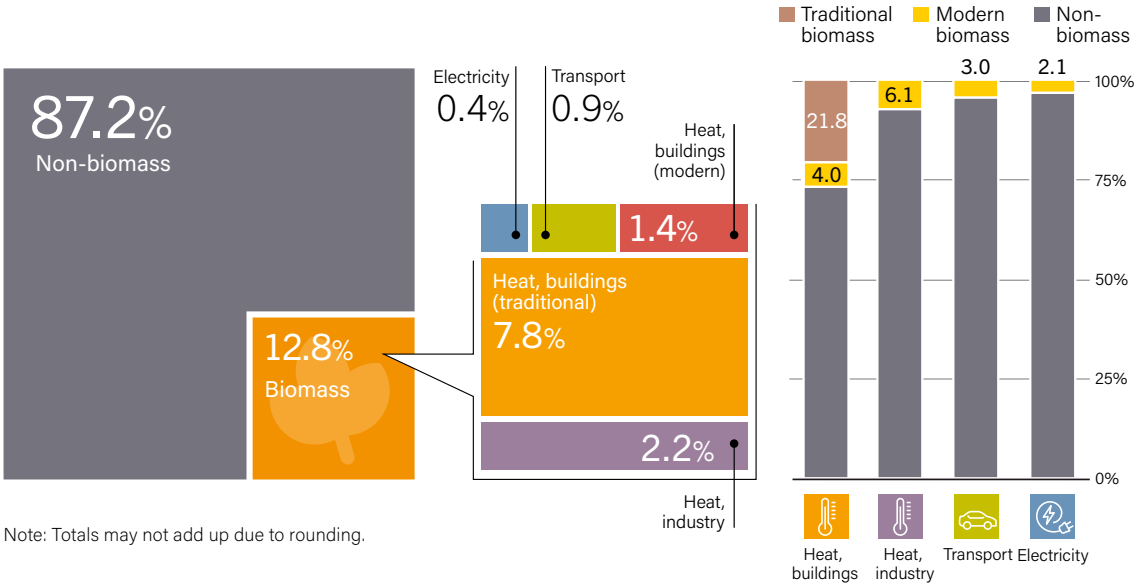
RENEWABLE POWER CAPACITIES IN WORLD, EU-28 AND TOP 6 COUNTRIES, 2017



* Not including hydropower.

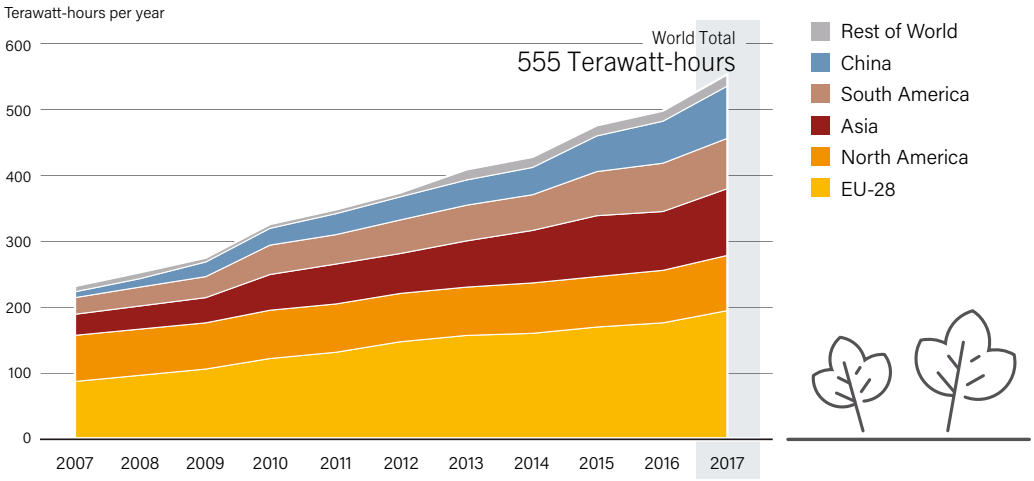
BIOMASS ENERGY

SHARES OF BIOMASS IN TOTAL FINAL ENERGY CONSUMPTION AND IN FINAL ENERGY CONSUMPTION, BY END-USE SECTOR, 2016



Note: Totals may not add up due to rounding.

GLOBAL BIO-POWER GENERATION, BY REGION, 2007-2017

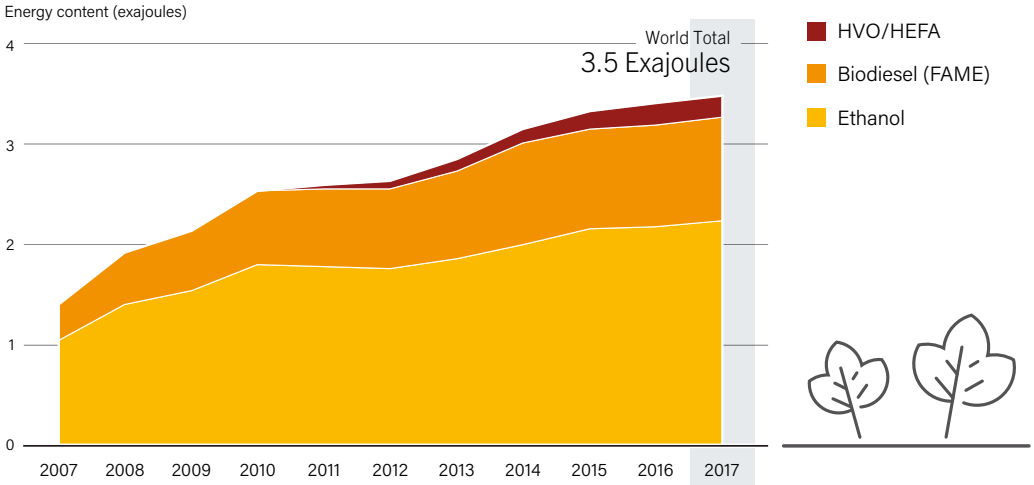


Total global bioelectricity generation rose

11%

in 2017

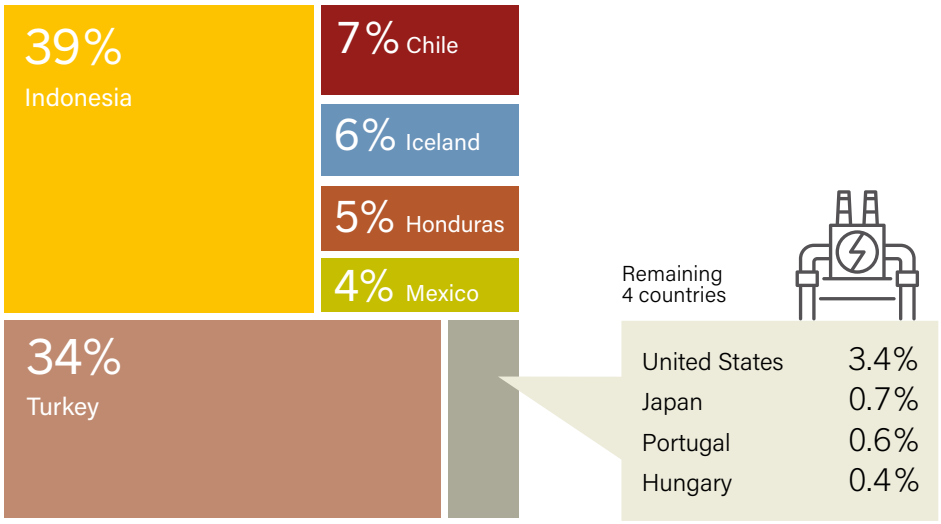
GLOBAL TRENDS IN ETHANOL, BIODIESEL AND HVO PRODUCTION, 2007-2017



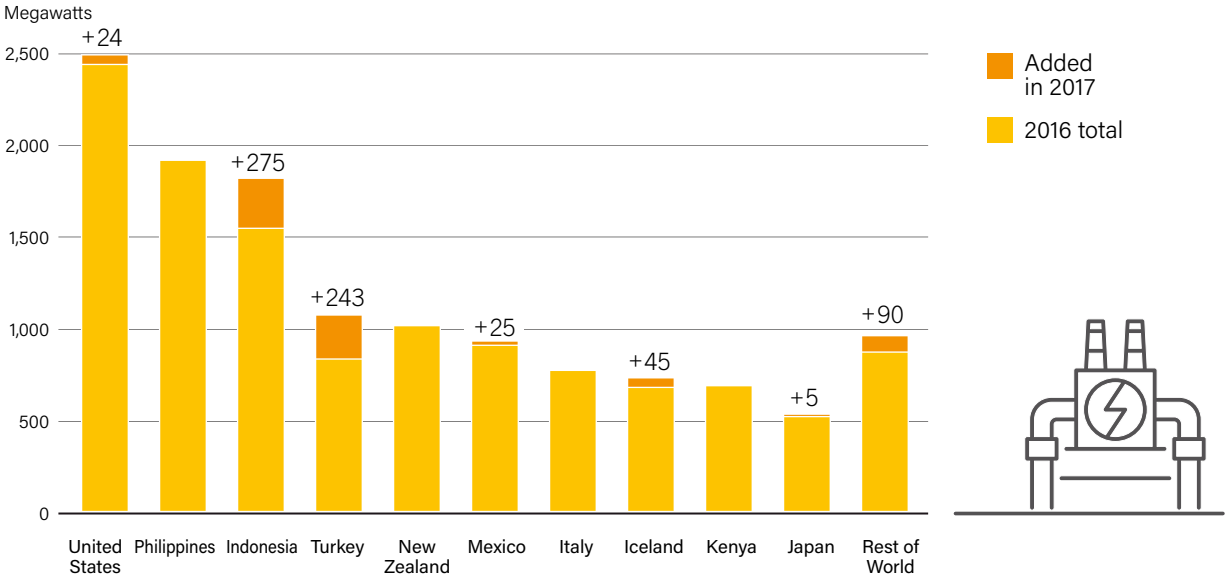
Note: HVO = hydrotreated vegetable oil; HEFA = hydrotreated esters and fatty acids; FAME = fatty acid methyl esters

GEOTHERMAL POWER

GEOTHERMAL POWER CAPACITY GLOBAL ADDITIONS, SHARE BY COUNTRY, 2017



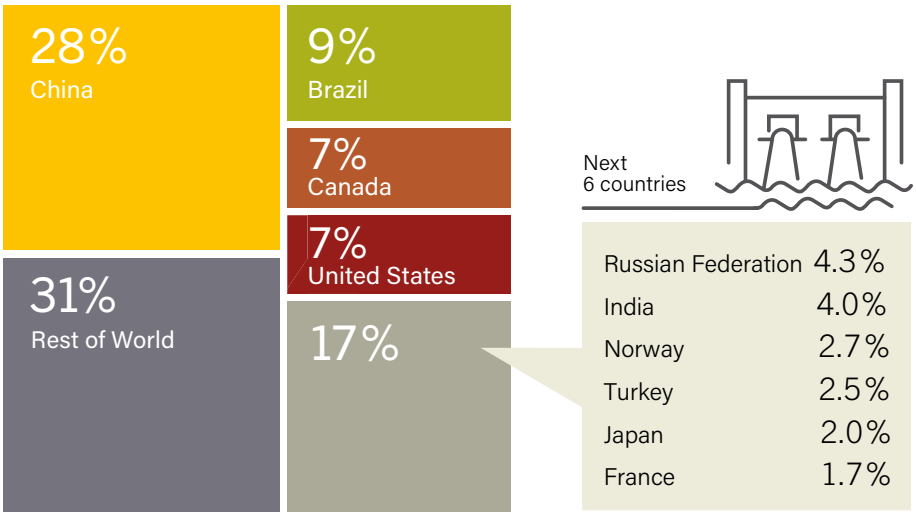
GEOTHERMAL POWER CAPACITY AND ADDITIONS, TOP 10 COUNTRIES AND REST OF WORLD, 2017



An estimated
0.7 GW_{th}
of new geothermal power generating capacity came online in 2017

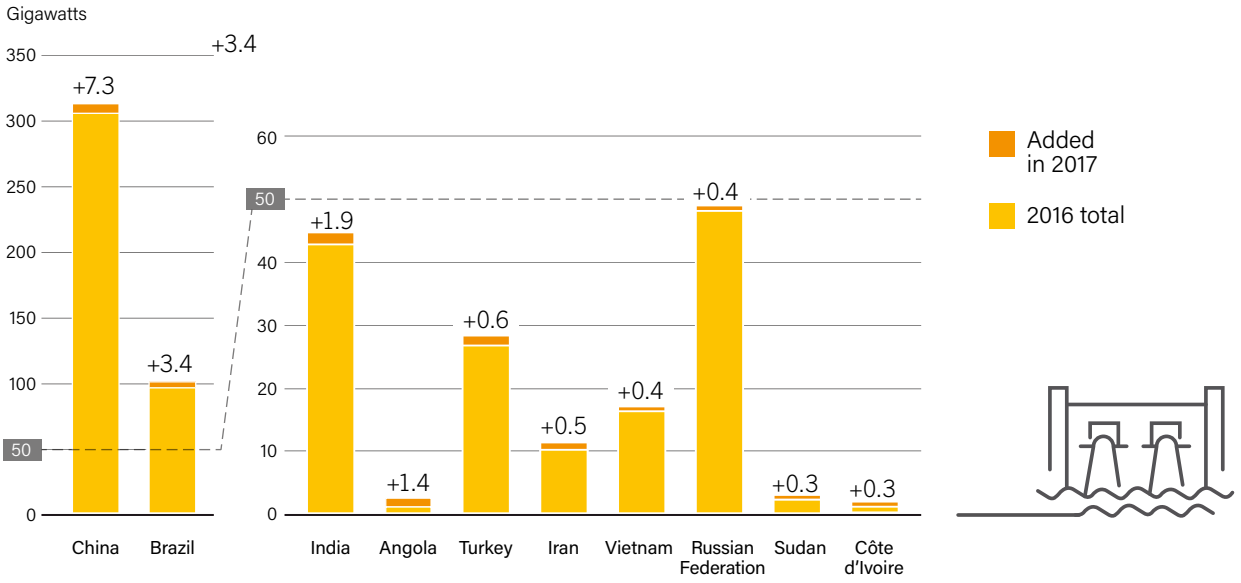
HYDROPOWER

HYDROPOWER GLOBAL CAPACITY, SHARES OF TOP 10 COUNTRIES AND REST OF WORLD, 2017



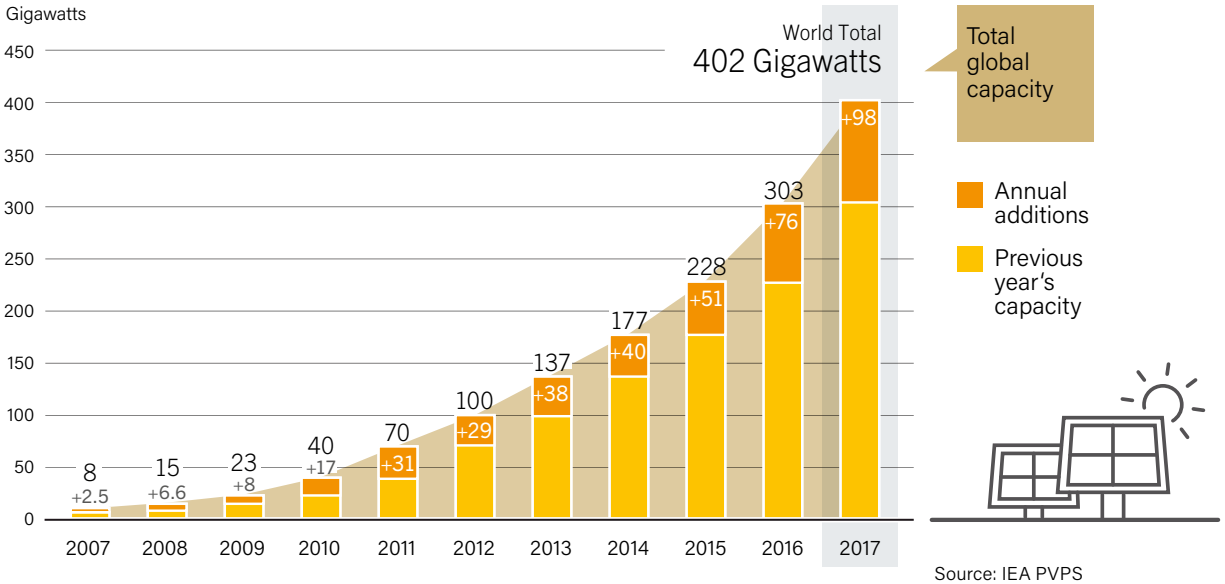
An estimated
19 GW
of hydropower capacity added globally in 2017

HYDROPOWER CAPACITY AND ADDITIONS, TOP 10 COUNTRIES FOR CAPACITY ADDED, 2017



SOLAR PV

SOLAR PV GLOBAL CAPACITY AND ANNUAL ADDITIONS, 2007-2017



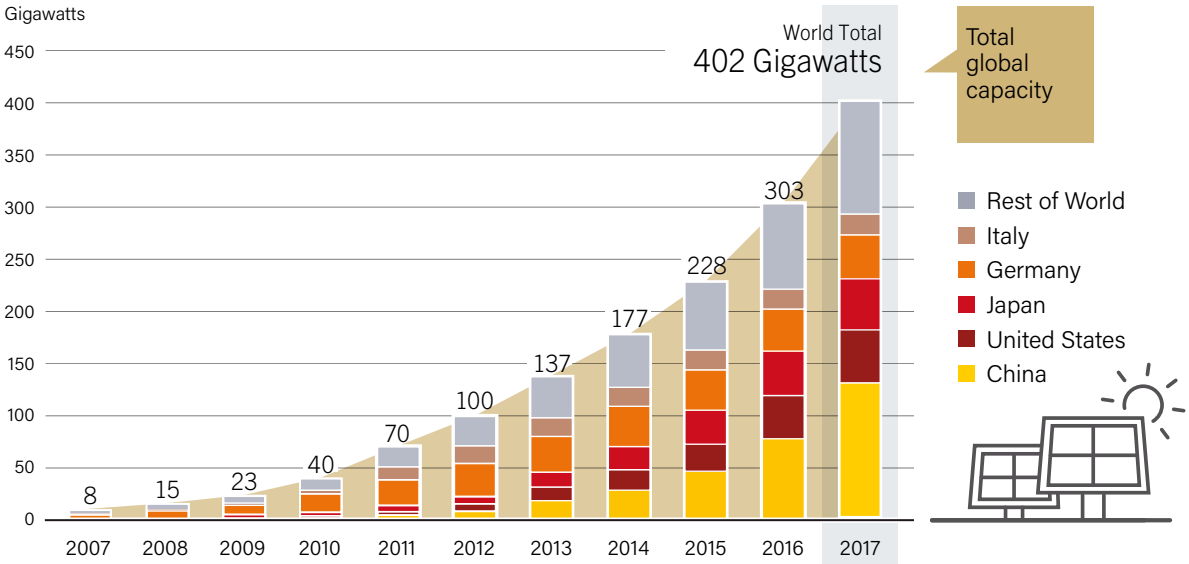
Note: Data are provided in direct current (DC). Totals may not add up due to rounding.

Source: IEA PVPS

40,000

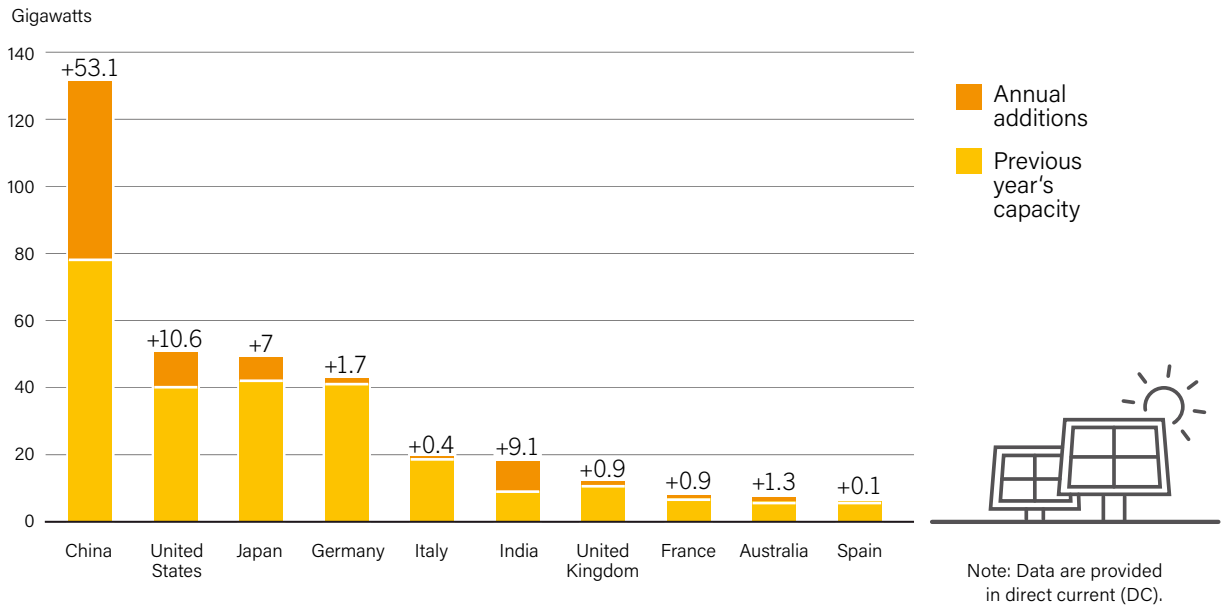
– the number of solar panels installed each hour of 2017, on average

SOLAR PV GLOBAL CAPACITY, BY COUNTRY OR REGION, 2007-2017



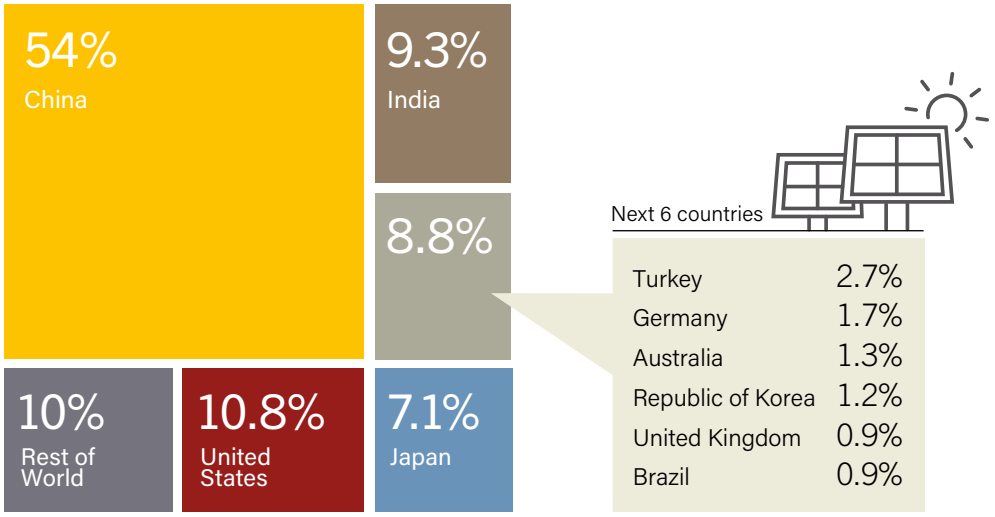
Note: Data are provided in direct current (DC).

SOLAR PV CAPACITY AND ADDITIONS, TOP 10 COUNTRIES, 2017



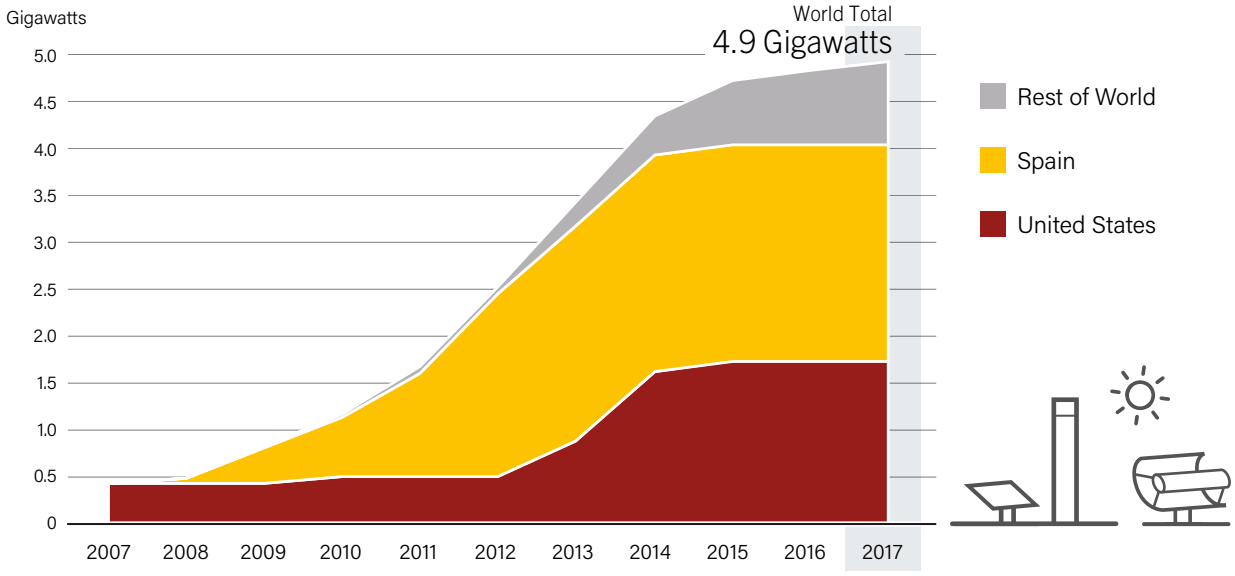
Note: Data are provided in direct current (DC).

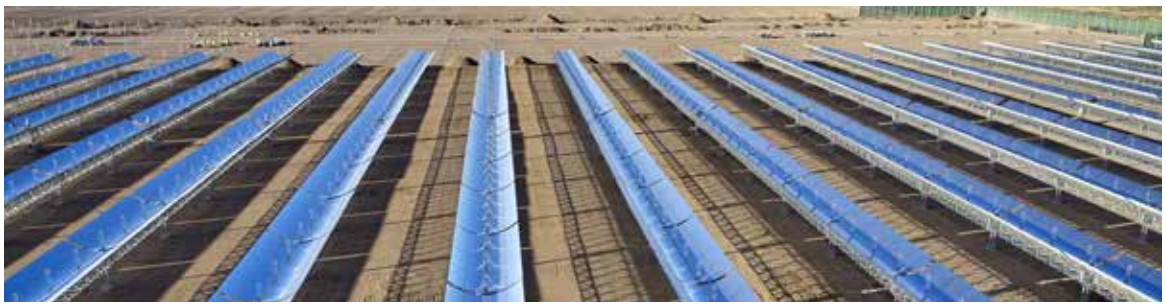
SOLAR PV GLOBAL CAPACITY ADDITIONS, SHARES OF TOP 10 COUNTRIES AND REST OF WORLD, 2017



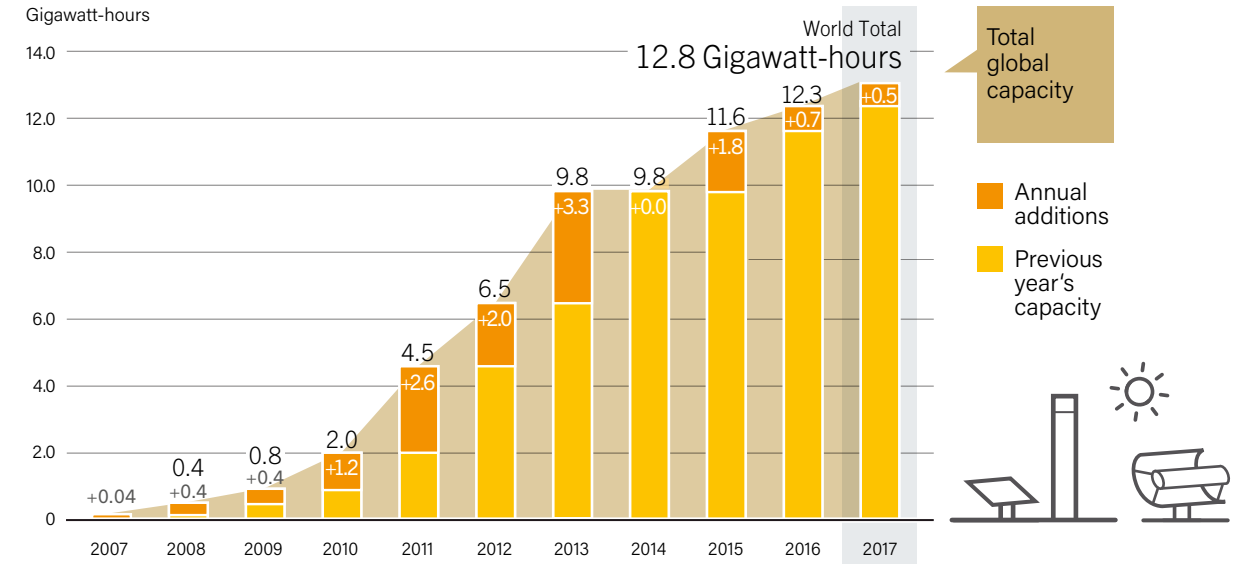
CONCENTRATING SOLAR POWER (CSP)

CONCENTRATING SOLAR THERMAL POWER GLOBAL CAPACITY, BY COUNTRY AND REGION, 2007-2017



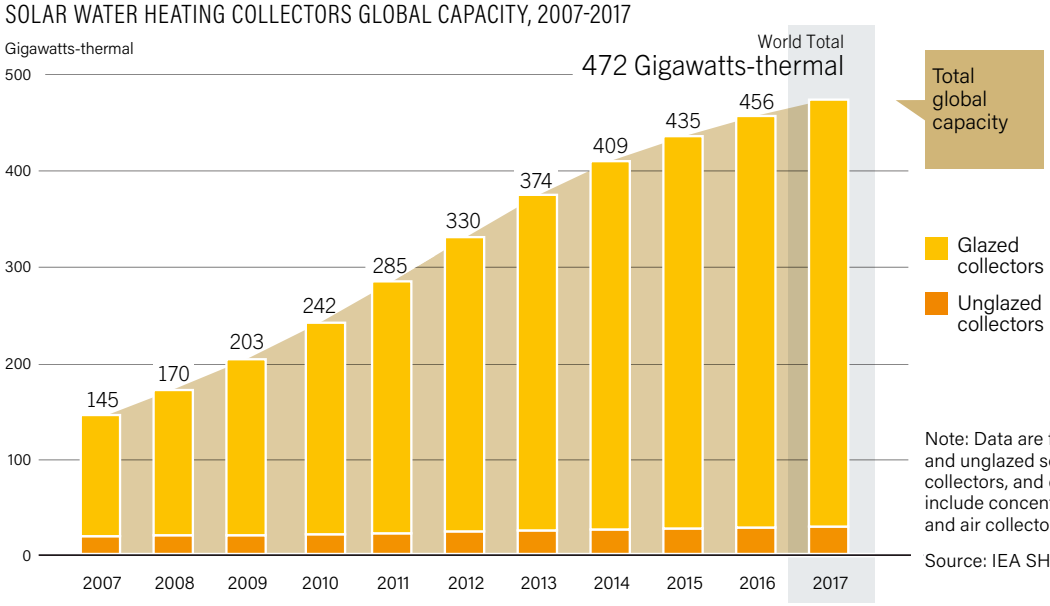


CSP THERMAL ENERGY STORAGE GLOBAL CAPACITY AND ANNUAL ADDITIONS, 2007-2017



SOLAR THERMAL HEATING AND COOLING

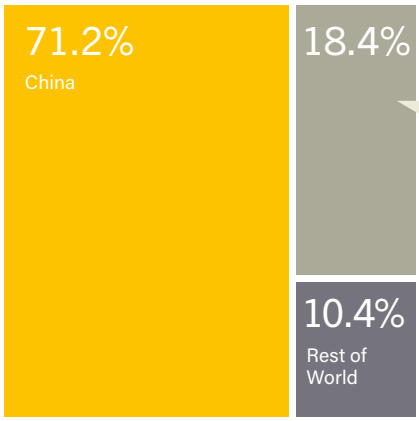
SOLAR WATER HEATING COLLECTORS GLOBAL CAPACITY, 2007-2017



Note: Data are for glazed and unglazed solar water collectors, and do not include concentrating and air collectors.

Source: IEA SHC

SOLAR WATER HEATING COLLECTORS GLOBAL CAPACITY IN OPERATION, SHARES OF TOP 12 COUNTRIES AND REST OF WORLD, 2016



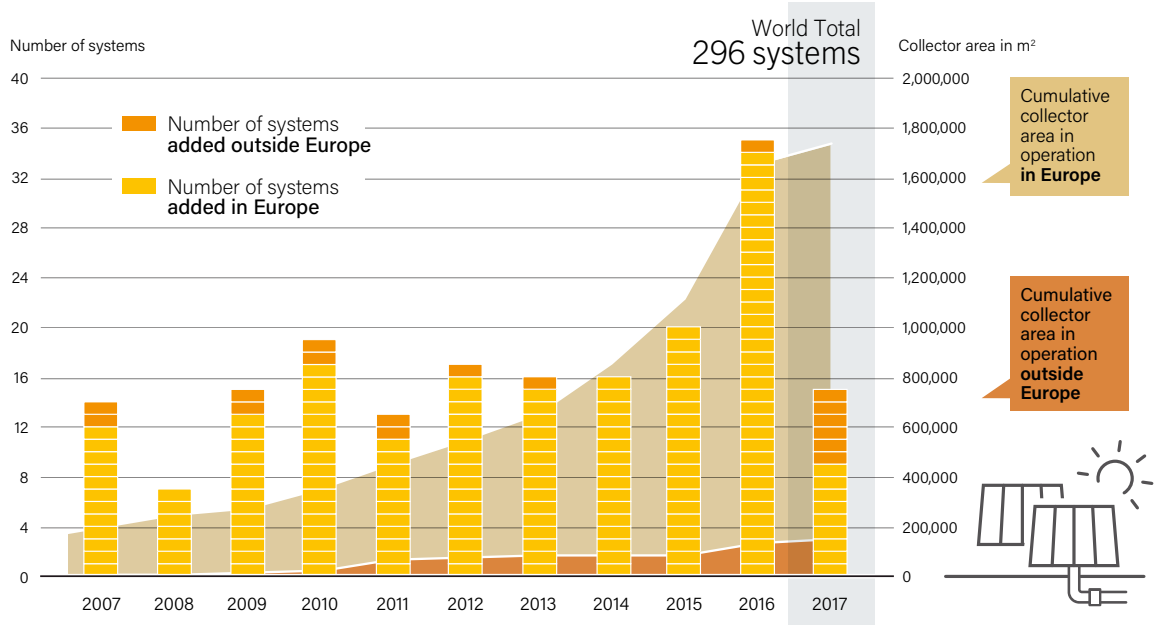
Next 11 countries

United States	3.9%
Turkey	3.3%
Germany	3.0%
Brazil	2.1%
India	1.5%
Australia	1.4%
Austria	0.8%
Israel	0.7%
Greece	0.7%
Italy	0.7%
Japan	0.5%

Note: Data are for glazed and unglazed solar water collectors, and do not include concentrating and air collectors. Total does not add up to 100% due to rounding.

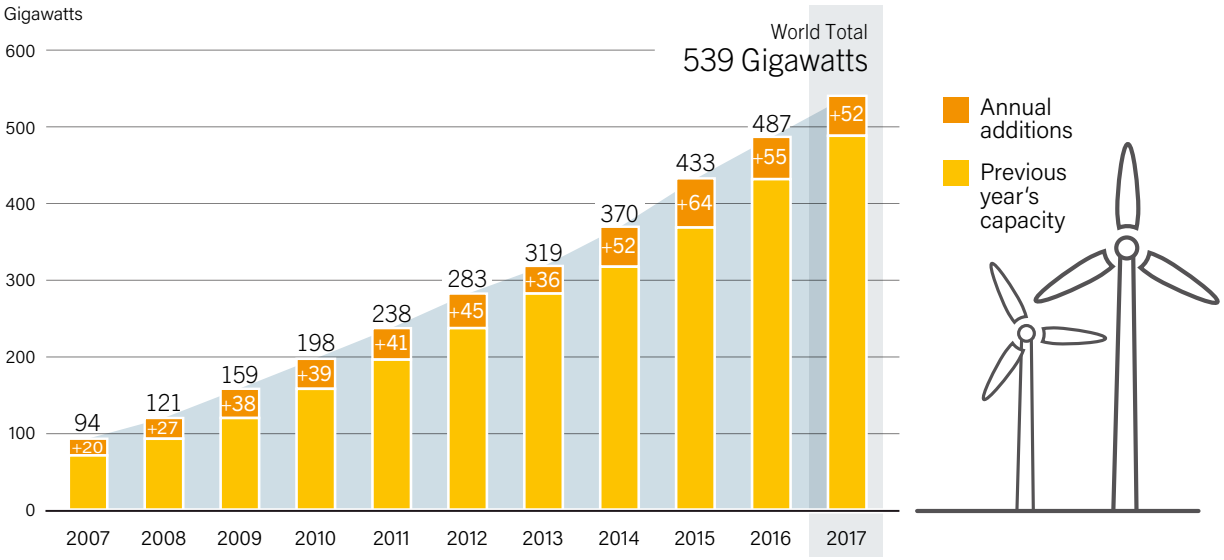
Source: IEA SHC

SOLAR DISTRICT HEATING GLOBAL ADDITIONS AND TOTAL AREA IN OPERATION, 2017



WIND POWER

WIND POWER GLOBAL CAPACITY AND ANNUAL ADDITIONS, 2007-2017

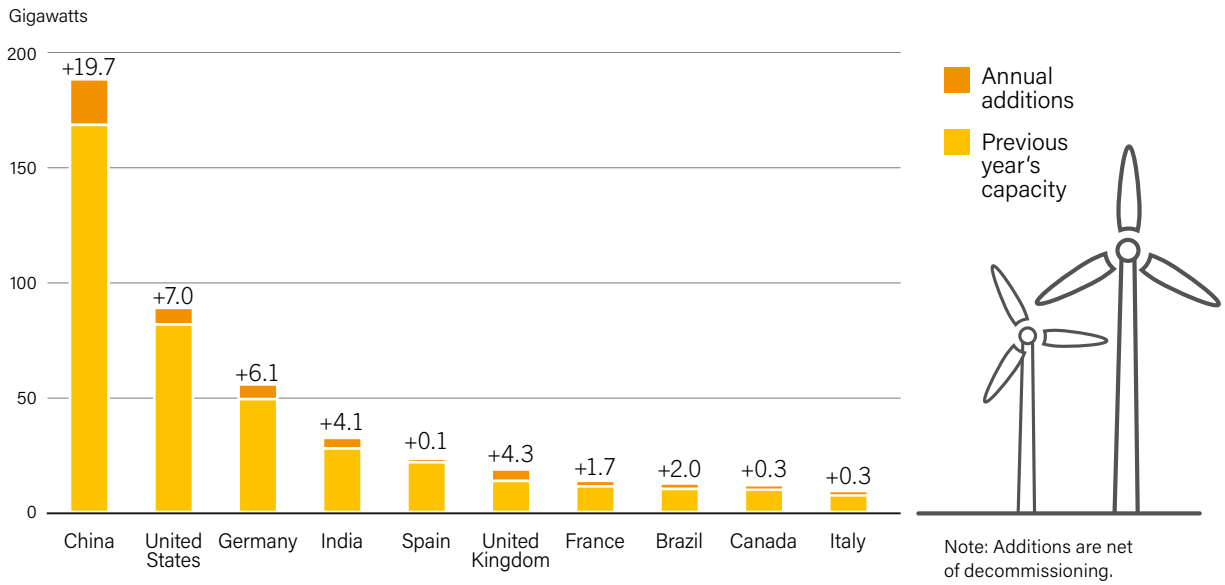


Asia was the largest regional market for wind power, installing

48%

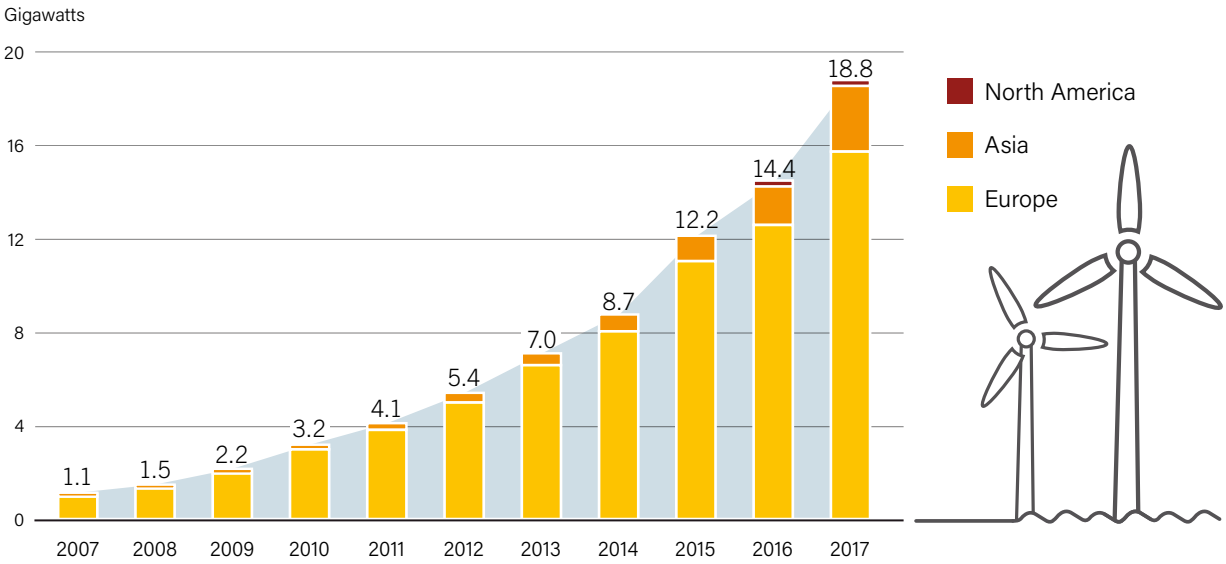
of new capacity

WIND POWER CAPACITY AND ADDITIONS, TOP 10 COUNTRIES, 2017

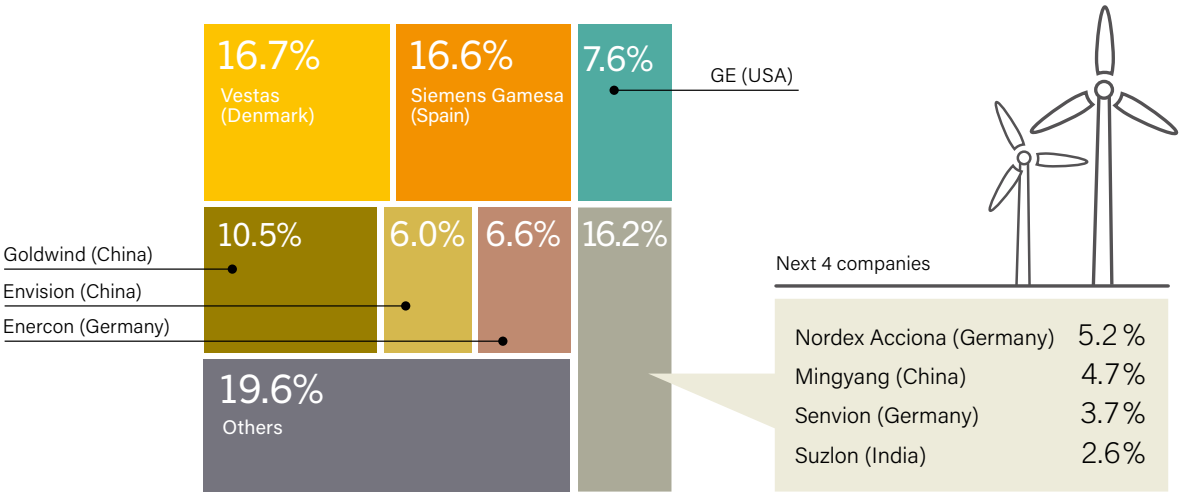


Note: Additions are net of decommissioning.

WIND POWER OFFSHORE GLOBAL CAPACITY BY REGION, 2007-2017



MARKET SHARES OF TOP 10 WIND TURBINE MANUFACTURERS, 2017



Source: FTI Consulting

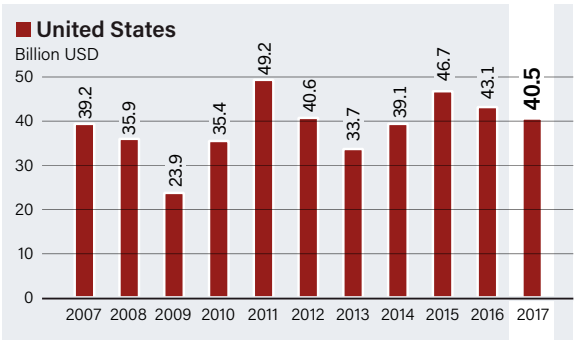
Offshore wind –
A record of

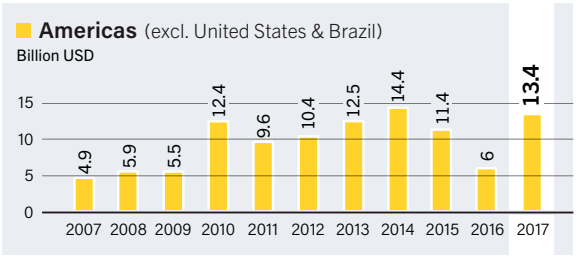
4.3 GW

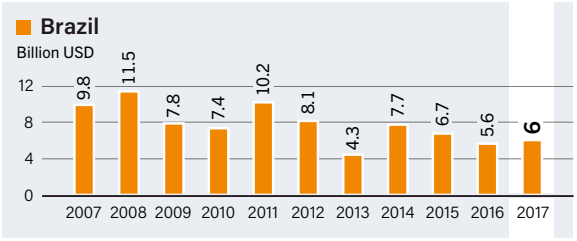
capacity added
in 2017

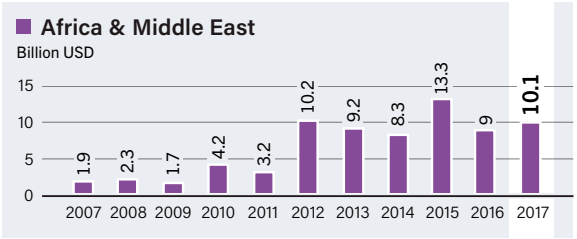
GLOBAL INVESTMENT 2017

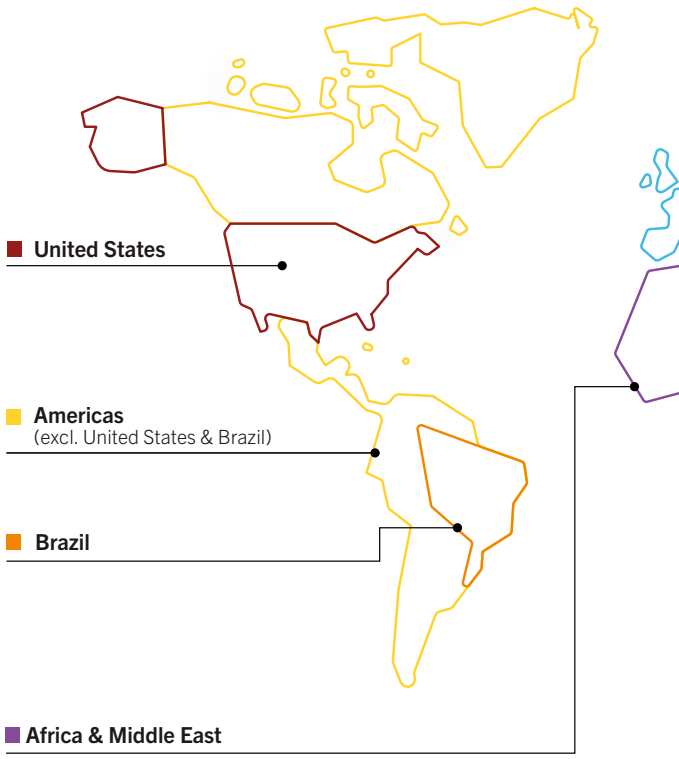
GLOBAL NEW INVESTMENT IN RENEWABLE POWER AND FUELS, BY COUNTRY OR REGION, 2007-2017

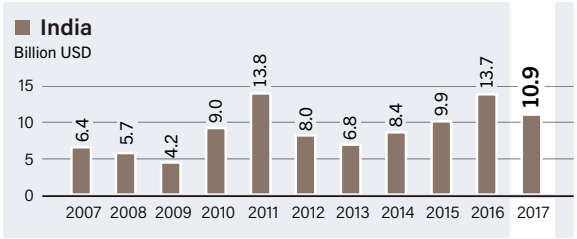


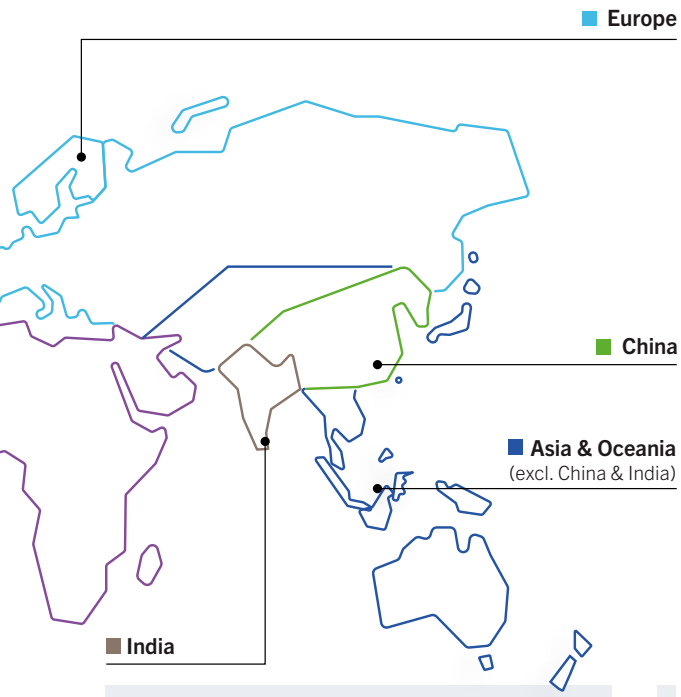


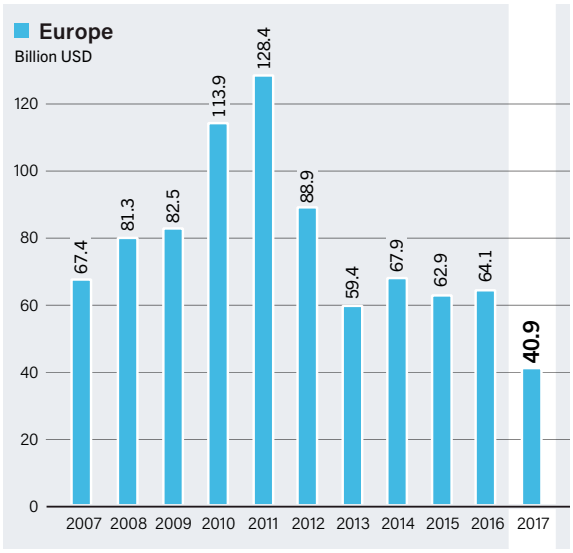


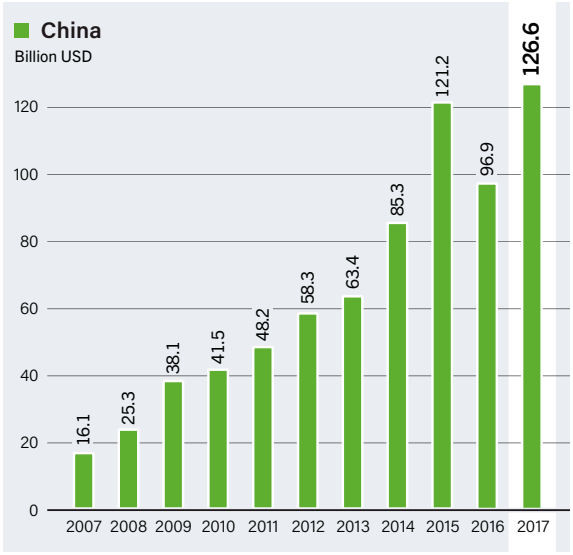


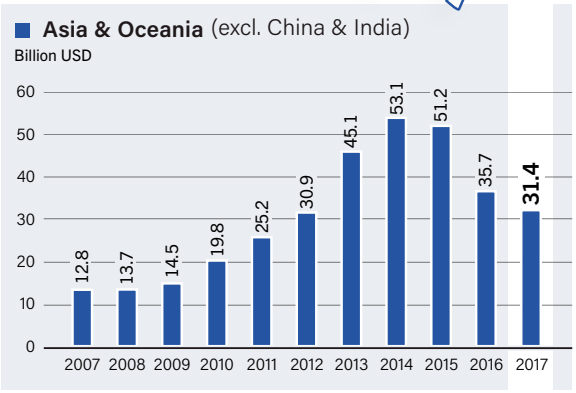












Source: BNEF
Note: Data include government and corporate R&D.

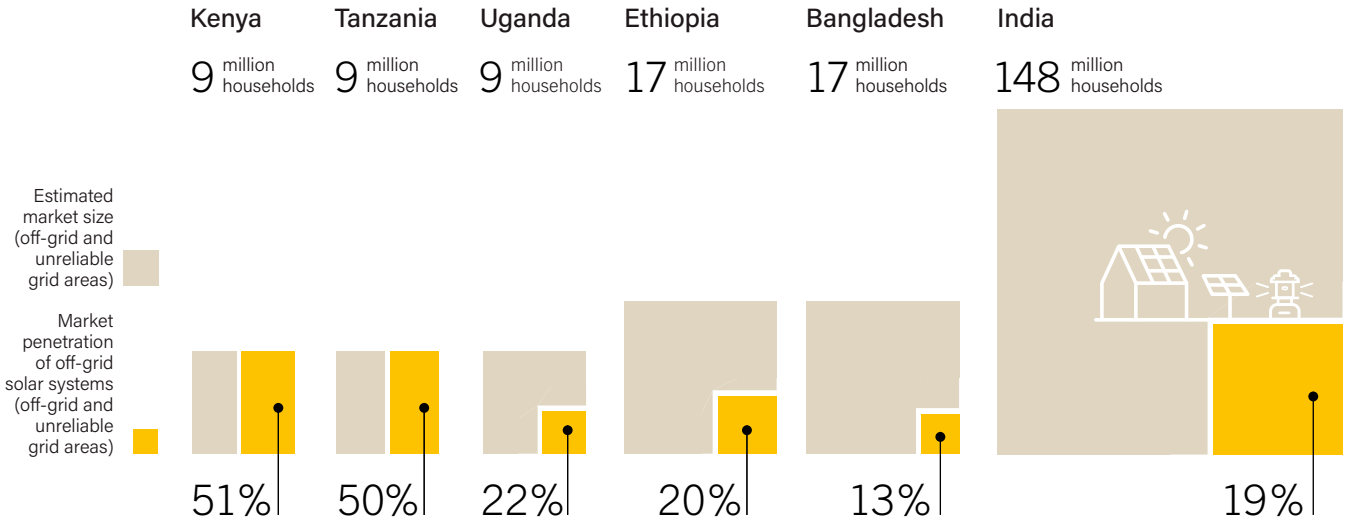
Solar PV dominates with a

57%

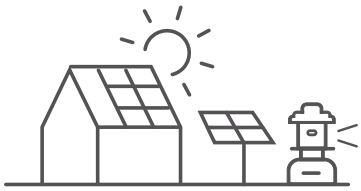
share of new investment in renewable power and fuels

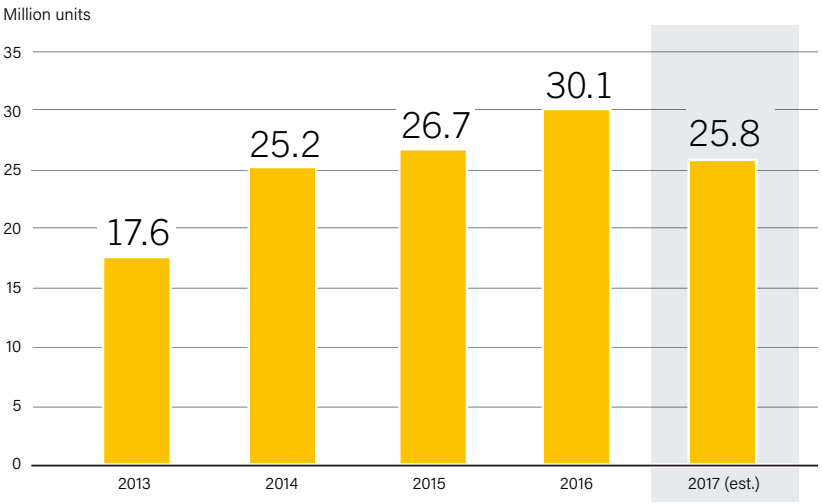
DISTRIBUTED RENEWABLES FOR ELECTRICITY ACCESS

MARKET SIZE AND CURRENT PENETRATION OF OFF-GRID SOLAR SYSTEMS IN SELECTED COUNTRIES, 2017

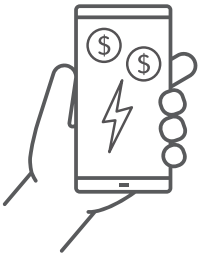


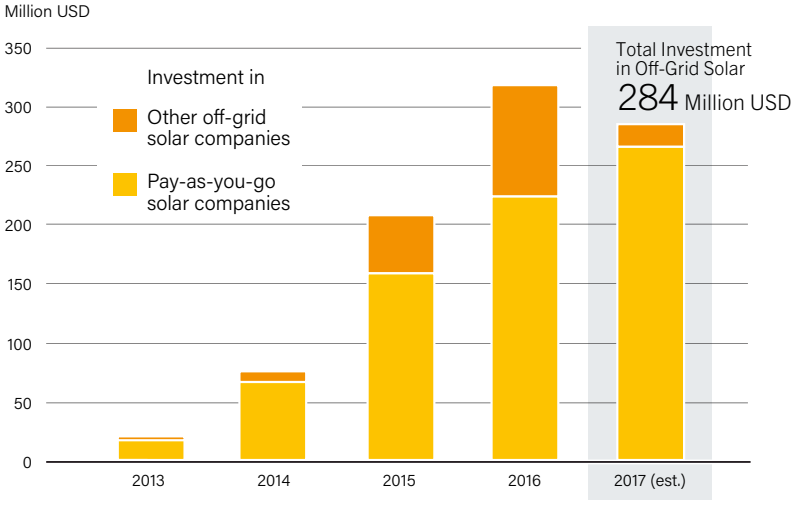
ANNUAL GLOBAL SALES OF OFF-GRID SOLAR SYSTEMS, 2013-2017





INVESTMENT IN OFF-GRID SOLAR COMPANIES, 2017

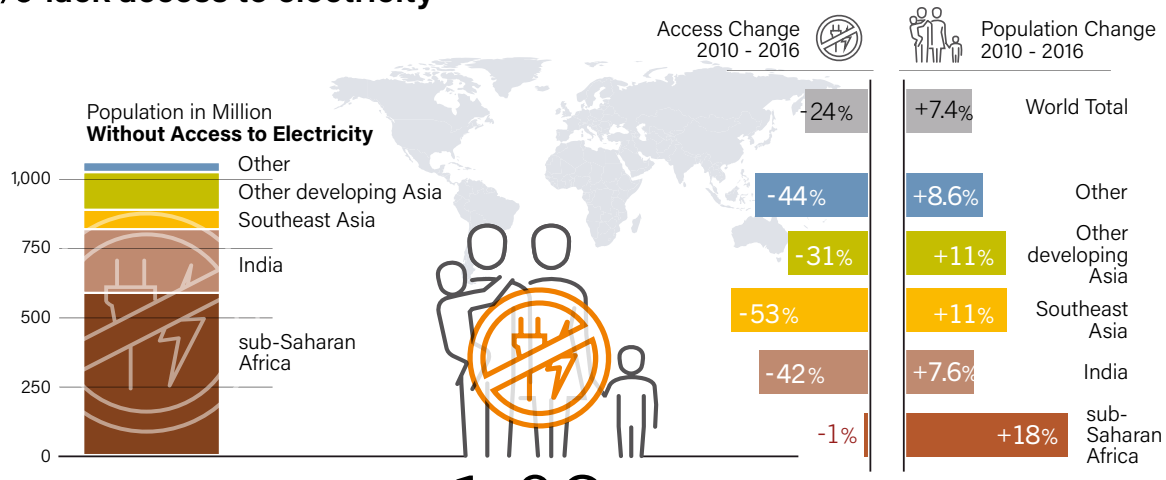




ENERGY ACCESS

WE MUST ACCELERATE RENEWABLES DEPLOYMENT TO REACH **UNIVERSAL ELECTRICITY ACCESS IN 2030**

14% of the global population still **lack access to electricity**



1.06 billion

Renewable energy **is already a reality** in developing countries...

266 GW
grid-connected renewable power capacity

Distributed renewable energy systems power
360 million
people

+60%
annual market growth in solar laterns and Solar Home Systems

...but **more investment** is needed:

45-56
billion USD
are needed annually

TO SPUR UPTAKE AND **REACH 100% ELECTRICITY ACCESS**, WE NEED TO:

INCREASE POLICY AND INSTITUTIONAL SUPPORT AND INVESTMENT

INVEST IN TECHNICAL CAPACITY BUILDING AND TRAINING

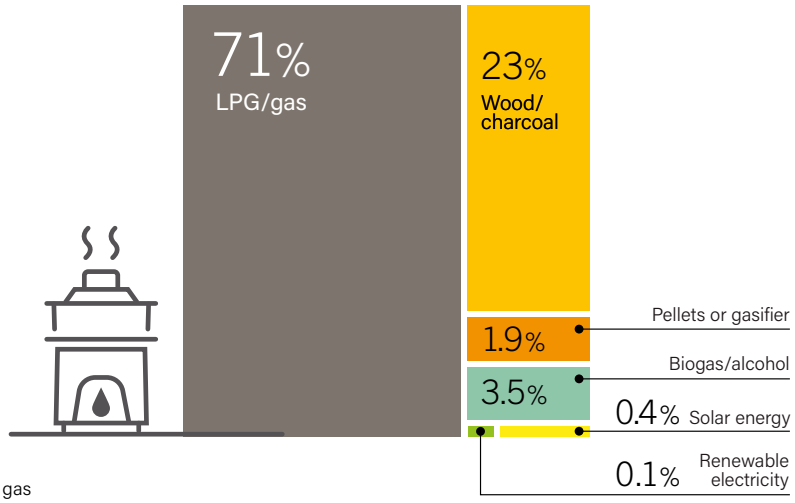
MAKE USE OF MODERN SMART GRID AND OFF GRID SOLUTIONS IN PLANNING

ACKNOWLEDGE THE VALUABLE ROLE OF DISTRIBUTED RENEWABLE ENERGY IN ELECTRIFYING POPULATIONS

CLEAN COOKING

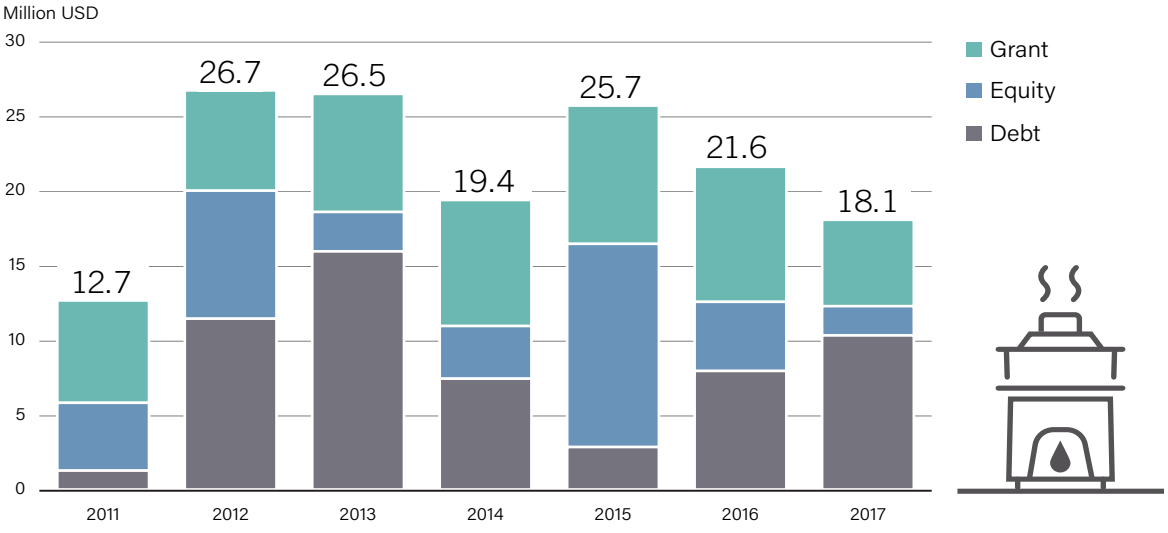
30.8 million
clean cook stoves distributed in 2016 - one-fourth use biomass in efficient cook stoves

APPROXIMATE PROPORTION OF CLEAN COOK STOVES BY ENERGY SOURCE, 2016



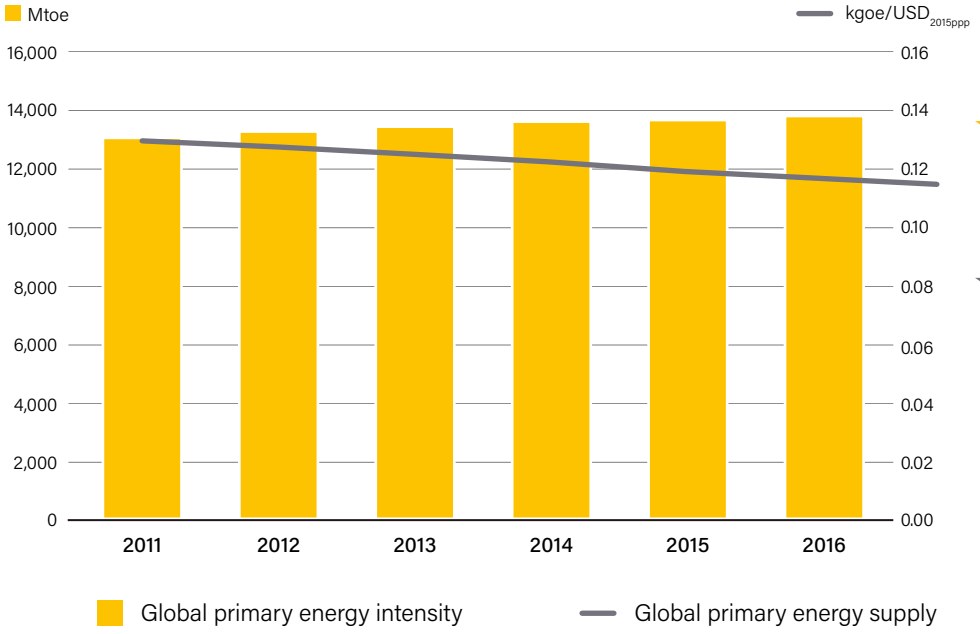
Note: LPG = liquified petroleum gas

INVESTMENT IN CLEAN COOK STOVE COMPANIES BY INVESTMENT TYPE, 2011-2017



ENERGY EFFICIENCY

GLOBAL PRIMARY ENERGY INTENSITY AND TOTAL PRIMARY ENERGY SUPPLY, 2011-2016



Compound average annual change, 2011-2016

+1.1% global primary energy supply

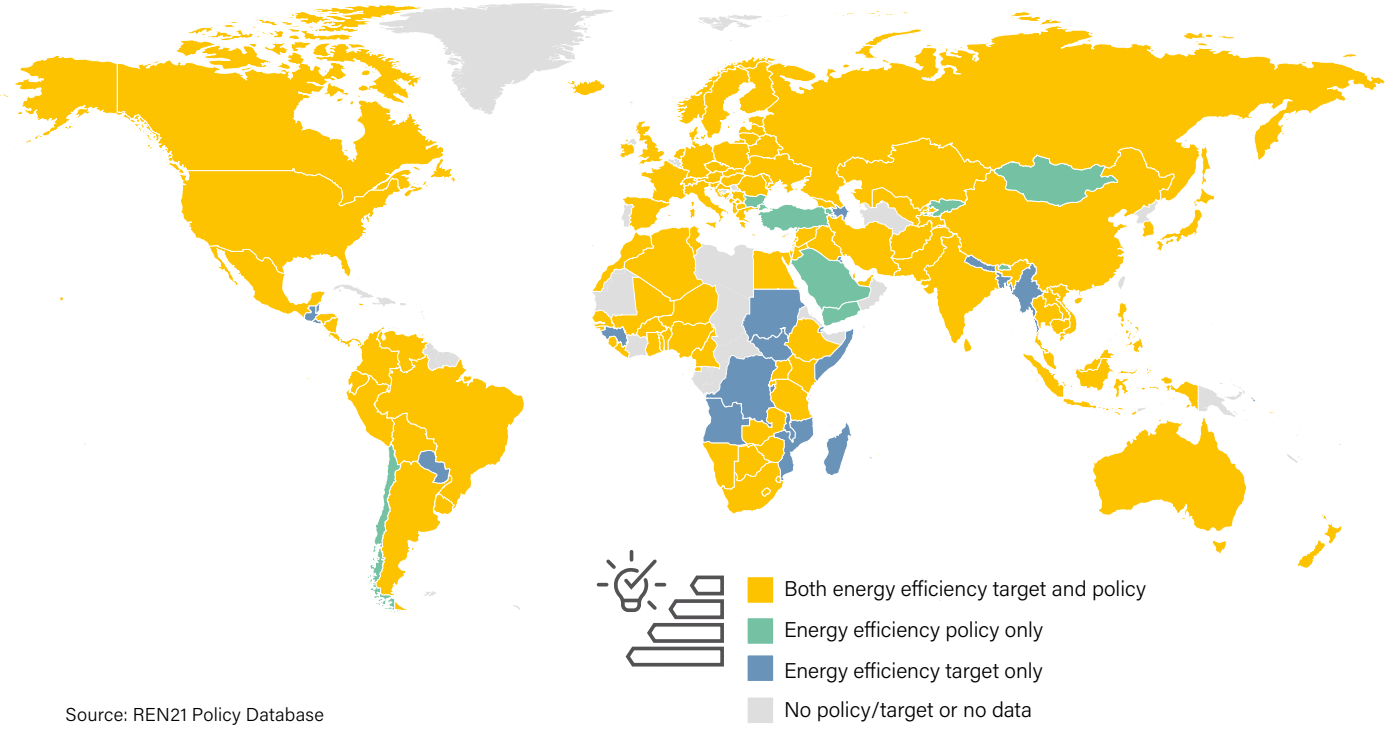
-2.1% global primary energy intensity

Note: Dollars are at constant purchasing power parities.

Mtoe = megatonnes of oil equivalent
kgoe = kilograms of oil equivalent

Source: Enerdata

COUNTRIES WITH ENERGY EFFICIENCY POLICIES AND TARGETS, END-2017



Source: REN21 Policy Database

MAKING THE CONNECTIONS

Good decisions require up-to-date information. REN21's ***Renewables Global Status Report (GSR)*** tracks the annual development of renewables using the most up-to-date information and data available. Its neutral, fact-based approach documents in detail the annual developments in market, industry and policy. The report is a collaborative effort, drawing on an international network of more than 900 authors, contributors and reviewers from over 155 countries. Now in its 13th year, the GSR is the most frequently referenced report on renewable energy market, industry and policy trends.

Advancing the Global Renewable Energy Transition: Highlights of REN21's Renewables 2018 Global Status Report in Perspective is a complementary publication to help decision makers understand the evolution of the renewable energy sector in the context of the overall energy transition. It looks at positive developments that occurred over the past year, drawing on some of the key developments and trends highlighted in the GSR, and notes areas where progress is lagging and offers recommendations for how to speed up the energy transition with renewables.

While the *Renewables Global Status Report* series provides a real-time snapshot of what is happening, REN21's *Renewables Global Futures Report* series presents thinking about how a renewable energy future will evolve. This series presents a range of credible possibilities for the future of renewable energy. It does not present just one vision of the future, but rather a full and objective range of visions, based on the collective and contemporary thinking of many experts.

Collectively these reports illustrate the distance between where we are now and what needs to happen if an energy transition with renewables is to be achieved.

The ***Renewables Global Futures Report: Great debates towards 100% renewable energy*** was released in April 2017. The report documents global views about the feasibility of achieving a 100% renewable energy future by mid-century. While there may be general agreement that we need to decarbonise our energy system, there is no one way to achieve this; what works in one country does not necessarily work in another. The report analyses the views of over 110 renowned energy experts from around the world who were interviewed over the course of 2016. It does not predict the future. The report is meant to spur debate about the opportunities and challenges of a 100% renewable energy future and, in turn, to support good decision making.

Access the reports:

www.ren21.net/GSR and **www.ren21.net/GFR**

The REN21 Secretariat has produced this document to highlight the important trends that have occurred in 2017 and to put them in perspective of the global energy transition. It draws on elements from REN21's *Renewables 2018 Global Status Report.*

Authoring support: Kelly Rigg (The Varda Group); Rana Adib, Hannah E. Murdock, Laura E. Williamson (REN21); Adam Brown

GSR 2018 PRODUCTION AND AUTHORING TEAM

RESEARCH DIRECTION AND LEAD AUTHORSHIP

Janet L. Sawin (Sunna Research)

Jay Rutovitz (Institute for Sustainable Futures, University of Technology Sydney – ISF-UTS)

Freyr Sverrisson (Sunna Research)

PROJECT MANAGEMENT AND GSR COMMUNITY MANAGEMENT (REN21 SECRETARIAT)

Hannah E. Murdock

Rana Adib

CHAPTER AUTHORS

Emma Aberg (International Renewable Energy Agency – IRENA)

Rana Adib (REN21)

Fabiani Appavou

Adam Brown

Scott Dwyer (ISF-UTS)

Barbel Epp (solrico)

Flávia Guerra (REN21)

Bozhil Kondev

Hannah E. Murdock (REN21)

Evan Musolino

Jay Rutovitz (ISF-UTS)

Janet L. Sawin (Sunna Research)

Kristin Seyboth (KMS Research and Consulting)

Jonathan Skeen (SOLA Future Energy)

Freyr Sverrisson (Sunna Research)

Sven Teske (ISF-UTS)

Stephanie Weckend (IRENA)

Henning Wuester (IRENA)

SPECIAL ADVISOR

Adam Brown

RESEARCH AND PROJECT SUPPORT (REN21 SECRETARIAT)

Linh H. Blanning, Flávia Guerra, Vibhushree Hamirwasia, Archita Misra, Katharina Satzinger

COMMUNICATION SUPPORT (REN21 SECRETARIAT)

Laura E. Williamson, Mimi Lie, Anna Nilsson

EDITING, DESIGN AND LAYOUT

Lisa Mastny, Editor

Lelani Arris, Editor

weeks.de Werbeagentur GmbH, Design

PRODUCTION

REN21 Secretariat, Paris, France

SUSTAINABLE ENERGY FOR ALL

REN21 is committed to mobilising global action to meet SEforALL objectives.

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HIGHLIGHTS

2018

RENEWABLES 2018
GLOBAL STATUS REPORT

For further details and access to the report and references, visit **www.ren21.net/GSR**

See Endnotes and Methodological Notes in the full GSR for further details on the information presented in this document.

REN21 Secretariat
c/o UN Environment
1 Rue Miollis
Building VII
75015 Paris
France

REN21 Renewable Energy Policy Network for the 21st Century

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