REN21 Renewable Energy Policy Network for the 21st Century

RENEWABLES 2016
GLOBAL STATUS REPORT

KEY FINDINGS
2016

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, nongovernmental 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.

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.

Global Status Report: yearly publication since 2005

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

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 500 authors, contributors and reviewers. Today it is the most frequently referenced report on renewable energy market, industry and policy trends.

REGIONAL REPORTS

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

RENEWABLES INTERACTIVE MAP

The Renewables Interactive Map is a research tool for tracking the development of renewable energy worldwide. It complements the perspectives and findings of REN21's Global and Regional Status Reports by providing continually updated market and policy information as well as offering detailed, exportable country profiles.

GLOBAL FUTURE REPORTS (GFR)

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

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 (IRECS)

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

Regional Reports

Global Futures Report

www.ren21.net/map

REN21 Renewables Academy

International Renewable Energy Conferences

2011
Global Status Report on Local Renewable Energy Policies

2012

2013
Global Futures Report
MENA Renewable Energy Status Report
ADIREC, Abu Dhabi International Renewable Energy Conference

2014
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

REN21 STEERING COMMITTEE

INDUSTRY ASSOCIATIONS

Ernesto Macías Galán
Alliance for Rural Electrification (ARE)

Greg Wetstone
American Council On Renewable Energy (ACORE)

Li Junfeng
Chinese Renewable Energy Industries Association (CREIA)

Kane Thornton
Clean Energy Council (CEC)

Rainer Hinrichs-Rahlwes
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Steve Sawyer
Global Wind Energy Council (GWEC)

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International Geothermal Association (IGA)

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International Hydropower Association (IHA)

Karin Haara
World Bioenergy Association (WBA)

Stefan Gsänger
World Wind Energy Association (WWEA)

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Mahama Kappiah
ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE)

Paula Abreu Marques
European Commission (EC)

David Rodgers
Global Environment Facility (GEF)

Paolo Frankl
International Energy Agency (IEA)

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International Renewable Energy Agency (IRENA)

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Mark Radka
United Nations Environment Programme (UNEP)

Pradeep Monga
United Nations Industrial Development Organization (UNIDO)

Gevorg Sargsyan
World Bank

NGOS

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Global Forum on Sustainable Energy (GFSE)

Emily Rochon
Greenpeace International

Emani Kumar
ICLEI – Local Governments for Sustainability, South Asia

Tetsunari Iida
Institute for Sustainable Energy Policies (ISEP)

Ibrahim Togola
Mali Folkecenter (MFC) / Citizens United for Renewable Energy and Sustainability

Ahmed Badr
Regional Center for Renewable Energy and Energy Efficiency (RCREEE)

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Renewable Energy Institute

Harry Lehmann
World Council for Renewable Energy (WCRE)

Stefan Schurig
World Future Council (WFC)

Rafael Senga
World Wildlife Fund (WWF)

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Chatham House

Michael Eckhart
Citigroup, Inc.

Peter Rae
REN Alliance

David Hales
Second Nature

Mohamed El-Ashry
United Nations Foundation

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Ursula Borak / Tania Rödiger-Vorwerk
Germany

Tarun Kapoor India

Øivind Johansen Norway

Wolsey Barnard South Africa

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Thani Ahmed Al Zeyoudi
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United States of America

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Fundacion Bariloche

Nebojsa Nakicenovic
International Institute for Applied Systems Analysis (IIASA)

David Renné
International Solar Energy Society (ISES)

Doug Arent
National Renewable Energy Laboratory (NREL)

Kevin Nassiep
South African National Energy Development Institute (SANEDI)

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Arthouros Zervos
National Technical University of Athens (NTUA)

EXECUTIVE SECRETARY

Christine Lins
REN21

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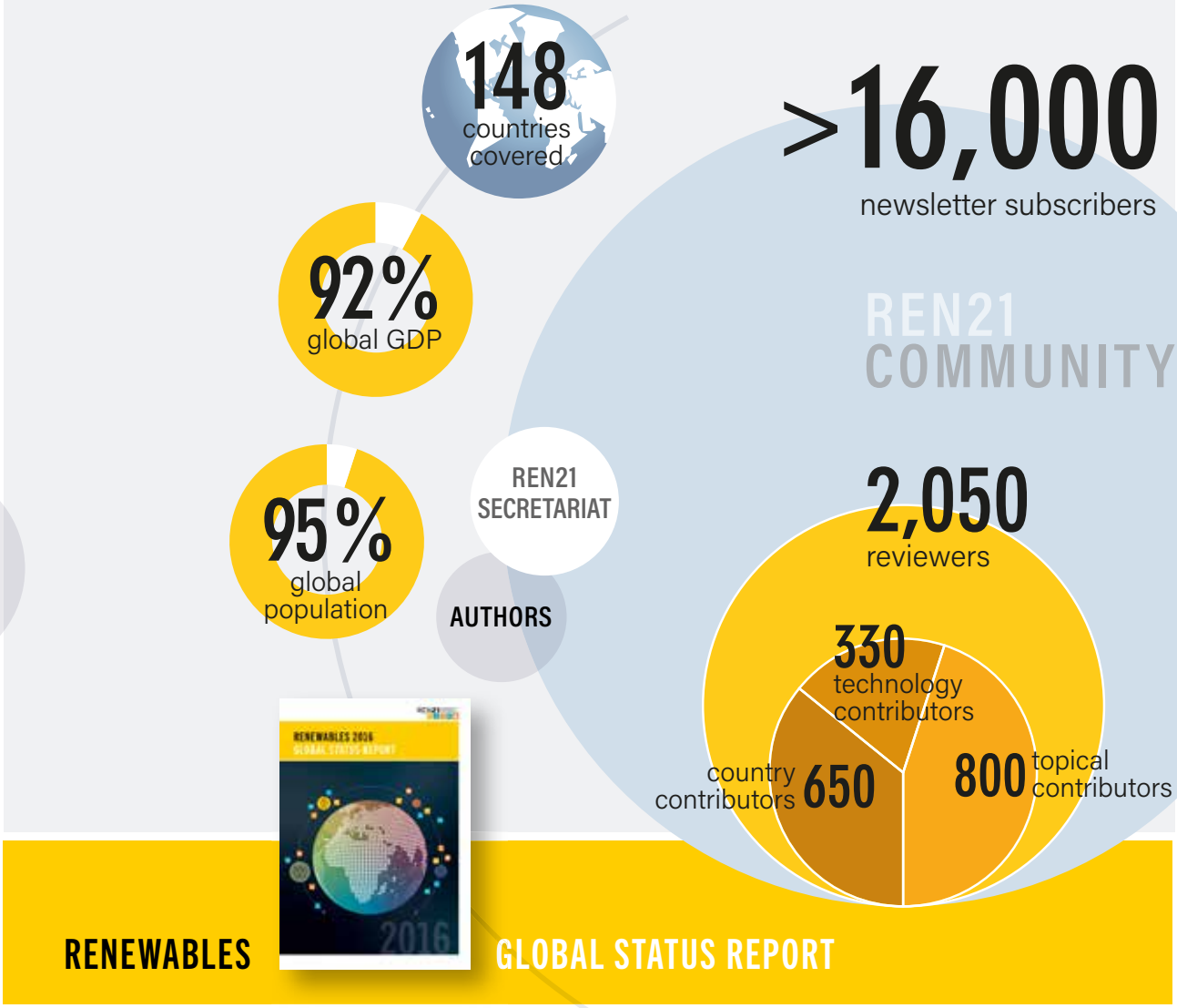
REN21 COMMUNITY

REN21 is a multi-stakeholder network; collectively this network shares its insight and knowledge, helping the REN21 Secretariat produce its annual *Renewables Global Status Report* as well as regional reports. Today the network stands at 700 renewable energy, energy access and energy efficiency experts. For GSR 2016, 180 experts joined the report process, equivalent to the total number of GSR experts in 2012.

These experts engage in the GSR process, giving their time, contributing data and providing comment in the peer review process. The result of this collaboration is an annual publication that has established itself as the world's most frequently referenced report on the global renewable energy market, industry and policy landscape.



KEY FINDINGS 2016

GLOBAL OVERVIEW

An extraordinary year for renewable energy

The year 2015 was an extraordinary one for renewable energy, with the largest global capacity additions seen to date, although challenges remain, particularly beyond the power sector. The year saw several developments that all have a bearing on renewable energy, including a dramatic decline in global fossil fuel prices; a series of announcements regarding the lowest-ever prices for renewable power long-term contracts; a significant increase in attention to energy storage; and a historic climate agreement in Paris that brought together the global community.

Renewables are now established around the world as mainstream sources of energy. Rapid growth, particularly in the power sector, is driven by several factors, including the improving cost-competiveness of renewable technologies, dedicated policy initiatives, better access to financing, energy security and environmental concerns, growing demand for energy in developing and emerging economies, and the need for access to modern energy. Consequently, new markets for both centralised and distributed renewable energy are emerging in all regions.

2015 was a year of firsts and high-profile agreements and announcements related to renewable energy. These include commitments by both the G7 and the G20 to accelerate access to renewable energy and to advance energy efficiency, and the United Nations General Assembly's adoption of a dedicated Sustainable Development Goal on Sustainable Energy for All (SDG 7).

The year's events culminated in December at the United Nations Framework Convention on Climate Change's (UNFCCC) 21st Conference of the Parties (COP21) in Paris, where 195 countries agreed to limit global warming to well below 2 degrees Celsius. A majority of countries committed to scaling up renewable energy and energy efficiency through their Intended Nationally Determined Contributions (INDCs). Out of the 189 countries that submitted INDCs, 147 countries mentioned renewable energy, and 167 countries mentioned energy efficiency; in addition, some countries committed to reforming their subsidies for fossil fuels. Precedent-setting commitments to renewable energy also were made by regional, state and local governments as well as by the private sector.

Although many of the initiatives announced in Paris and elsewhere did not start to affect renewable markets in 2015, there were already signs that a global energy transition is under way. Renewable energy provided an estimated 19.2% of global final energy consumption in 2014, and growth in capacity and generation continued in 2015.

An estimated 147 gigawatts (GW) of renewable power capacity was added in 2015, the largest annual increase ever, while renewable heat capacity increased by around 38 gigawatts-thermal (GW_{th}), and total biofuels production also rose. This growth occurred despite tumbling global prices for all fossil fuels, ongoing fossil fuel subsidies and other challenges facing renewables, including the integration of rising shares of renewable generation, policy and political instability, regulatory barriers and fiscal constraints.

Global investment also climbed to a new record level, in spite of the plunge in fossil fuel prices, the strength of the US dollar (which reduced the dollar value of non-dollar investments), the continued weakness of the European economy and further declines in per unit costs of wind and solar PV. For the sixth consecutive year, renewables outpaced fossil fuels for net investment in power capacity additions.

Private investors stepped up their commitments to renewable energy significantly during 2015. The year witnessed both an increase in the number of large banks active in the renewables sector and an increase in loan size, with major new commitments from international investment firms to renewables and energy efficiency. New investment vehicles – including green bonds, crowdfunding and yieldcos – expanded during the year. Mainstream financing and securitisation structures also continued to move into developing country markets as companies (particularly solar PV) and investors sought higher yield, even at the expense of higher risk.

In parallel with growth in markets and investments, 2015 saw continued advances in renewable energy technologies, ongoing energy efficiency improvements, increased use of smart grid technologies and significant progress in hardware and software to support the integration of renewable energy, as well as progress in energy storage development and commercialisation. The year also saw expanded use of heat pumps, which can be an energy-efficient solution for heating and cooling.

Employment in the renewable energy sector (not including large-scale hydropower) increased in 2015 to an estimated 8.1 million jobs (direct and indirect). Solar PV and biofuels provided the largest numbers of renewable energy jobs. Large-scale hydropower accounted for an additional 1.3 million direct jobs. Considering all renewable energy technologies, the leading employers in 2015 were China, Brazil, the United States and India.

POWER SECTOR

Record year for solar PV and wind, transformation accelerates

The power sector experienced its largest annual increase in capacity ever, with significant growth in all regions. Wind and solar PV had record additions for the second consecutive year, accounting for about 77% of new installations, and hydropower represented most of the remainder. The world now adds more renewable power capacity annually than it adds (net) capacity from all fossil fuels combined. By the end of 2015, renewable capacity in place was enough to supply an estimated 23.7% of global electricity, with hydropower providing about 16.6%.

Around the world, technical, economic and market transformation of the electric power sector continued to accelerate, and many countries have begun to respond to the challenge of grid integration. Technological advances, expansion into new markets with better resources, and improved financing conditions continued to reduce costs in 2015.

Electricity from hydro, geothermal and some biomass power sources has been broadly competitive with power from fossil fuels for some time; in favourable circumstances (i.e., with good resources and a secure regulatory framework), onshore wind and solar PV also are cost-competitive with new fossil capacity, even without accounting for externalities. In 2015 and early 2016, expectations of further cost improvements were made evident by record-low winning bids in power auctions in places ranging from Latin America, to the Middle East and North Africa region, to India.

Globally, renewable electricity production in 2015 continued to be dominated by large (e.g., megawatt-scale and up) generators that are owned by utilities or large investors. At the same time, there are markets where distributed, small-scale generation has taken off, or is starting to do so. Bangladesh is the world's largest market for solar home systems, and other developing countries (e.g., Kenya, Uganda and Tanzania in Africa; China, India and Nepal in Asia; Brazil and Guyana in Latin America) are seeing rapid expansion of small-scale renewable systems, including renewables-based mini-grids, to provide electricity for people living far from the grid. Developed countries and regions – including Australia, Europe, Japan and North America – have seen significant growth in numbers of residential and industrial electricity customers who produce their own power.

HEATING AND COOLING SECTOR

Increasing awareness, but challenges continue to inhibit growth rates

Modern renewable energy supplies approximately 8% of final energy for heating and cooling services worldwide in buildings and industry, the vast majority of which is provided by biomass, with smaller contributions from solar thermal and geothermal energy. However, approximately three-quarters of global energy use for heat is fossil fuel-based.

Although the total capacity and generation of renewable heating and cooling technologies continued to rise, 2015 saw global growth rates decline, due in part to low global oil prices. Trends differed substantially by region, however. Solar energy was integrated into a number of district heating systems in 2015, largely in Europe. While there is growing interest in district cooling systems, the use of renewable energy in these systems is as of yet rare.

Policy support for renewable heating and cooling remained far below support in other sectors. Overall, despite ongoing challenges to renewable heating and cooling markets in 2015, there were international signals that awareness and political support for related technologies may be growing.

TRANSPORT SECTOR

Advances in new markets, applications and infrastructure

Renewable energy accounted for an estimated 4% of global fuel for road transport in 2015. Liquid biofuels continued to represent the vast majority of the renewable energy contribution to the transport sector. The year saw advances in new markets and applications, such as aviation biofuels.

Infrastructure for compressed natural gas vehicles and fuelling stations continued to spread, creating further opportunities for integrating biomethane, particularly in Europe. Electric mobility research advanced, with a number of announcements regarding new developments in both light- and heavy-duty electric vehicles (EVs), while exploration of methods to integrate renewable energy into EV charging stations also continued to expand.

Policy support for renewable energy in the transport sector continues to lag behind such support in the power sector.

POLICY LANDSCAPE

The vast majority of countries worldwide had renewable energy support policies in place by the end of 2015. These policies received increased interest during the year as part of the global effort during COP21 in Paris to mitigate global climate change.

The total number of countries with renewable energy policies increased again in 2015. As of year-end 2015, at least 173 countries had renewable energy targets (not considering INDCs), and an estimated 146 countries had renewable energy support policies, at the national or state/provincial level. Several jurisdictions raised the ambition of their targets and strengthened their policies, although many weakened their support for renewables.

POLICIES FOR ELECTRICITY

Electricity continues to dominate policy makers' focus

Policy makers continued to focus predominantly on renewable power generation technologies, particularly solar PV and wind power. As of year-end 2015, 110 jurisdictions at the national or state/provincial level had enacted feed-in policies, making this the most widely adopted regulatory mechanism to promote renewable power.

Tendering has gained significant momentum in recent years and is preferred to feed-in policies in a growing number of countries. By the end of 2015, at least 64 countries had held renewable energy tenders, with record bids in terms of both low price and high volume seen across the world's developing and emerging countries. European countries also are transitioning to tendering, reflecting the shift in EU policy.

In addition, 52 countries had adopted net metering / net billing policies, including four new policies adopted at the national level and five added at the state/provincial level. Fiscal policies, including grants, loans and tax incentives, continued to be important tools for promoting the deployment of new projects and the advanced development of renewable energy technologies. Many countries use a combination of these policies to advance renewables in the power sector.

POLICIES FOR HEATING AND COOLING

Policy support remains well below other sectors

The slow pace of adoption of policies to support renewable heating and cooling technologies continued throughout 2015. Policies that have been adopted are directed mainly towards renewable heating technologies rather than renewable cooling, and they focus primarily on smaller-scale solar thermal heating options in residential and commercial buildings, such as solar water heaters.

An estimated 47 countries worldwide had targets for renewable heating or cooling in place by the end of 2015. Renewable heating targets were included in the INDCs submitted to the UNFCCC by Bosnia and Herzegovina, Jordan and Malawi. At least 21 countries had mandates for renewable heating and cooling technologies during the year, and no new ones were added at the national or state/provincial level. Due to the slow progress in adopting regulatory support, fiscal incentives remain the primary mechanism that policy makers use to support the renewable heating and cooling sectors.

RENEWABLE ENERGY TRANSPORT POLICIES

Slow development and shifting support to second-generation biofuels

Nearly all policies adopted in the renewable transport sector in 2015, as in past years, were directed at road transport through support for biofuels production and use. Policies to promote the integration of renewable energy and electric vehicles, as well as the use of renewables in aviation, rail or shipping, have been slow to develop.

As of year-end 2015, biofuel mandates were in place in 66 countries at the national or state/provincial level. Support has shifted increasingly towards the promotion of advanced biofuels in new policy development, although, globally, most policies adopted to date focus on first-generation biofuels.

CITY AND LOCAL GOVERNMENT RENEWABLE ENERGY POLICIES

Continuing to lead with innovative policies

Cities and municipalities continued to expand their influence as leaders in the global energy transition. The important role of municipal governments and local-level climate-based commitments in promoting deployment of renewable energy technologies on a large scale was highlighted as an important component of the COP21 climate negotiations in Paris.

Cities relied on a mix of regulatory policies, mandates and direct purchasing to support the deployment of renewable energy within their jurisdictions.

In 2015, some cities – such as Amsterdam (Netherlands) and Graz (Austria) – committed to developing their renewable heat sectors, while others – including Cape Town (South Africa) and Banff (Canada) – adopted regulatory measures to promote renewable power. In the transport sector, some national governments (including Kenya, Mexico and Vietnam) introduced biofuel blend mandates as pilot initiatives in cities.

The 100% Renewable Energy movement expanded in 2015 with new members including Byron Shire, Coffs Harbour and Uralla in Australia; Oxford County and Vancouver in Canada; and the US cities of Rochester (Minnesota) and San Diego (California). The list of cities around the world that have committed to achieving a 100% renewable electricity or energy (across all sectors) system is growing rapidly.

Cities continued to work together to advance their common renewable energy goals through their membership in several high-profile global and regional partnerships, such as the Covenant of Mayors and the Compact of Mayors.

RENEWABLE ENERGY INDICATORS 2015

		2014	2015
INVESTMENT			
New investment (annual) in renewable power and fuels[1]	billion USD	273	**285.9**
POWER			
Renewable power capacity (total, not including hydro)	GW	665	**785**
Renewable power capacity (total, including hydro)	GW	1,701	**1,849**
Hydropower capacity[2]	GW	1,036	**1,064**
Bio-power capacity[3]	GW	101	**106**
Bio-power generation (annual)	TWh	429	**464**
Geothermal power capacity	GW	12.9	**13.2**
Solar PV capacity	GW	177	**227**
Concentrating solar thermal power	GW	4.3	**4.8**
Wind power capacity	GW	370	**433**
HEAT			
Solar hot water capacity[4]	GW_{th}	409	**435**
TRANSPORT			
Ethanol production (annual)	billion litres	94.5	**98.3**
Biodiesel production (annual)	billion litres	30.4	**30.1**
POLICIES			
Countries with policy targets	#	164	**173**
States/provinces/countries with feed-in policies	#	110	**110**
States/provinces/countries with RPS/quota policies	#	98	**100**
Countries with tendering/ public competitive bidding[5]	#	60	**64**
Countries with heat obligation/mandate	#	21	**21**
Countries with biofuel mandates[6]	#	64	**66**

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

[2] The GSR 2015 reported a global total of 1,055 GW of hydropower capacity at end-2014. The value of 1,036 GW shown here reflects the full difference between end-2015 capacity (1,064 GW) and new installations in 2015 (28 GW). Capacity at end-2014 may have been greater than 1,036 GW considering an undetermined amount of capacity retirements and plant repowering during the year. Note also that the GSR strives to exclude pure pumped storage capacity from hydropower capacity data.

[3] Bio-power capacity for 2014 was adjusted upwards relative to data in GSR 2015 to reflect the most recent data available.

[4] Solar hot water capacity data include water collectors only. The number for 2015 is a preliminary estimate.

[5] Data for tendering/ public competitive bidding reflect all countries that have held tenders at any time up to the year of focus.

[6] Biofuel policies include policies listed both under the biofuels obligation/mandate column in Table 4 (Renewable Energy Support Policies) and in Reference Table R25 (National and State/Provincial Biofuel Blend Mandates). Countries are considered to have policies when at least one national or state/provincial-level policy is in place.

Note: All values are rounded to whole numbers except for numbers <15, biofuels and investment, which are rounded to one decimal point.

MARKET AND INDUSTRY TRENDS

BIOMASS ENERGY

Continued growth but challenges remain

Bioenergy production continued to increase in 2015, helping to meet rising energy demand in some countries and contributing to environmental objectives. However, the sector also faced a number of challenges, in particular from low oil prices and policy uncertainty in some markets.

Bio-heat production for buildings and industrial uses grew slowly in 2015, with modern uses of bio-heat rising by approximately 3% from 2014 levels. There has been marked growth in the use of biomass for district heating in the Baltic and Eastern European regions. The use of bio-power has increased more quickly – averaging some 8% annually – with rapid growth in generation notable in China, Japan, Germany and the United Kingdom.

Ethanol production increased by 4% globally, with record production levels in the United States and Brazil. Global production of biodiesel fell slightly due to constrained production in some Asian markets, although growth continued in the major producing countries (the United States and Brazil). Blend mandates sheltered demand for biofuels from falling fossil fuels prices, but uncertainty about future markets constrained investment in new production capacity during the year.

2015 saw continuing progress in the commercialisation and development of advanced biofuels, with expansion in the capacity and production of fuels by both thermal and biological routes.

GEOTHERMAL POWER AND HEAT

Steady growth hampered by low fossil fuel prices and high development risk

About 315 MW of new geothermal power capacity came online in 2015, bringing the global total to 13.2 GW. Geothermal power generated an estimated 75 terawatt-hours (TWh) during the year. Low fossil fuel prices, coupled with perpetually high project development risk, created unfavourable conditions for geothermal power. Turkey led the market, commanding about half of new global capacity additions.

Geothermal direct use amounted to an estimated 272 petajoules (75 TWh) of heat energy in 2015. An estimated 1.2 GW_{th} was added in 2015 for a total capacity of 21.7 GW_{th}. The average annualised growth rate in direct use geothermal heat consumption has been a little over 3% in recent years.

HYDROPOWER

Industry responds to climate risk and rising shares of variable renewables

Approximately 28 GW of new hydropower capacity (excluding pumped storage) was commissioned in 2015, increasing total global capacity to about 1,064 GW. It is estimated that global generation rose to about 3,940 TWh. Persistent droughts continued to adversely affect hydropower output in many regions, including the Americas and Southeast Asia. China's domestic market continued to contract, but the country retained the global lead by a wide margin, with 16 GW added. Significant capacity also was added in Brazil, Turkey, India, Vietnam, Malaysia, Canada, Colombia and Lao PDR.

Climate risk and growing shares of variable renewable power are driving further adaptation in the hydropower industry. Modernisation, retrofits and expansion of existing facilities continued in many markets to improve efficiency, flexibility and system resilience. Responses to rising shares of variable renewables have included an increased emphasis on pumped storage and co-implementation of hydropower with solar and wind power.

OCEAN ENERGY

Development continues in wave and tidal current technologies

Ocean energy capacity, mostly tidal power, remained at about 530 megawatts (MW) in 2015. The year presented a mixture of tail- and headwinds for the ocean energy industry. A number of companies continued to successfully advance their technologies and to deploy new or improved devices, mostly in European waters. However, at least one company had to declare bankruptcy, and the industry as a whole continued to face a constrained financial landscape beyond public funding. As in most years, ocean energy technology deployments in 2015 were predominantly demonstration projects, with most activity concentrated in tidal energy technologies, followed by wave energy conversion devices.

SOLAR PV

Record deployment and rapid expansion into new markets

The solar PV market was up 25% over 2014 to a record 50 GW, lifting the global total to 227 GW. The annual market in 2015 was nearly 10 times the world's cumulative solar PV capacity of a decade earlier. China, Japan and the United States again accounted for the majority of capacity added, but emerging markets on all continents contributed significantly to global growth, driven largely by the increasing cost-competitiveness of solar PV.

An estimated 22 countries had enough capacity at end-2015 to meet more than 1% of their electricity demand, with far higher shares in some countries (e.g., Italy 7.8%, Greece 6.5% and Germany 6.4%). China achieved 100% electrification, in part because of significant off-grid solar PV installed since 2012; on-grid, however, curtailment of solar generation started to become a serious challenge for China's solar PV sector.

The industry recovery of recent years strengthened further due to the rise of new markets and strong global demand, and most top-tier companies were back on their feet in 2015. Record-low bids for large-scale solar PV projects were seen in tenders from Latin America to the Middle East to India. Distributed rooftop solar PV remains more expensive than large-scale projects but has followed similar price trajectories and is competitive with retail prices in many locations.

CONCENTRATING SOLAR THERMAL POWER (CSP)

Marked shift to developing regions, increasing importance of thermal energy storage

Morocco (160 MW), South Africa (150 MW) and the United States (110 MW) all brought new CSP facilities online in 2015, raising total global capacity by about 10% to nearly 4.8 GW.

The new facilities represent a mix of parabolic trough and tower technologies, and all incorporate thermal energy storage (TES). By year's end, additional CSP capacity was under construction in Morocco (350 MW), South Africa (200 MW), Israel (121 MW), Chile (110 MW), Saudi Arabia (100 MW), China (50 MW) and India (25 MW), reflecting a shift from traditional markets (Spain and the United States) to developing regions with high direct normal irradiation (DNI) levels.

Industrial capacity continued to expand in developing regions, supported in part by local content requirements associated with CSP procurement programmes. Large facilities (greater than 100 MW) are increasingly the norm, as is the incorporation of TES and dry cooling technologies. CSP bid prices in national tenders continued to decline, most notably in South Africa and Morocco. Cost reduction and increased thermal efficiency were key areas of focus in several research and development (R&D) programmes around the world.

SOLAR THERMAL HEATING AND COOLING

Continued slowdown in China and Europe, but increased deployment of large-scale projects

Global capacity of glazed and unglazed solar thermal collectors rose by more than 6% in 2015, despite a market slowdown due primarily to the continued contraction of markets in China and Europe. China accounted for about 77% of newly installed solar water heater capacity, followed by Turkey, Brazil, India and the United States. Cumulative capacity of water collectors reached an estimated 435 GW_{th} by year's end (with air collectors adding another 1.6 GW_{th}), enough capacity to provide approximately 357 TWh of heat annually.

Market development varied widely from country to country. Denmark, Israel, Mexico, Poland and Turkey reported significant growth. By contrast, low oil and gas prices in Europe and the ongoing slowdown in housing construction in China dampened these markets. Even so, several European solar thermal manufacturers managed to increase their sales by developing new business models, offering heat supply contracts or energy service company (ESCO) contracts, or offering extended finance periods.

2015 saw increasing interest in and deployment of large-scale solar thermal systems in district heating networks and for industrial use. Large investments signaled a new era with the start of the construction of a 1 GW_{th} solar process heat plant in Oman.

WIND POWER

Largest source of new renewable power capacity; growing role in meeting electricity demand

Wind power was the leading source of new power generating capacity in Europe and the United States in 2015, and the second largest in China. Globally, a record 63 GW was added for a total of about 433 GW. Non-OECD countries were responsible for the majority of installations, led by China, and new markets emerged across Africa, Asia and Latin America. Corporations and other private entities continued turning to wind energy for reliable and low-cost power, while many large investors were drawn by its stable returns.

The offshore sector had a strong year with an estimated 3.4 GW connected to grids, mostly in Europe, for a world total exceeding 12 GW.

Wind power is playing a major role in meeting electricity demand in an increasing number of countries, including Denmark (42% of demand in 2015), Germany (more than 60% in four states) and Uruguay (15.5%).

The industry had another strong year, and most top turbine manufacturers broke their own annual installation records. To meet rising demand, new factories opened or were under construction around the world. Challenges included lack of transmission infrastructure and curtailment of wind generation (particularly in China).

DISTRIBUTED RENEWABLE ENERGY FOR ENERGY ACCESS

Positive market trends, innovative business models, increased investment

Approximately 1.2 billion people (constituting 17% of the global population) live without electricity, with the vast majority in the Asia-Pacific region and sub-Saharan Africa. Distributed renewable energy (DRE) systems continue to play an increasing role in providing energy services to these populations.

Advances in technology, increased awareness of deforestation and enhanced government support enabled the expansion of DRE in the cooking and heating sector in 2015. By year's end, approximately 28 million households worldwide were using clean cook stoves.

DRE solar PV markets also continued to flourish. Roughly 44 million off-grid pico-solar products had been sold globally by mid-2015, representing an annual market of USD 300 million. About 70 countries worldwide either had some off-grid solar PV capacity installed or had programmes in place to support off-grid solar PV applications by the end of 2015. In addition, several thousand renewables-based mini-grids were in operation, with primary markets in Bangladesh, Cambodia, China, India, Mali and Morocco.

The year saw positive market trends and increased investment. Innovative business models also continued to mature, with expanding use of mobile payment systems and scratch cards, the "Powerhive" business model, pay-as-you-go micro-payment schemes and integrated service providers with products that range from simple solar lamps with radios and mobile phones, to aspirational items like televisions.

DRE deployment in 2015 was supported by a variety of policy types, such as auctions, dedicated electrification targets and initiatives related to clean renewable cooking. Fiscal and other incentives that focus on specific renewable energy technologies, such as exemptions on value-added tax (VAT) and import duties, also were in use to support DRE deployment.

Dozens of international actors, including at least 30 programmes and approximately 20 global networks, also were involved in deploying DRE in 2015. Many international programmes focus specifically on improving energy access with renewables, in Africa and elsewhere.

INVESTMENT FLOWS

A new record high; developing and emerging countries lead

Global new investment in renewable power and fuels climbed to a record USD 285.9 billion in 2015 (not including hydropower projects >50 MW[i]). This represents a rise of 5% compared to 2014 and exceeds the previous record (USD 278.5 billion) achieved in 2011. Including investments in hydropower projects larger than 50 MW, total new investment during 2015 in renewable power and fuels (not including renewable heating and cooling) was at least USD 328.9 billion.

In 2015, global investment in new renewable power capacity, at USD 265.8 billion[ii], was more than double the USD 130 billion allocated to new coal- and natural gas-fired power generation capacity. This difference in favour of renewables is the largest witnessed to date. If hydropower projects larger than 50 MW are considered, the spread between renewables and fossil fuel investment in new power capacity is even greater.

For the first time in history, total investment in renewable power and fuels in developing countries in 2015 exceeded that in developed economies. The developing world, including China, India and Brazil, committed a total of USD 156 billion (up 19% compared to 2014). China played a dominant role, increasing its investment by 17% to USD 102.9 billion, accounting for 36% of the global total. Renewable energy investment also increased significantly in India, South Africa, Mexico and Chile. Other developing countries investing more than USD 500 million in renewables in 2015 included Morocco, Uruguay, the Philippines, Pakistan and Honduras.

By contrast, renewable energy investment in developed countries as a group declined by 8% in 2015, to USD 130 billion. The most significant decrease was seen in Europe (down 21% to USD 48.8 billion), despite the region's record year of financing for offshore wind power (USD 17 billion, up 11% from 2014). In the United States, renewable energy investment (dominated largely by solar power) increased by 19% to USD 44.1 billion, the country's largest increase in dollar terms since 2011.

Investment in renewable energy has been weighted increasingly towards wind and solar power. Solar power was again the leading sector by far in terms of money committed during 2015, accounting for USD 161 billion (up 12% over 2014), or more than 56% of total new investment in renewable power and fuels. Wind power followed with USD 109.6 billion, or 38.3% of the total (up 4%). All technologies except solar and wind power saw investment decline relative to 2014: investment in biomass and waste-to-energy fell by 42% to USD 6 billion, small-scale hydropower fell by 29% to USD 3.9 billion, biofuels fell by 35% to USD 3.1 billion, geothermal energy fell by 23% to USD 2 billion, and ocean energy fell by 42% to USD 215 million.

ENERGY EFFICIENCY

Increased awareness, investment, policies and targets

Emphasis on activities to improve energy efficiency in all sectors increased during 2015 at all levels of government, as well as in the private sector. There is growing recognition worldwide that energy efficiency can play a key role in reducing energy-related emissions and that it can provide multiple economy-wide benefits – such as enhanced energy security, reduced fuel poverty and improved public health.

By the end of 2015, at least 146 countries had enacted some kind of energy efficiency policy, and at least 128 countries had one or more energy efficiency targets (not considering INDCs). Some policies attempt to harness the synergy between energy efficiency and renewable energy, as efficiency measures have the potential to enable a more rapid increase in renewable energy's share of global energy consumption.

Driven by structural changes and energy efficiency improvements among other factors, global primary energy intensity declined between 1990 and 2014 at an average annual rate of 1.5%, falling by more than 30% overall during this period. However, the global economy has expanded even more, and energy demand has risen steadily.

In the transport and industrial sectors, global energy intensity has declined over the past few decades. In the buildings sector, the relatively small but growing market for more-efficient building envelopes and materials is resulting in improved building energy performance, particularly in developed countries. Total energy demand for a number of appliance and equipment categories (e.g., computers, fans, motors) continues to rise, despite improvements in efficiency, due largely to a rapid increase in the use of electricity-consuming products.

Energy efficiency improvements reflect, in part, increasing investments. In 2013, global investment in energy efficiency totalled an estimated USD 130 billion, including the end-user categories of buildings, transport and industry as well as associated costs such as labour and taxes (but not fuel switching). In September 2015, 70 financial institutions from more than 20 countries – including national, regional and global banks – committed to increasing financing for energy efficiency investments.

Advancements also reflect increased use of support policies and programmes. A growing number of countries is setting energy efficiency targets and defining roadmaps; adopting new policies and updating existing legislation to advance energy efficiency; and expanding the coverage of standards and labelling programmes, with developing and emerging countries playing an increasing role in these trends. Several developed countries also have introduced new financial incentives to channel additional funding towards energy efficiency measures.

i Investment data do not include hydropower projects >50 MW, except where specified.

ii This number is for renewable power asset finance and small-scale projects. It differs from the overall total for renewable energy investment (USD 285.9 billion) provided elsewhere in the report because it excludes biofuels and some types of non-capacity investment, such as equity-raising on public markets and development R&D. In addition, it does not include investment in hydropower projects >50 MW.

TOP FIVE COUNTRIES

Annual investment / net capacity additions / biofuel production in 2015

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

Total capacity or generation as of end-2015

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

[1] Countries considered include only those covered by Bloomberg New Energy Finance (BNEF); GDP (at purchasers' prices) data for 2014 from World Bank. BNEF data include the following: all biomass, geothermal and wind generation 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 and referred to as small-scale projects or small distributed capacity; 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 three countries brought concentrating solar thermal power (CSP) plants online in 2015, which is why no countries are listed in places 4 and 5.

[3] Per capita renewable power capacity ranking considers only those countries that place among the top 20 worldwide for total installed renewable power capacity, not including hydropower. Several other countries including Austria, Finland, Ireland and New Zealand also have high per capita levels of non-hydro renewable power capacity, with Iceland likely the leader among all countries. Population data are for 2014 and are 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 and to match peaks in demand.

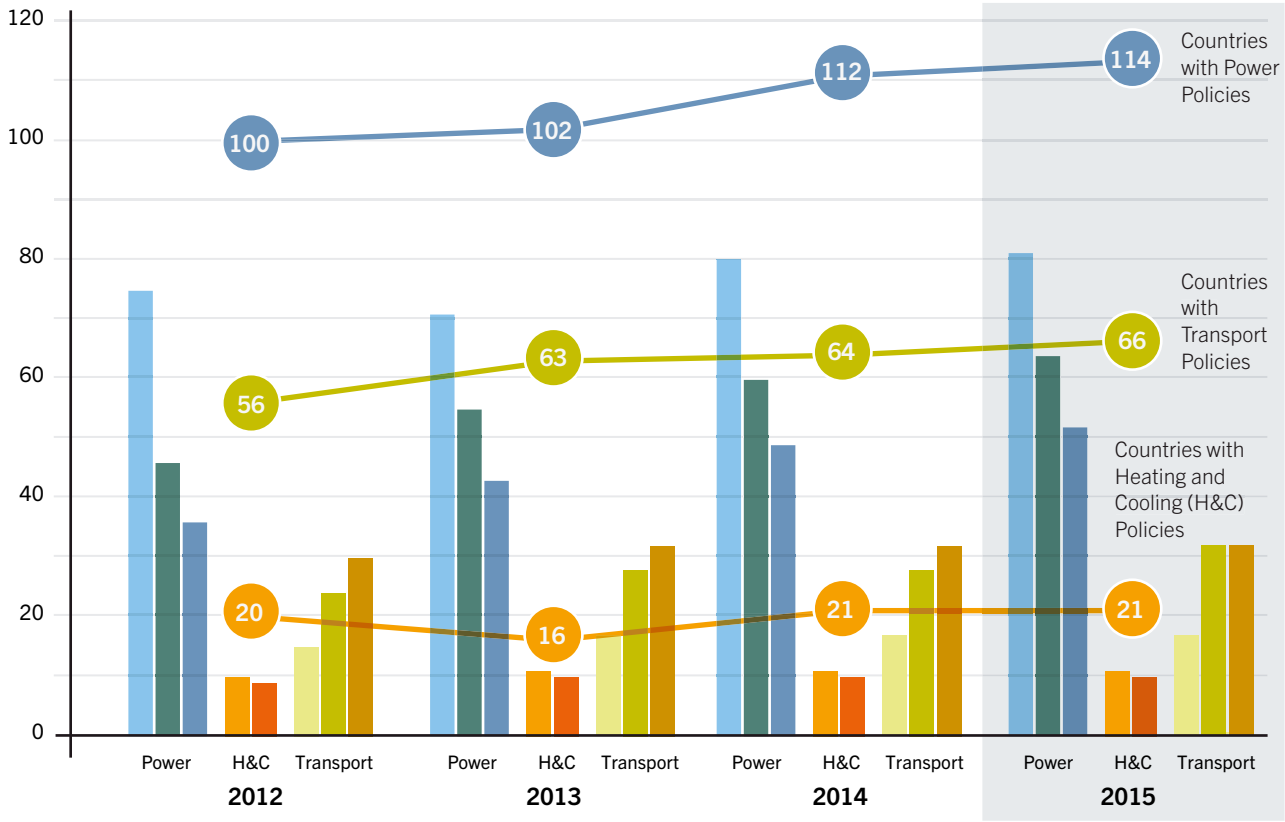
[5] Solar water heating collector rankings for total capacity and per capita are for year-end 2014 and are based on capacity of water (glazed and unglazed) collectors only. Data from IEA SHC. Total capacity rankings are estimated to remain unchanged for year-end 2015.

[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 per capita, national GDP or other basis, the rankings would be different for many categories (as seen with per capita rankings for renewable power, solar PV, wind power and solar water collector capacity).

POLICY LANDSCAPE

Number of Renewable Energy Policies and of Countries with Renewable Energy Policies, by Type, 2012–2015



Power Policies

- FIT
- Tendering
- Net metering

Heating and Cooling Policies

- Technology-neutral obligation
- Solar obligation

Transport

- Biodiesel
- Ethanol
- Non-blend mandate

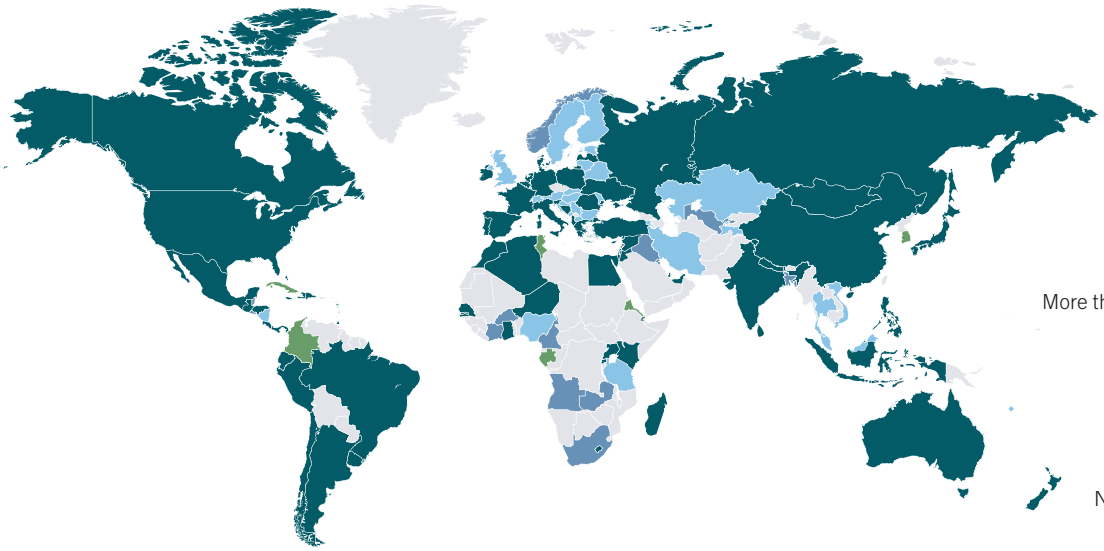
Source: REN21 Policy Database

Figure does not show all policy types in use. Countries are considered to have policies when at least one national or state/provincial-level policy is in place. Some transport policies include both biodiesel and ethanol; in this case, the policy is counted once in each category (biodiesel and ethanol).

REGULATORY POLICIES IN THE **POWER SECTOR** COVER OVER **87%** OF THE WORLD POPULATION, WHILE REGULATORY POLICIES IN THE **HEATING AND COOLING AND TRANSPORT SECTORS** COVER OVER **50%** AND **73%**, RESPECTIVELY.

Source: REN21 Policy Database

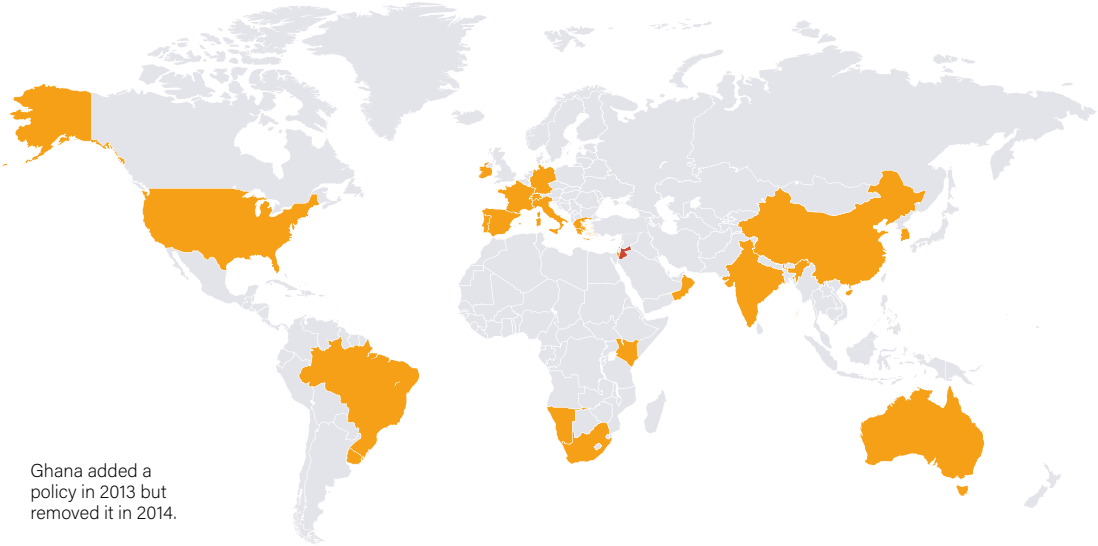
Countries with Renewable Energy Power Policies, by Type, 2015



Power

More than one policy type
Feed-in tariff / premium payment
Tendering
Net metering
No policy or no data

Countries with Renewable Energy Heating and Cooling Obligations, 2010–2015



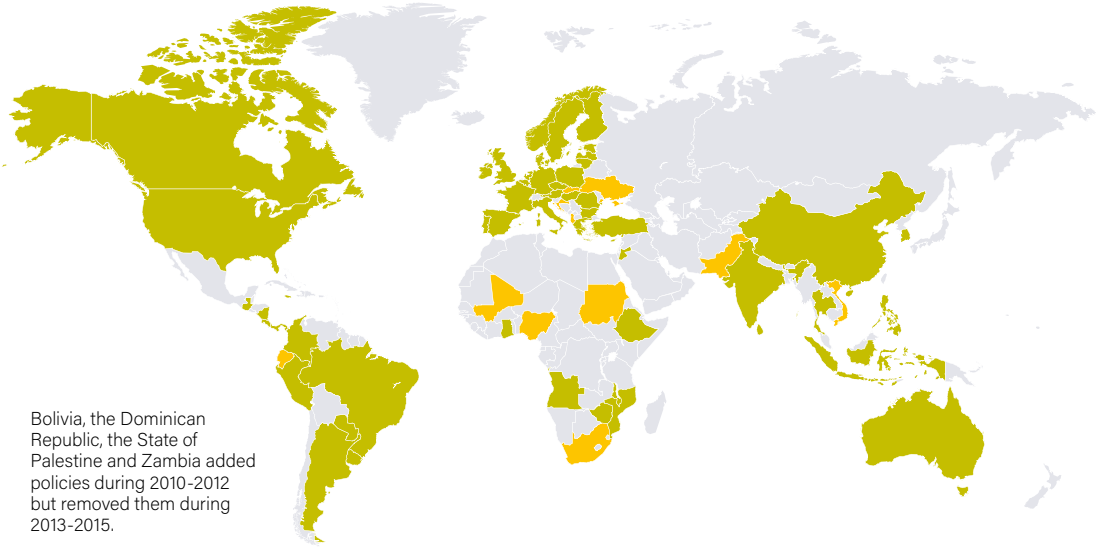
Heating and Cooling

Countries that added policies in 2013–2015: 1

Countries with policies in place in 2010–2012: 20

Ghana added a policy in 2013 but removed it in 2014.

Countries with Renewable Energy Transport Obligations, 2010–2015



Transport

Countries that added policies in 2013–2015: 11

Countries with policies in place in 2010–2012: 55

Bolivia, the Dominican Republic, the State of Palestine and Zambia added policies during 2010-2012 but removed them during 2013-2015.

Countries are considered to have policies when at least one national or state/provincial-level policy is in place.

MAINSTREAMING RENEWABLES: GUIDANCE FOR POLICY MAKERS

The universal nature of energy was emphasised in the international political sphere in 2015. In September 2015, the United Nations General Assembly adopted the Sustainable Development Goal on ensuring access to sustainable energy for all (SDG 7). Furthermore, 195 countries adopted the Paris Agreement to address climate change in December 2015, committing to increasing renewables and energy efficiency as part of the goal to limit global temperature rise to 2 degrees Celsius above pre-industrial levels.

There is a clear link between environmental protection, poverty reduction, economic growth and technology development, **and this work on cross-cutting issues cannot be done in silos**. In order to meet the agreed targets, it will be necessary to work across the various domains, including increasing dialogue, using multi-stakeholder approaches and cross-cutting educational programmes, and supporting interministerial collaboration. National budgeting structures also must contain cross-cutting aspects, and finance (and potentially other) ministries must be included in climate and energy decision-making processes alongside energy ministries.

Outside of the political sphere, civil society demonstrated its overwhelming support for a transition to renewable energy, including through the Pope's environmental encyclical and the Islamic, Hindu and Buddhist declarations on climate change, all of which called on communities of faith to commit to a zero- or low-carbon future. Pressure also is being placed on the more-reluctant energy sector players. Even shareholders in fossil fuel companies increasingly are pushing for the companies to become 'greener'. The private sector is taking advantage of the falling costs of renewable energy technologies, and new initiatives have emerged that include both public and private sector actors, acknowledging that all have a role to play in the energy transition.

In parallel, increasing energy access for the 1.2 billion people without access to electricity is an international priority. In order to meet the target of limiting global temperature increase to below 2 degrees Celsius, while at the same time increasing energy access, **remaining fossil fuel reserves will have to be kept in the ground, and both renewable energy and energy efficiency will have to be scaled up dramatically.**

LEVEL THE PLAYING FIELD

Fossil fuel subsidies have to be phased out, as they distort the true costs of energy and encourage wasteful spending and increased emissions. Fossil fuel subsidies also present a barrier to scaling up clean energy by: decreasing the costs of fossil fuel-powered electricity generation, thereby blunting the cost-competitiveness of renewables; creating an incumbent advantage that strengthens the position of fossil fuels in the electricity system; and creating conditions that favour investments in fossil fuel-based technologies over renewables.[i] Fossil fuel subsidies were estimated to be over USD 490 billion[ii] in 2014, compared with subsidies of only USD 135 billion for renewables.[iii]

Policy design should financially discourage investments in fossil fuels and nuclear, while also removing risk from investments in renewable energy. This is crucial for scaling up renewables, which can help close the energy access gap. Although there has been some divestment from fossil fuels and advances in renewable energy investment, fossil fuel and nuclear investments continue to be favoured over clean energy in many instances, particularly when short-term gains are the primary consideration and long-term thinking is discounted. This can occur when politicians think only in terms of the next election cycle, or when companies attempt to provide shareholders with quick returns. Furthermore, fossil fuels are more institutionalised and have long-standing, well-financed lobbies.

Conversely, renewables are still less known and often suffer from negative images and messages that are widely communicated, such as the idea that incorporating large shares of renewables is unrealistic due to variability, or that renewables are too expensive. Simultaneously, renewable energy policy changes and uncertainties undermine investor confidence, inhibiting investment and deployment in some markets. Investors consider all of these factors in their decision making, as do insurers (demonstrated by the increasing presence of insurance addressing climate change risks). Likewise, **policy makers should think on a long-term basis in order to increase investment in clean energy and advance the energy transition in their countries.**

THINK BEYOND THE POWER SECTOR

More emphasis needs to be placed on strengthening the role of renewable energy in the heating and cooling and transport sectors, as well as on sector coupling. Policy support for the use of renewables in these sectors has advanced at a much slower pace over the past 10 years than it has in the power sector; currently renewable heat obligations exist in only 21 countries and biofuel mandates exist in only 66 countries, compared to 114 countries with renewable energy regulatory policies in the power sector. Not only should policy support for renewables increase in general, but interaction among the three sectors also needs to increase, and national policies should strengthen local capacity, particularly in the heating and cooling sector due to its distributed nature and to its large reliance on local resources.

Policy makers need to remove barriers that are preventing the increased share of renewables in heating and cooling and transport. Current policy initiatives in both sectors are not sufficient to drive the transition from fossil fuels. Policies in the heating and cooling sector, in particular, have not progressed, although heat represents nearly half of annual final energy consumption. To resolve a structural problem of this magnitude, both supply- and demand-side barriers to increasing the use of renewables in both sectors must be addressed, such as lack of trained personnel, costs to retrofit or upgrade, lack of awareness

or knowledge of renewable alternatives, reluctance to change and low consumer confidence. These barriers and others can and should be tackled through a suite of programmes and policy support options, including public awareness campaigns, training programmes and renewable energy incentive policies.

PLAN FOR A DISTRIBUTED FUTURE

It is imperative to plan proactively for a future with a higher amount of distributed energy generation. There is a growing trend towards generation closer to the consumption point, and the use of distributed renewable energy is rising in both developing and developed countries. In developing countries, the use of distributed renewables is primarily a tool for increasing energy access, particularly in rural areas; in developed countries, it is in response to a demand for self-sufficiency and a desire for more-reliable electricity for those connected to the grid, with an increasing number of 'prosumers' emerging.

This change necessitates advanced planning that incorporates a transition to new business models and several policy incentives, while also taking into account the expansion of rooftop solar, decreasing storage costs, increasing energy efficiency measures, the development of community energy projects and the involvement of a new 'smart' technology industry. It also will require a scaling up of infrastructure investments to maintain and build out stable grid networks ready to integrate high shares of variable renewables.

Comprehensive energy planning is needed to intensify research, development and deployment of enabling infrastructure for distributed resources, including strengthened electricity networks, energy storage, demand response and flexible power plants. In industrialised countries, a change in existing infrastructure needs to take place; in developing countries, the concept of distributed resources should be taken into account in planning and investment, rather than defaulting to the traditional model of connecting everyone to a centralised grid. To provide proper guidance to decision makers, tools need to be developed that reflect these new renewable energy realities and changing business models, and that help to plan for the integration of distributed renewables in developing and developed countries alike. Rather than resorting to an 'either-or' mentality, off-grid and on-grid solutions can be pursued simultaneously.

The private sector also should plan for a decentralised energy landscape, as the rapid and exponential growth of renewable power generation and distributed resources comes with both opportunities and challenges, resulting in both winners and losers. In response to new competition and the disruption of traditional business models, some utilities and electricity suppliers are resisting change. Others, however, are repositioning themselves and taking advantage of the renewables opportunity by shifting more towards renewable assets and new markets and embracing the idea of a much more decentralised future power system, with less emphasis on fossil fuels.

ADAPT TO THE NEW, COMPLEX ENERGY SYSTEM

Systemic, cross-cutting approaches are needed for scaling up renewables. Policies often have focused on a single sector, source or technology and were envisioned in the context of centralised power (infra)structures, which no longer reflects the reality of an increasingly complex energy system with increasing crossover and decentralisation. Planning should occur across sectors and across government departments and ministries; policy design should be performed in close dialogue between the public and private sectors; and policies at different levels of government should be complementary and reinforcing.

Scaling up renewables is often less a problem of finance, and more one of political will and of capacity; however, in many developing countries, policies and government support still are necessary to establish stable conditions, to ensure that finance can reach projects and to enable private investors to engage. In addition to robust policies that are adapted to the complexity of the new energy system, **strong leadership is necessary to advance the energy transition,** as ambitious policies require political support, skilled direction and a vision for the future.

To support systemic, cross-cutting approaches to energy, capacity needs to be built at both the political and the technical levels. **Training has to be made available for both current and future decision makers, but also to build up the technical workforce** to expand technological and economic solutions and to remove barriers that are standing in the way of the energy transition. Such training could include streamlining energy efficiency and renewable energy courses into university curricula, and interdisciplinary/intersectoral internships that link research, markets, business and the public sector.

Additionally, renewables should be considered alongside energy efficiency and energy access. Just as the energy transition cannot occur if all focus is on a single sector, it likewise cannot be achieved without increases in both renewables and energy efficiency. Greater synergies between the two are possible in all sectors, and strengthening measures for one often will, in turn, strengthen the other. To expand energy access, decision makers also must make use of both renewable energy and energy efficiency across all sectors. By building both renewables and efficiency into energy access policies and programmes from the beginning, available energy supply effectively can be increased, and more-reliable supply can be provided at a lower cost.

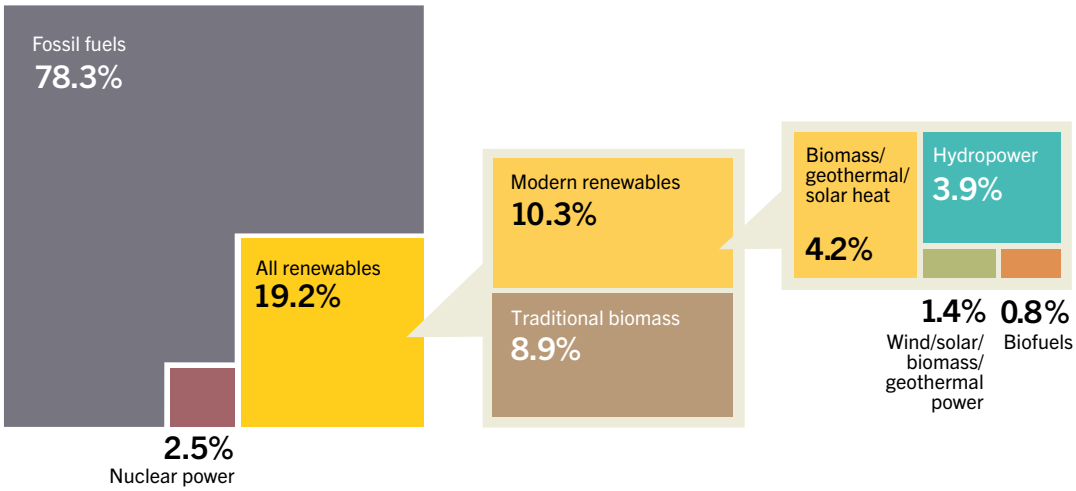
i Richard Bridle and Lucy Kitson, *The Impact of Fossil-Fuel Subsidies on Renewable Electricity Generation* (Winnipeg, Canada: International Institute for Sustainable Development, December 2014), https://www.iisd.org/gsi/sites/default/files/ffs_rens_impacts.pdf.

ii International Energy Agency (IEA) estimates include subsidies to fossil fuels consumed by end-users and subsidies to consumption of electricity generated by fossil fuels. IEA, *World Economic Outlook 2015* (Paris: 2015), p. 96.

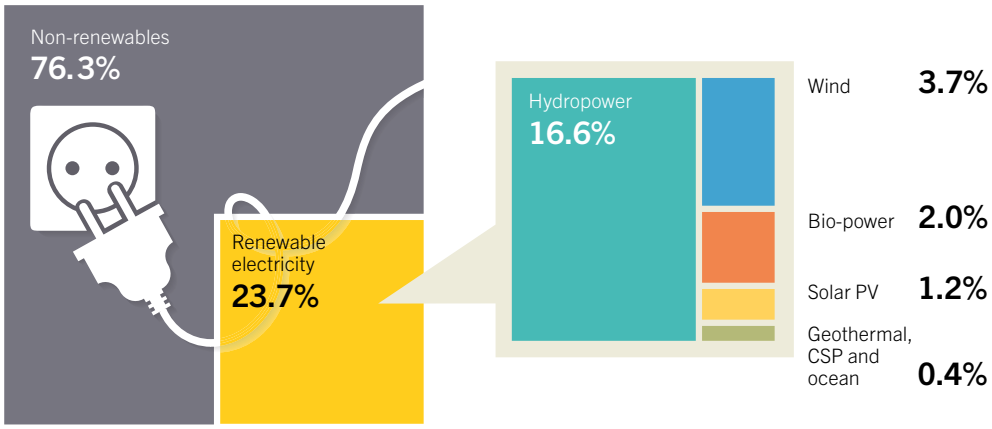
iii The value of fossil fuel subsidies fluctuates from year to year depending on reform efforts, the consumption level of subsidised fuels, international fossil fuel prices, exchange rates and general price inflation, from ibid. See also "OECD-IEA analysis of fossil fuels and other support," http://www.oecd.org/site/tadffss/, viewed 3 March 2016. Subsidies for renewables in 2014 included USD 112 billion in the power sector and USD 23 billion for biofuels, from IEA, op. cit. this note, p. 27.

SELECTED FIGURES & TABLES

Estimated Renewable Energy Share of Global Final Energy Consumption, 2014

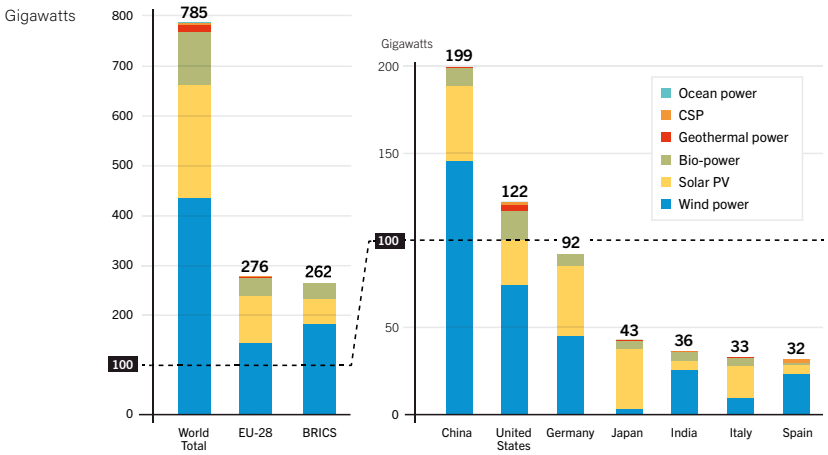


Estimated Renewable Energy Share of Global Electricity Production, End–2015



Based on renewable generating capacity at year-end 2015. Percentages do not add up internally due to rounding.

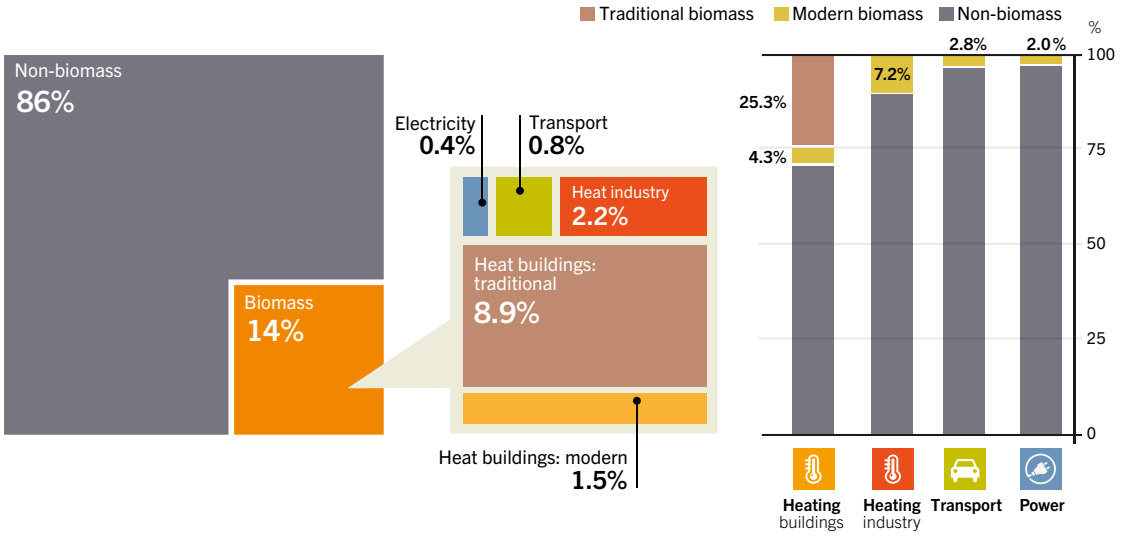
Renewable Power Capacities, in World, EU-28, BRICS and Top Seven Countries, End-2015



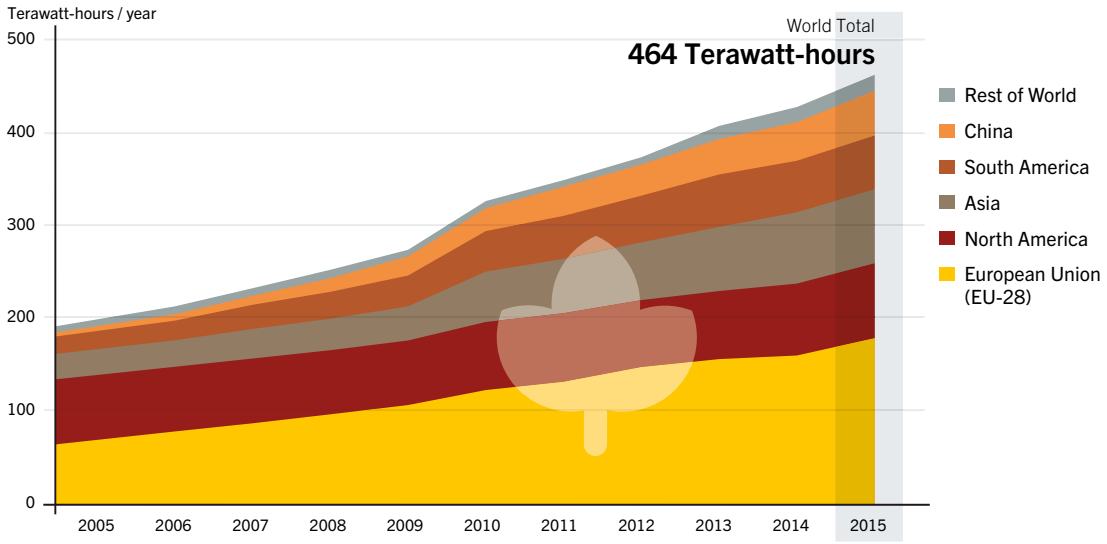
**Not including hydropower (see Reference Table R2 for data including hydropower). The five BRICS countries are Brazil, the Russian Federation, India, China and South Africa.*

BIOMASS ENERGY

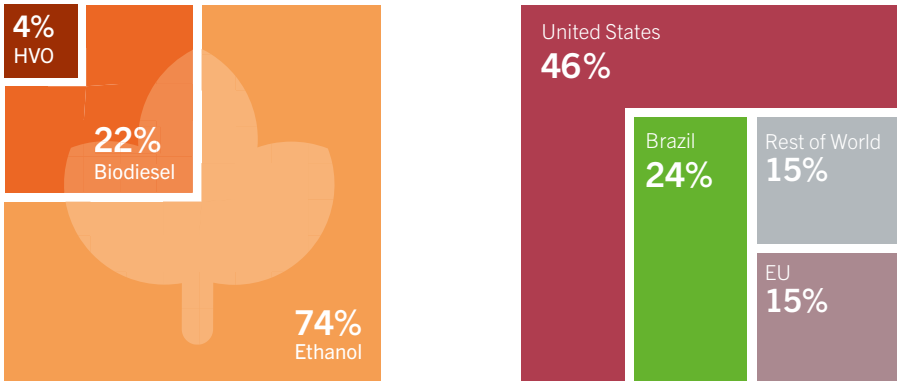
Shares of Biomass in Total Final Energy Consumption and in Final Energy Consumption by End-use Sector, 2014



Global Bio-power Generation, by Country/Region, 2005–2015

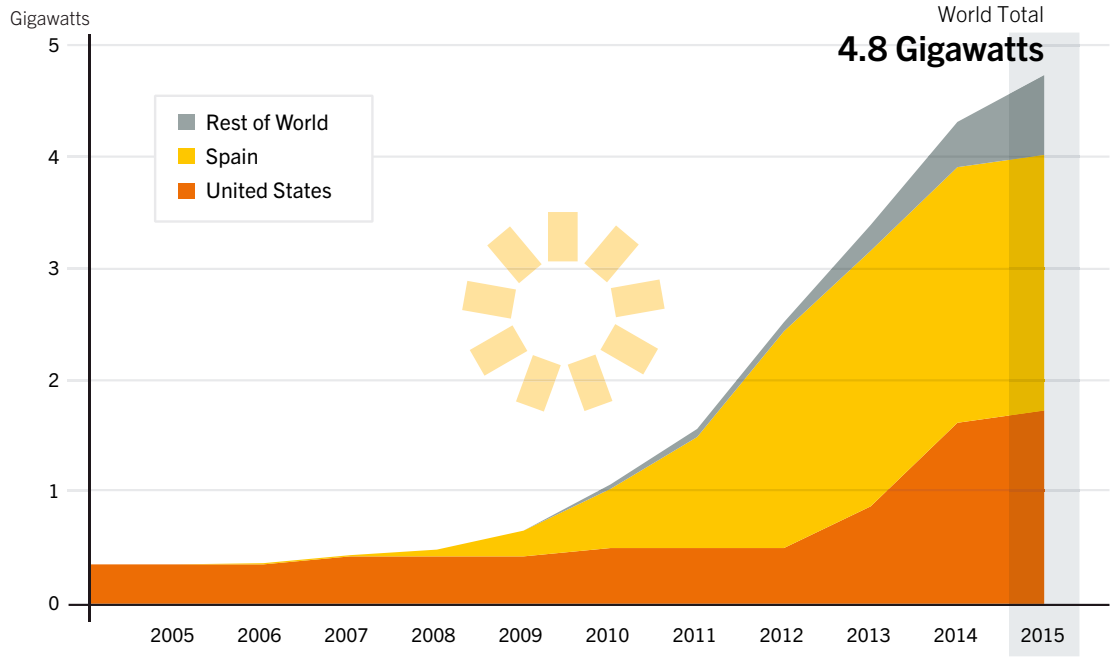


Biofuels Global Production, Shares by Type and by Country/Region, 2015



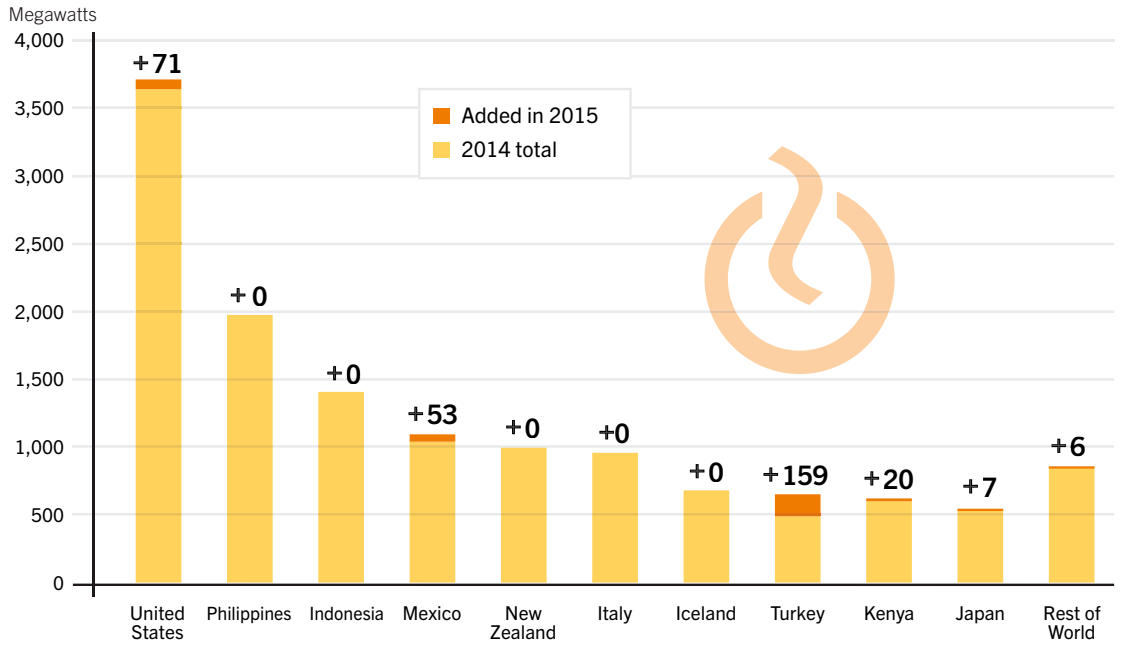
CONCENTRATING SOLAR THERMAL POWER

Concentrating Solar Thermal Power Global Capacity, by Country/Region, 2005–2015



GEOTHERMAL POWER

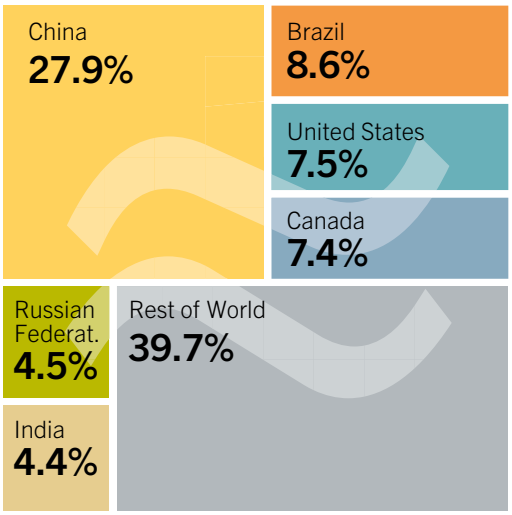
Geothermal Power Capacity and Additions, Top 10 Countries and Rest of World, 2015



Additions are net repowering and retirements.

HYDROPOWER

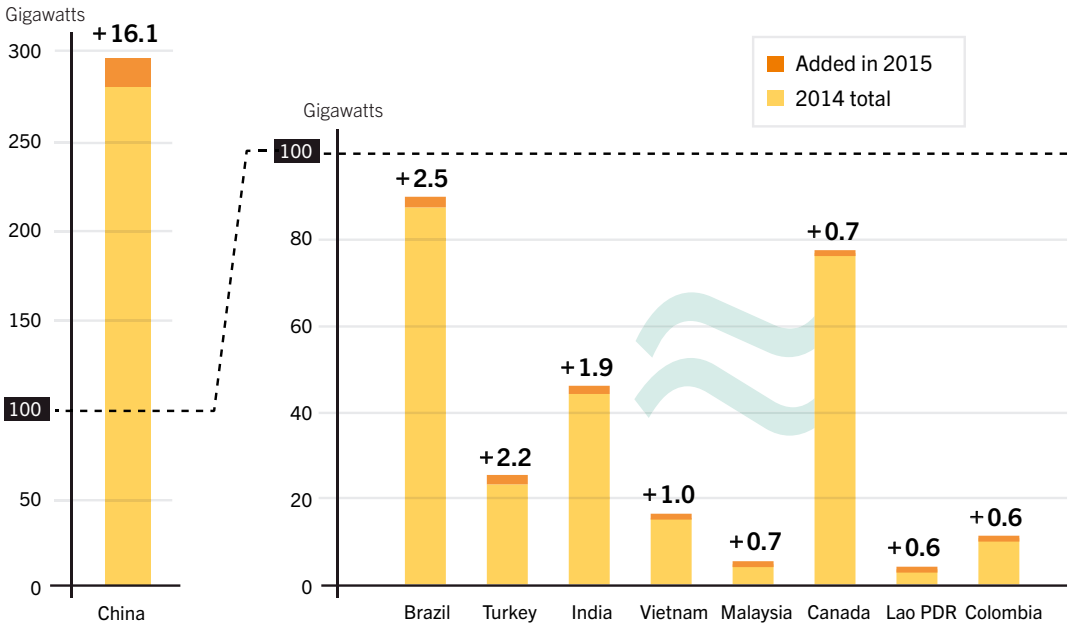
Hydropower Global Capacity, Shares of Top Six Countries and Rest of World, 2015



GLOBAL CAPACITY REACHED

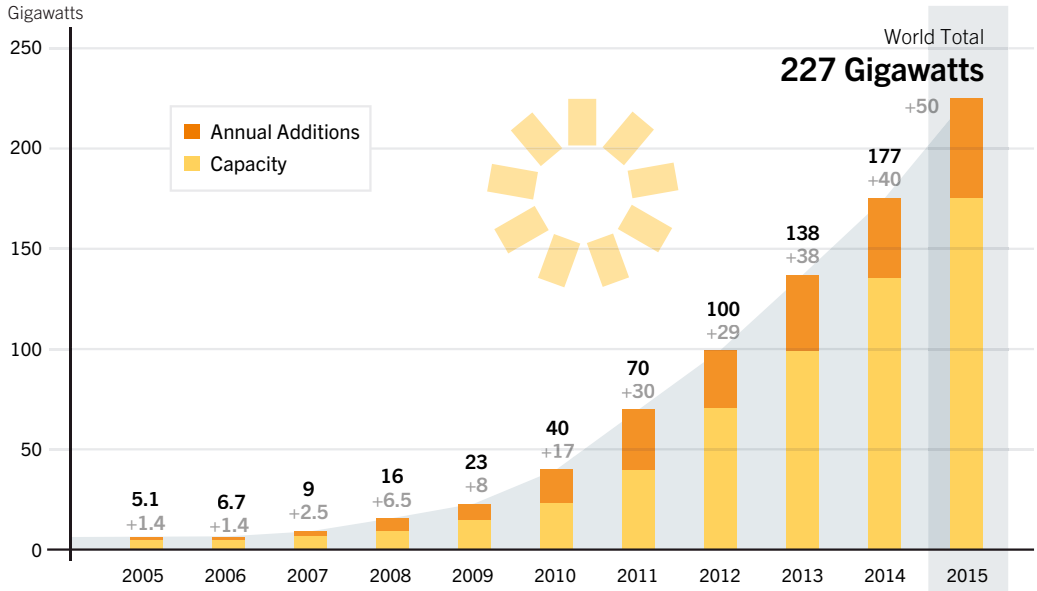
1,064 GW

Hydropower Capacity and Additions, Top Six Countries for Capacity Added, 2015

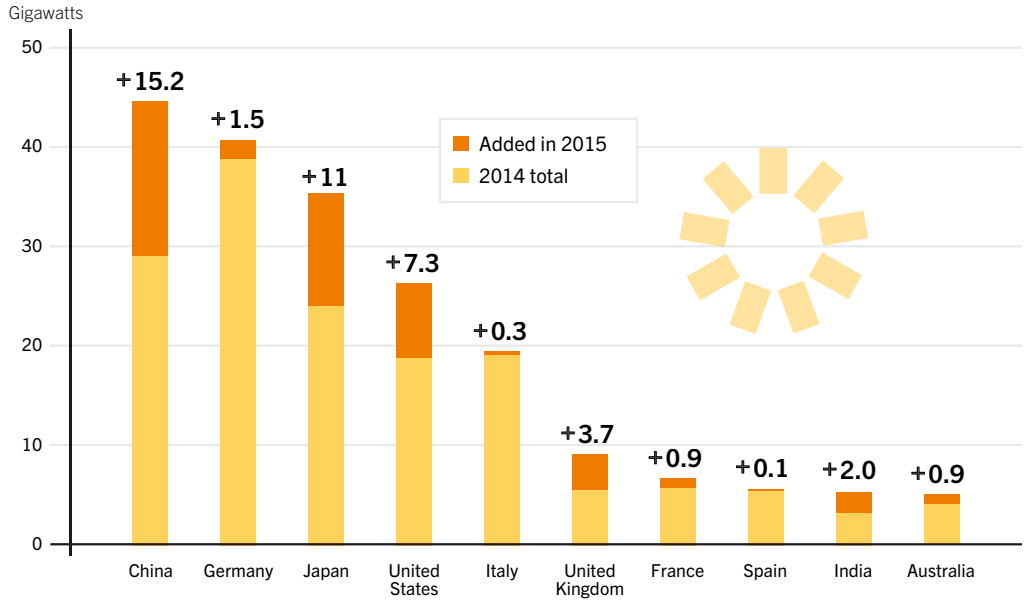


SOLAR PV

Solar PV Global Capacity and Annual Additions, 2005–2015



Solar PV Capacity and Additions, Top 10 Countries, 2015

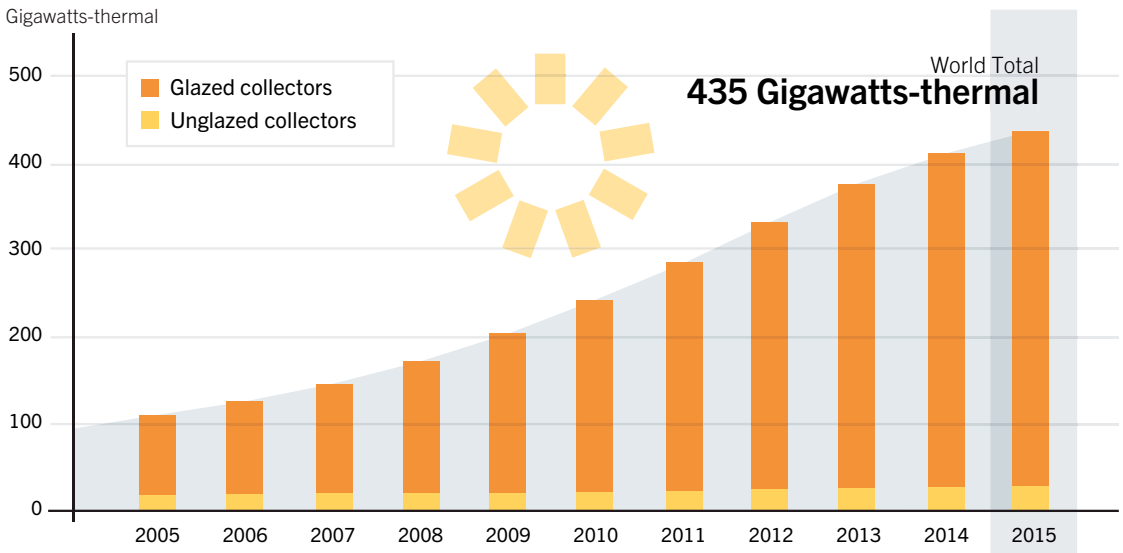


50 GW

ADDED IN 2015

SOLAR THERMAL HEATING AND COOLING

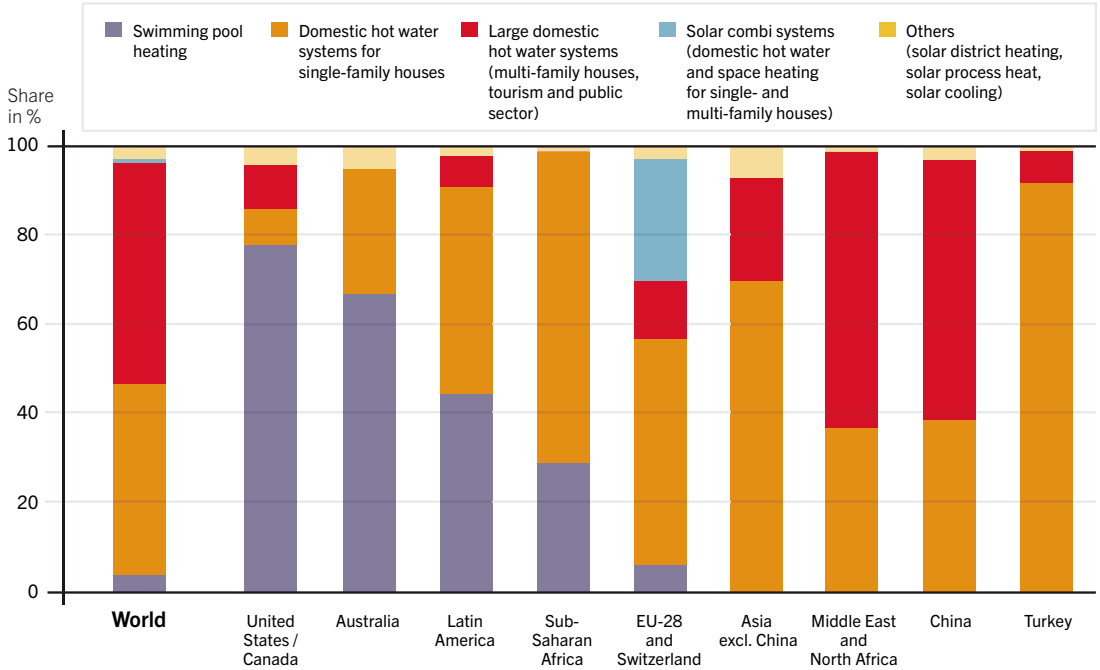
Solar Water Heating Collectors Global Capacity, 2005–2015



Source: IEA SHC

40 GW$_{th}$ ADDED IN 2015

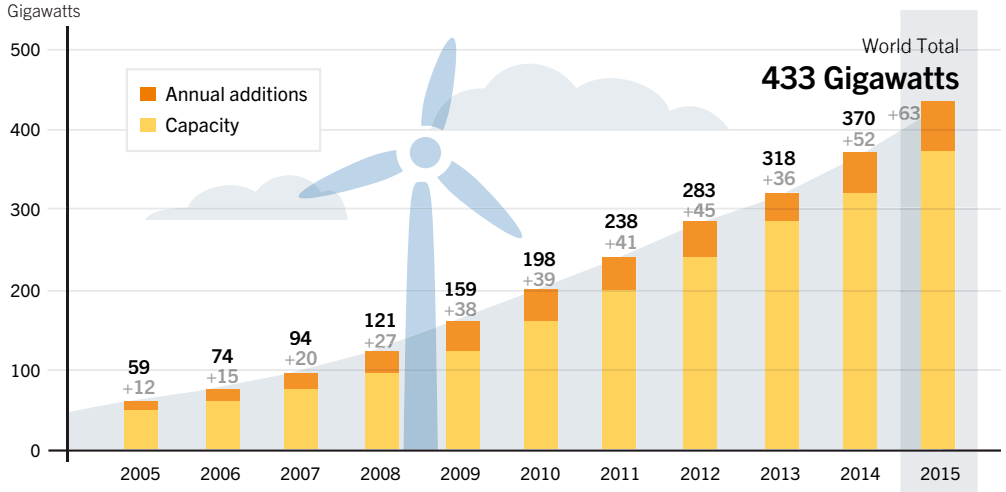
Solar Water Heater Applications for Newly Installed Capacity, by Country/Region, 2014



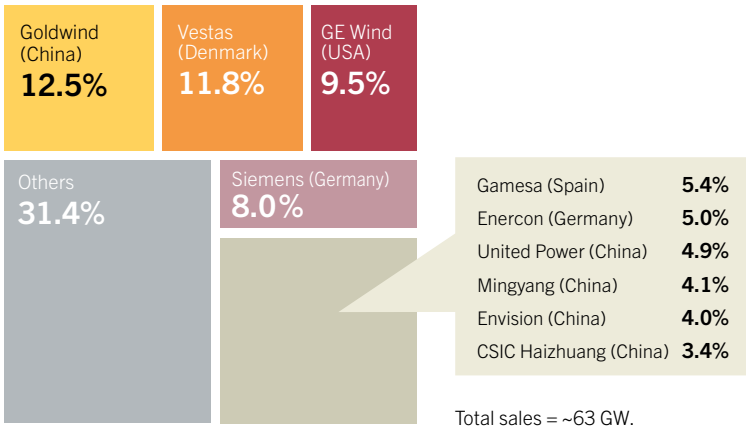
Source: IEA SHC

WIND POWER

Wind Power Global Capacity and Annual Additions, 2005–2015

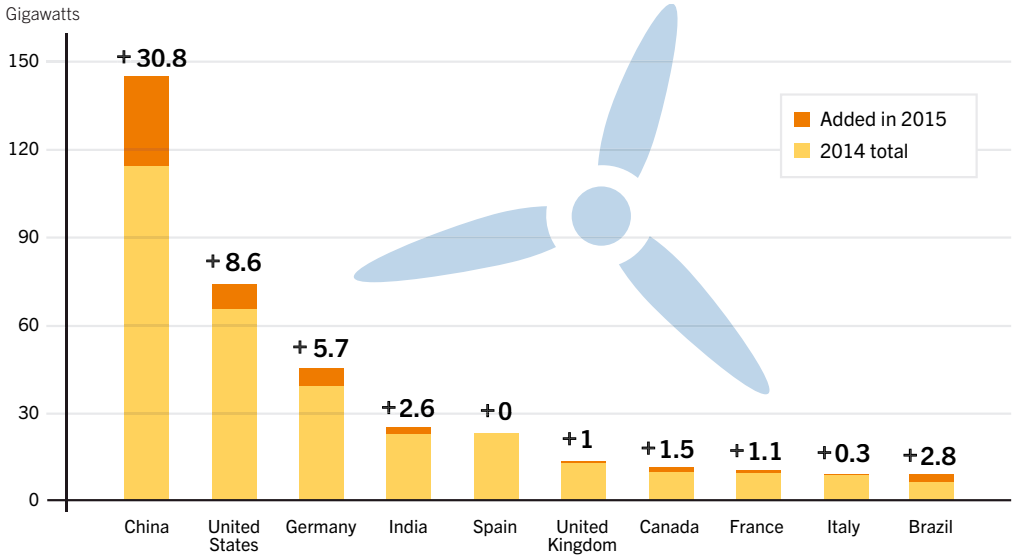


Market Shares of Top 10 Wind Turbine Manufacturers, 2015



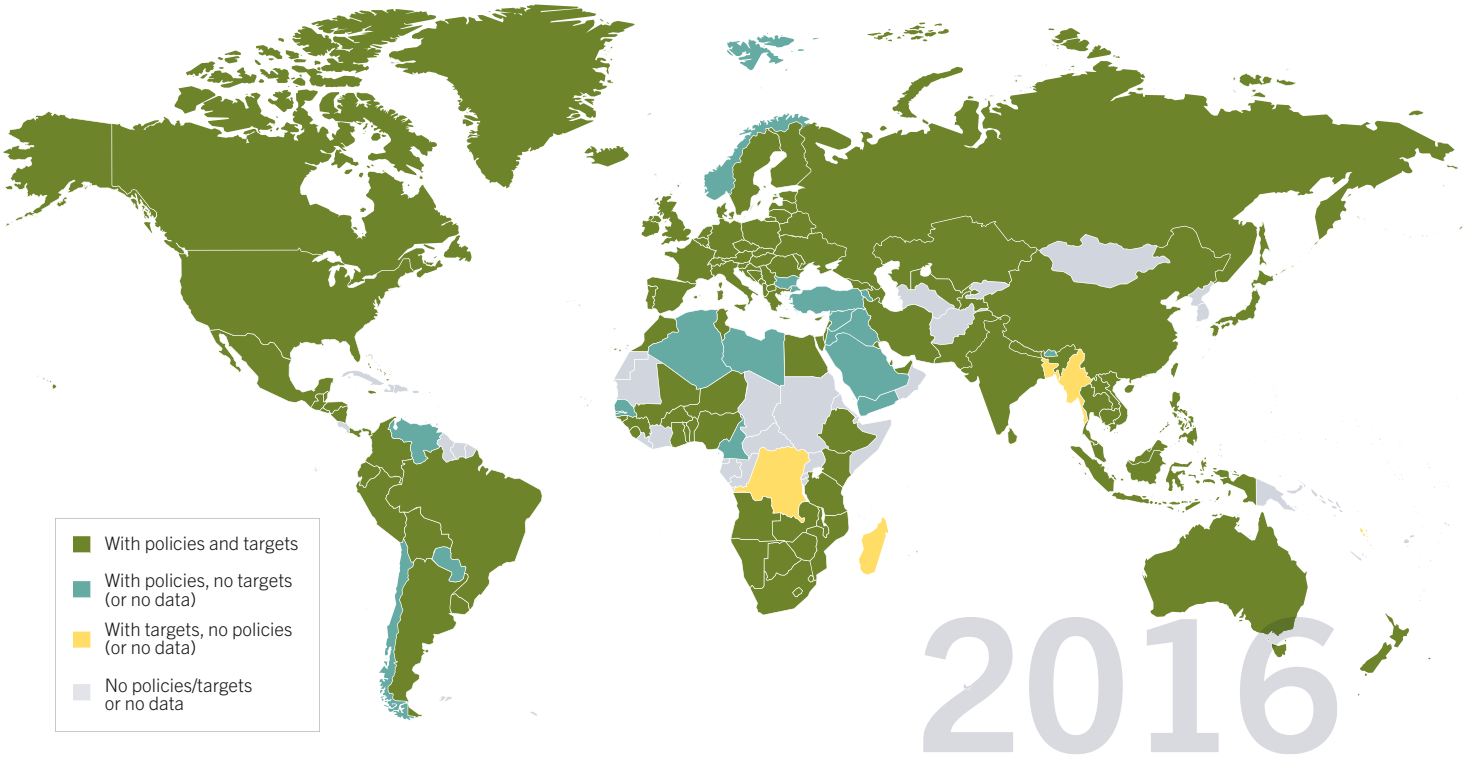
Source: FTI Consulting.

Wind Power Capacity and Additions, Top 10 Countries, 2015

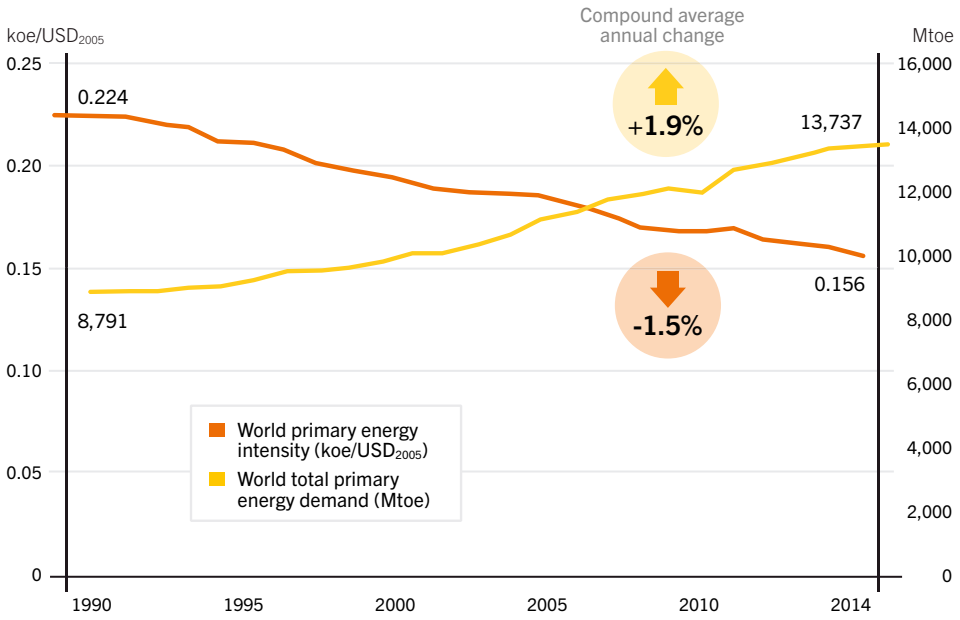


ENERGY EFFICIENCY

Countries with Energy Efficiency Policies and Targets, 2015



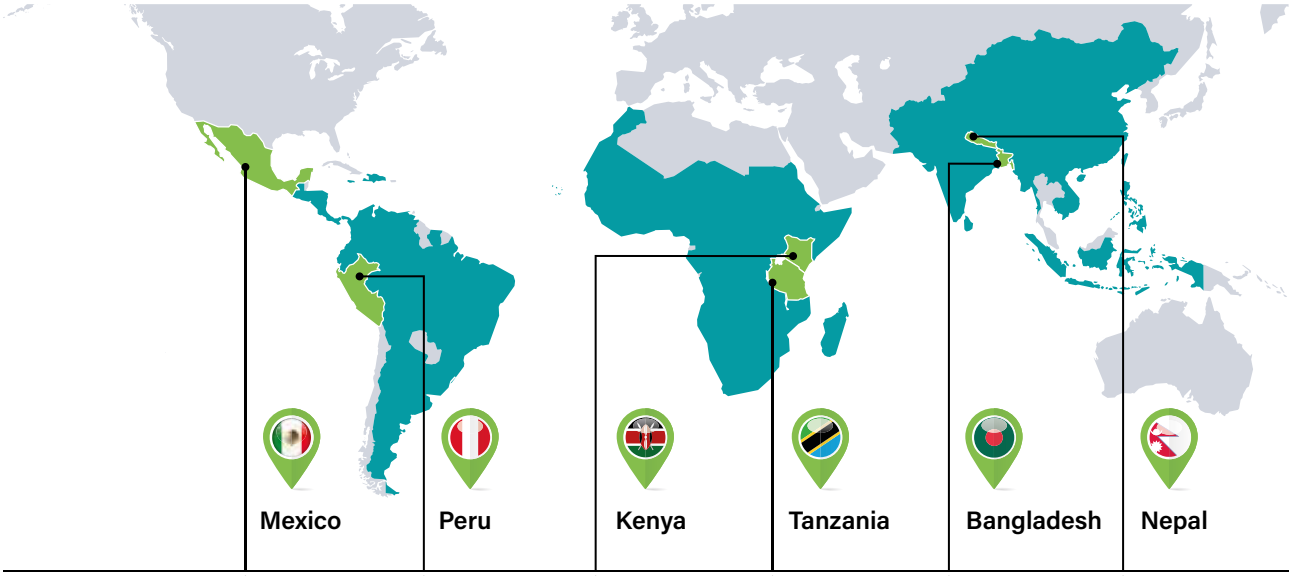
Global Primary Energy Intensity and Total Primary Energy Demand, 1990–2014



Dollars are at constant purchasing power parities.

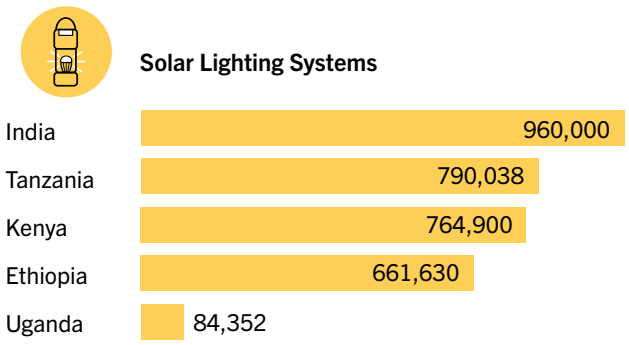
DISTRIBUTED RENEWABLE ENERGY

Market Penetration of DRE Systems in Selected Countries

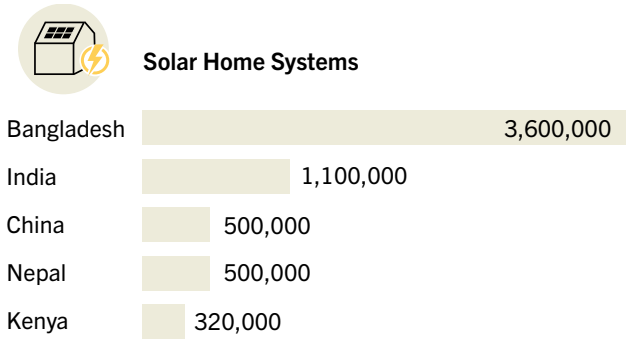


	Mexico	Peru	Kenya	Tanzania	Bangladesh	Nepal
Clean Cook Stoves	**10%** of households that cook with biomass use clean cook stoves	About **30%** of households that cook with biomass use clean cook stoves		At least **1.2 million** households use clean cook stoves	At least **1.3 million** households use clean cook stoves	More than **15%** of households use clean cook stoves
Solar Lighting Systems			**15-20%** of households use off-grid solar lighting systems	About **530,000** pico-solar products were sold during 2014-2015 under Lighting Global		
Solar Home Systems (SHS)	Residential and commercial small-scale SHS markets represent **80%** of total solar PV installed	Government contract awarded in 2015 to install **500,000** SHS	More than 300,000 SHS installed and **30,000** SHS sold annually		**10%** of population is served by SHS	
Micro-Hydro Systems						**20%** of population served by micro-hydropower

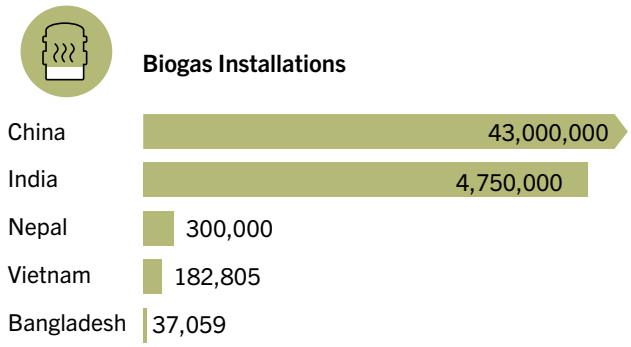
Number of Solar Lighting Systems in Top Five Countries, End-2014



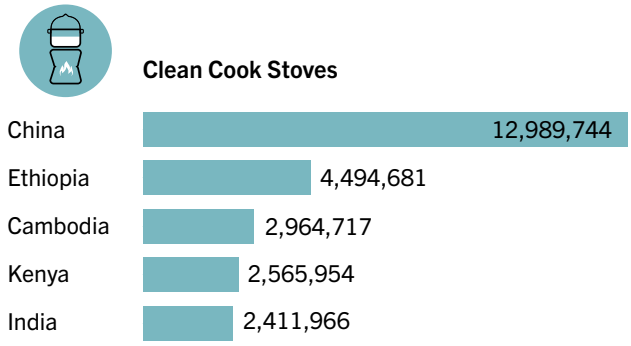
Number of Solar Home Systems in Top Five Countries, End-2014



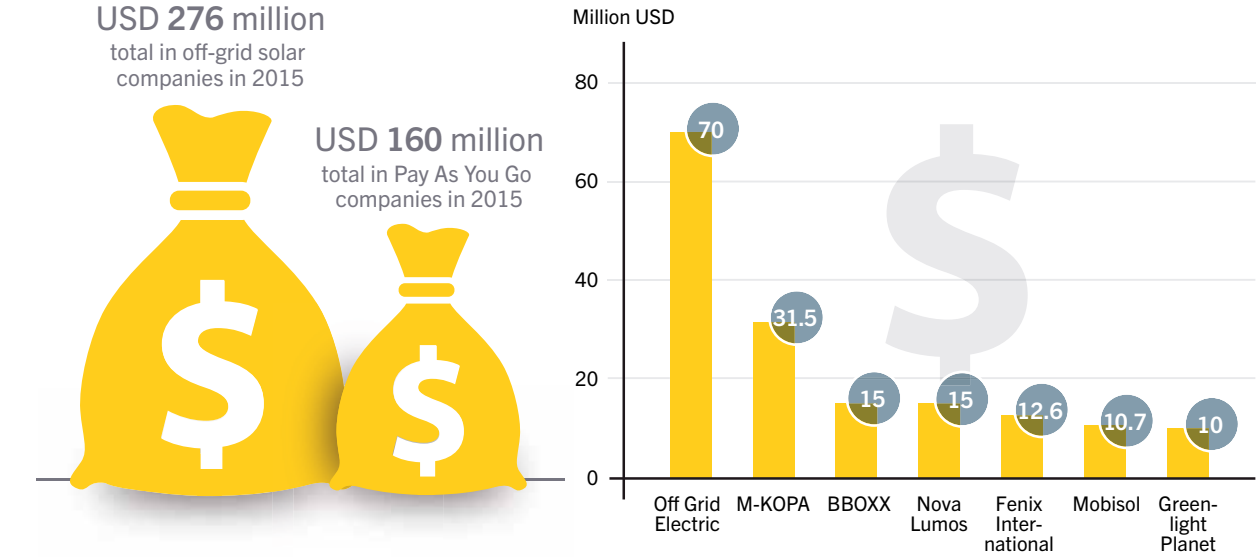
Number of Biogas Installations in Top Five Countries, End-2014



Number of Installed Clean Cook Stoves in Top Five Countries, 2012–2014



Capital Raised by Off-Grid Renewable Energy Companies in 2015

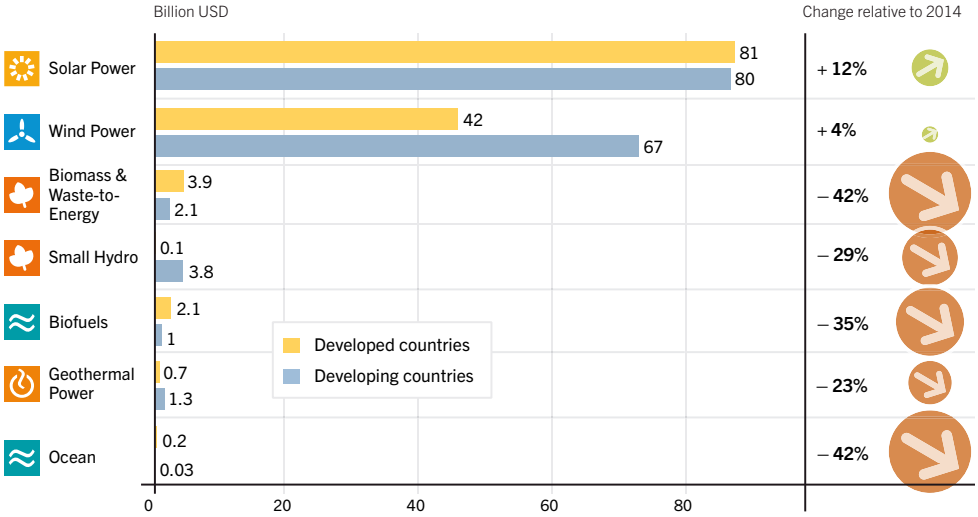


PAYG companies attracted about 58% of the money raised by off-grid solar companies in 2015.

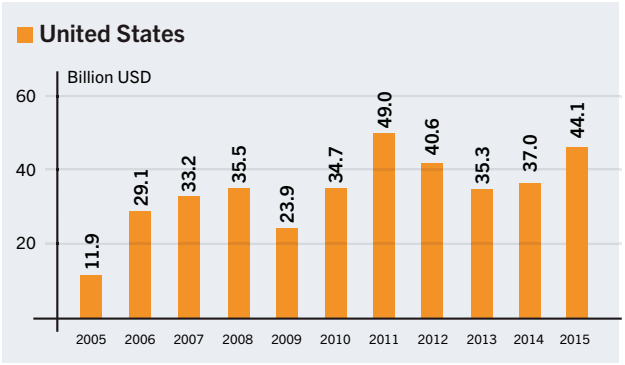
THE LARGEST MARKET FOR OFF-GRID SOLAR PRODUCTS WAS SUB-SAHARAN AFRICA (1.37 MILLION UNITS), FOLLOWED BY SOUTH ASIA (1.28 MILLION UNITS SOLD)

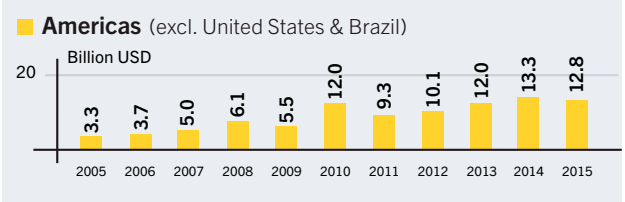
INVESTMENT FLOWS

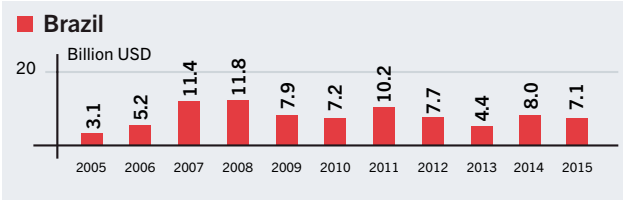
Global New Investment in Renewable Energy by Technology, Developed and Developing Countries, 2015

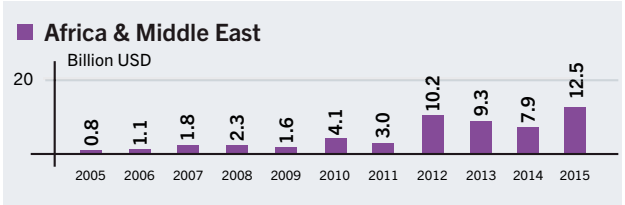


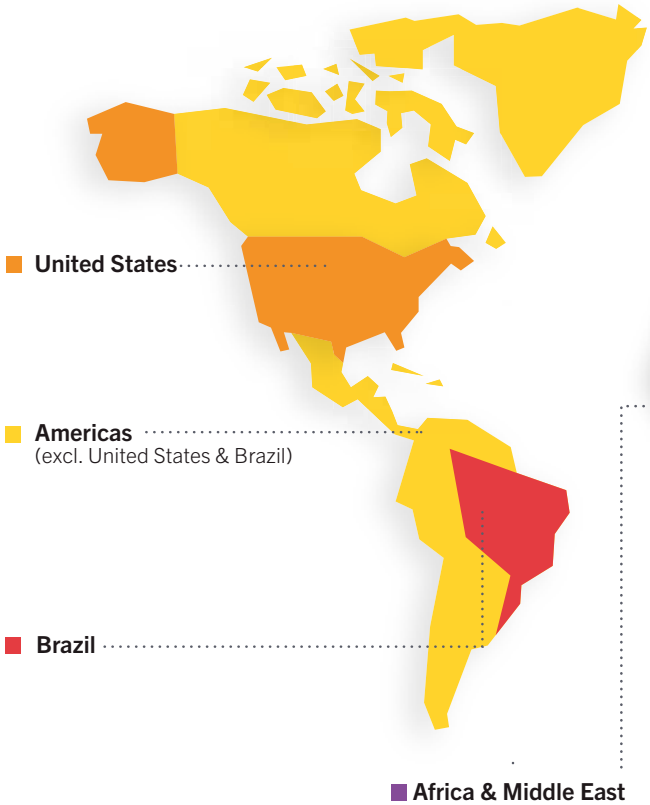
Global New Investment in Renewable Power and Fuels, by Country/Region, 2004–2015

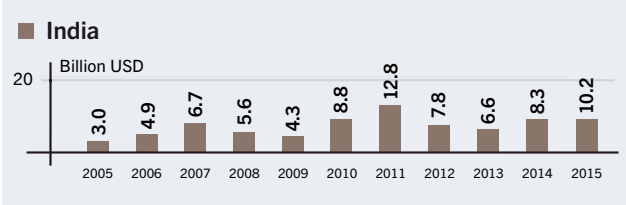




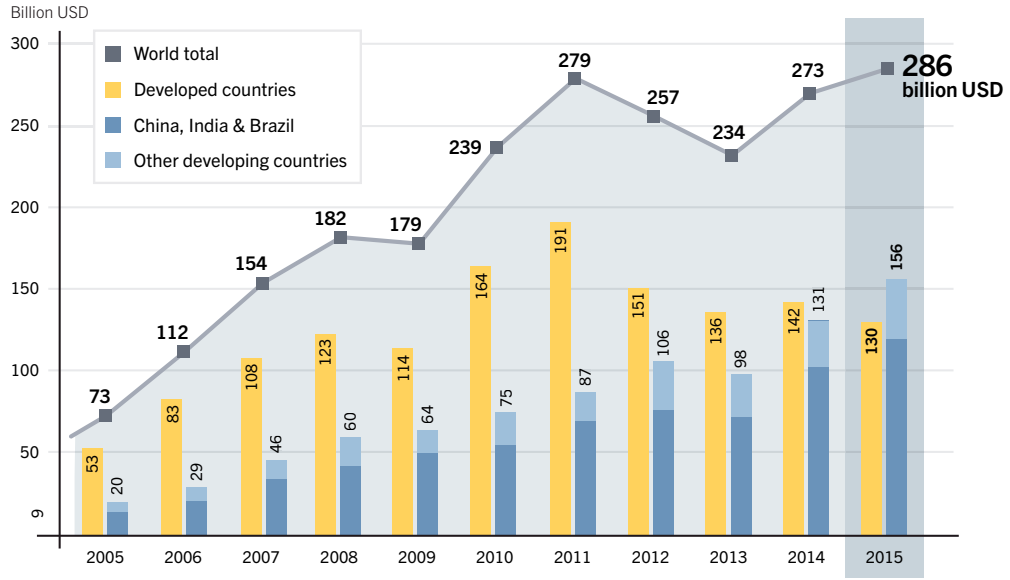


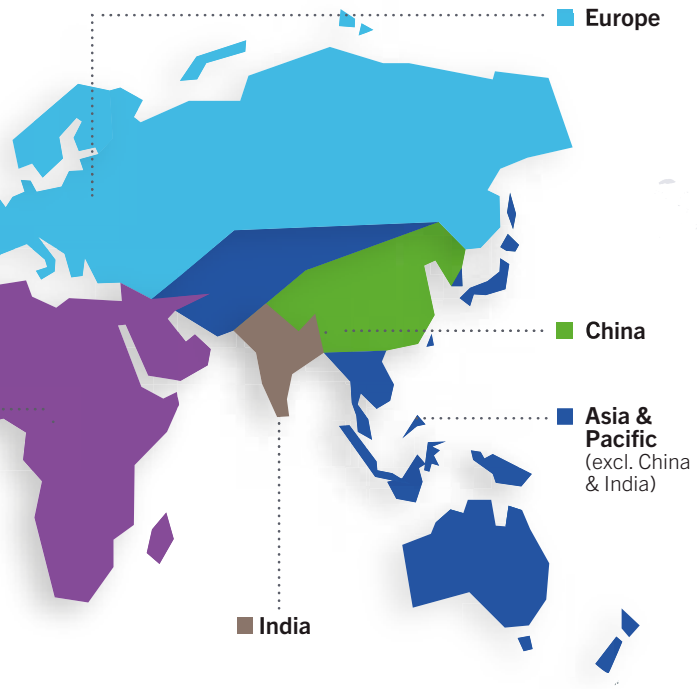


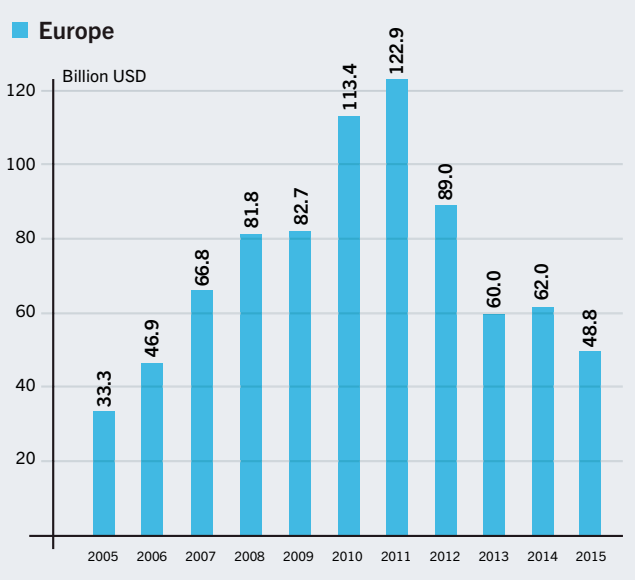




Global New Investment in Renewable Power and Fuels, Developed, Emerging and Developing Countries, 2004–2015

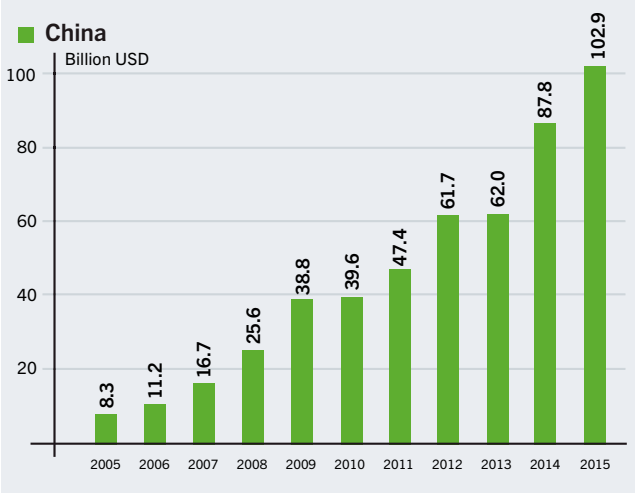






Source: BNEF

Note: Data include government and corporate R&D.



JOBS IN RENEWABLE ENERGY

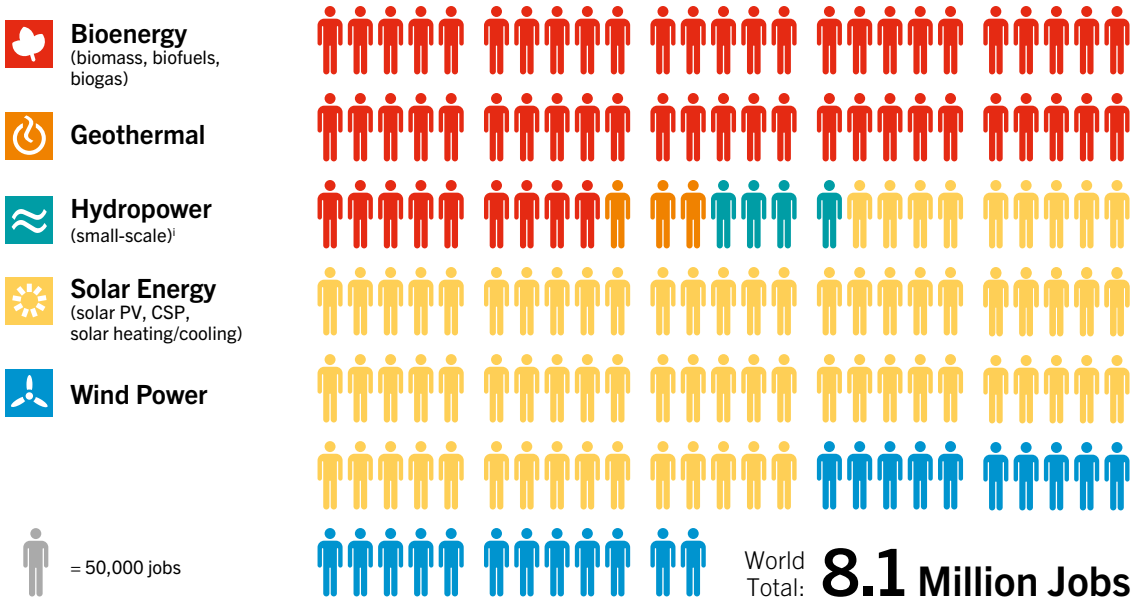
Estimated Direct and Indirect Jobs in Renewable Energy Worldwide, by Industry

	World	China	Brazil	United States	India	Japan	Bang-ladesh	European Union[j]		
								Germany	France	Rest of EU
	THOUSAND JOBS									
Solar PV	**2,772**	1,652	4	194	103	377	127	38	21	84
Liquid biofuels	**1,678**	71	821[c]	277[f]	35	3		23	35	47
Wind power	**1,081**	507	41	88	48	5	0.1	149	20	162
Solar heating/ cooling	**939**	743	41[d]	10	75	0.7		10	6	19
Solid biomass[a,g]	**822**	241		152[e]	58			49	48	214
Biogas	**382**	209			85		9	48	4	14
Hydropower (small-scale)[b]	**204**	100	12	8	12		5	12	4	31
Geothermal energy[a]	**160**			35		2		17	31	55
CSP	**14**			4				0.7		5
Total	**8,079[h]**	**3,523**	**918**	**769**	**416**	**388**	**141**	**355[j]**	**170**	**644[k]**

Note: Figures provided in the table are the result of a comprehensive review of primary (national entities such as ministries, statistical agencies, etc.) and secondary (regional and global studies) data sources and represent an ongoing effort to update and refine available knowledge. Totals may not add up due to rounding.

[a] Power and heat applications (including heat pumps in the case of the EU). [b] Although 10 MW is often used as a threshold, definitions are inconsistent across countries. [c] About 268,400 jobs in sugar cane and 190,000 in ethanol processing in 2014; also includes 200,000 indirect jobs in equipment manufacturing and 162,600 jobs in biodiesel in 2015. [d] Equipment manufacturing and installation jobs. [e] Biomass power direct jobs run to only 15,500. [f] Includes 227,562 jobs for ethanol and 49,486 jobs for biodiesel in 2015. [g] Traditional biomass is not included. [h] The total for 'World' is calculated by adding the individual totals of the technologies, with 3,700 jobs in ocean energy, 11,000 jobs in renewable municipal and industrial waste and 14,000 jobs in others (jobs that cannot be broken down by technology). [i] All EU data are from 2014, and the two major EU countries are represented individually. [j] Includes 8,300 jobs in publicly funded R&D and administration; not broken down by technology. [k] Includes 8,000 jobs in renewable municipal and industrial waste and 3,700 jobs in ocean energy.

Jobs in Renewable Energy



Source: IRENA

[i] This sidebar is drawn from IRENA, *Renewable Energy and Jobs – Annual Review 2016*. Data are principally for 2014–2015, with dates varying by country and technology, including some instances where only dated information is available.

[ii] IRENA defines large-scale hydropower as projects above 10 MW. Definitions may vary across IRENA member countries. Projects below 10 MW are considered as small-scale hydropower.

PRODUCTION & AUTHORING TEAM

RESEARCH DIRECTION AND LEAD AUTHORSHIP

Janet L. Sawin,
Lead Author and Content Editor
(Sunna Research)

Kristin Seyboth
(KMS Research and Consulting)

Freyr Sverrisson (Sunna Research)

PROJECT MANAGEMENT AND GSR COMMUNITY MANAGEMENT (REN21 SECRETARIAT)

Rana Adib
Hannah E. Murdock

CHAPTER AUTHORS

Fabiani Appavou

Adam Brown

Bärbel Epp (solrico)

Anna Leidreiter
(World Future Council – WFC)

Christine Lins (REN21 Secretariat)

Hannah E. Murdock (REN21 Secretariat)

Evan Musolino

Ksenia Petrichenko, Timothy C. Farrell, Thomas Thorsch Krader, Aristeidis Tsakiris (Copenhagen Centre on Energy Efficiency)

Janet L. Sawin (Sunna Research)

Kristin Seyboth
(KMS Research and Consulting)

Jonathan Skeen

Benjamin Sovacool
(Aarhus University/University of Sussex)

Freyr Sverrisson (Sunna Research)

SPECIAL ADVISOR

Adam Brown

RESEARCH SUPPORT

Stefanie E. Di Domenico,
Daniele Kielmanowicz
(REN21 Secretariat)

Aarth Saraph (United Nations Environment Programme – UNEP)

COMMUNICATION SUPPORT

Laura E. Williamson,
Rashmi Jawahar
(REN21 Secretariat)

EDITING, DESIGN AND LAYOUT

Lisa Mastny, Editor

weeks.de Werbeagentur GmbH, Design

PRODUCTION

REN21 Secretariat, Paris, France

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

www.ren21.net

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