

RENEWABLES 2016 GLOBAL STATUS REPORT



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February 7th, 2017



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

NGOs:

ALER, CURES, GFSE, Gogla, Greenpeace, ICLEI, ISEP, Renewable Energy Institute, RCREEE, SLoCaT, WCRE, WFC, WRI, WWF

Industry Associations:

ACORE, ARE, CEC, CREIA, EREF, GSC, GWEC, IGA, IHA, IREF, RES4MED, WBA, WWEA

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

International Organisations:

ADB, EC, ECREEE, GEF, IEA, IRENA, UNDP, UNEP, UNIDO, World Bank

National Governments:

Brazil, Denmark, Germany, India, Norway, Spain, UAE, US, UK



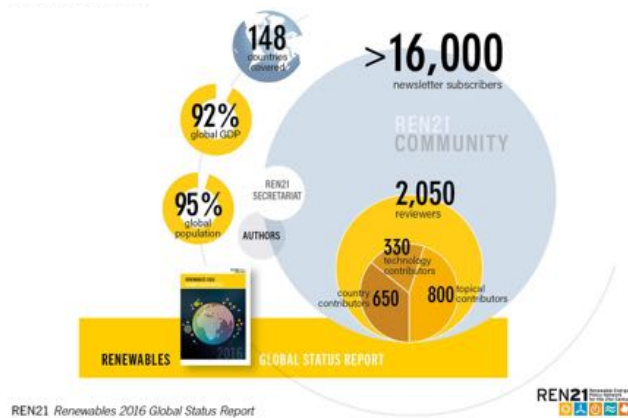
RENEWABLES 2016 GLOBAL STATUS REPORT



REN21 Community

REN21 network:

16.000 contacts
800 dedicated renewable energy, energy access & energy efficiency experts
148 countries world-wide



REN21 Renewables 2016 Global Status Report



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2015 Conclusions

- Largest global capacity additions from renewables to date
- Second year in a row: global carbon emissions associated with energy use remained stable while the global economy grew
- Majority of remaining fossil fuel reserves need to be kept in the ground in order to reach 2° climate target
- More emphasis on renewable energy in the heating and cooling as well as transport sectors and on sector-coupling
- Need to build a smarter, more flexible system that accommodates both centralised as well as decentralised generation



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REN21 Renewables 100% Global Futures Report 2017

Great debates towards 100 % renewable energy

- Follow-up to 2013 edition of the REN21 Renewables Global Futures Report
- Based on over 115 interviews with global experts stemming from Australia Oceania, Africa, America, China, Europe, India, Japan
- Overview of current thinking of experts on the question of a 100% renewable energy supply globally by 2050
- Identification of key technology trends, bottle necks, challenges and barriers to a 100 % renewable energy world



RENEWABLES 2016 GLOBAL STATUS REPORT



BloombergBusiness News Markets Insights Video

Solar Energy Is Cheapest Source of Power in Chile, Deutsche Says

by Vanessa Dezem

November 4, 2015 – 10:13 PM CET

Three solar farms offered to sell power for \$65 to \$68 a megawatt-hour in the auction, Shah said. Two wind farms bid \$79 a megawatt-hour, and a solar-thermal plant with storage offered power at \$97. Coal power was offered for \$85 in the same event.

Country expected to install 1 gigawatt of solar this year

Solar and wind offered lowest prices in October energy auction

Solar power is now the cheapest source of electricity in Chile, according to Deutsche Bank AG.

Clean Technica

Tremendously Low 4.8¢/kWh Solar Price In Peru, Unsubsidized

February 25th, 2016 by Guest Contributor

Peru recently awarded 185 megawatts (MW) of new solar photovoltaic (PV) contracts in a renewable energy solicitation, at record-low prices for a nation not offering any tax breaks for such development.

Of the 185 MW of new project capacity, 144 MW relates to a bid from Enel Green Power at \$47.98/MWh (megawatt-hours); and 40 MW relates to a bid from Enersur at \$48.50/MWh.

Notably, the projects aren't expected to be built until 2017 — when solar PV prices are expected to be notably lower, hence the lower bids and contracts.

According to the press release from Peru's Supervisory Agency for Energy and Mines (Osinergmin), the Enel Green Power contract is for the provision of 415 gigawatt-hours (GWh) of electricity a year from the company's planned Rubi solar PV project at the aforementioned price of \$47.98/MWh. The Enersur contract is for the provision of 108 GWh of electricity a year from the planned Intipampa solar PV project at \$48.50/MWh.

Delivery of electricity from the projects is currently set to begin by the end of 2018 — if the terms of the contracts are to be met.

Along with the above-mentioned solar energy projects, 3 wind energy projects were awarded contracts following the recent solicitation. Contract prices for these projects ranges from \$36.64–\$37.83/MWh. In addition, a number of hydroelectric and biomass projects were awarded contracts as well.

...er for \$65 to \$68 a megawatt-hour in the auction, Shah said. Two wind farms bid \$79 a megawatt-hour, and a solar-thermal plant with storage offered power at \$97. Coal power was offered for \$85 in the same event.

gtm: Solar Stuns in Mexico's First Clean Energy Auction: 1,860MW Won at \$50.7 per MWh

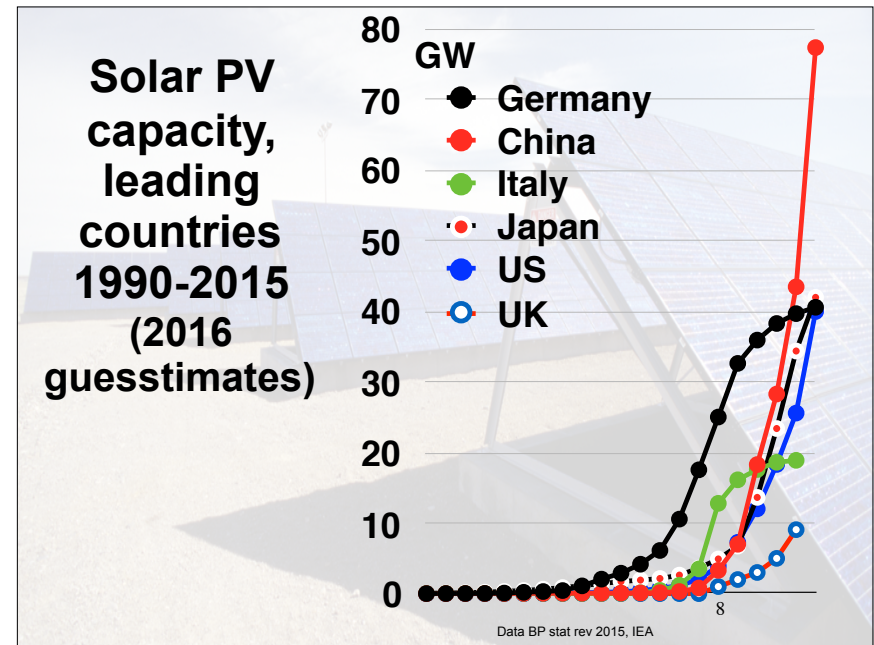
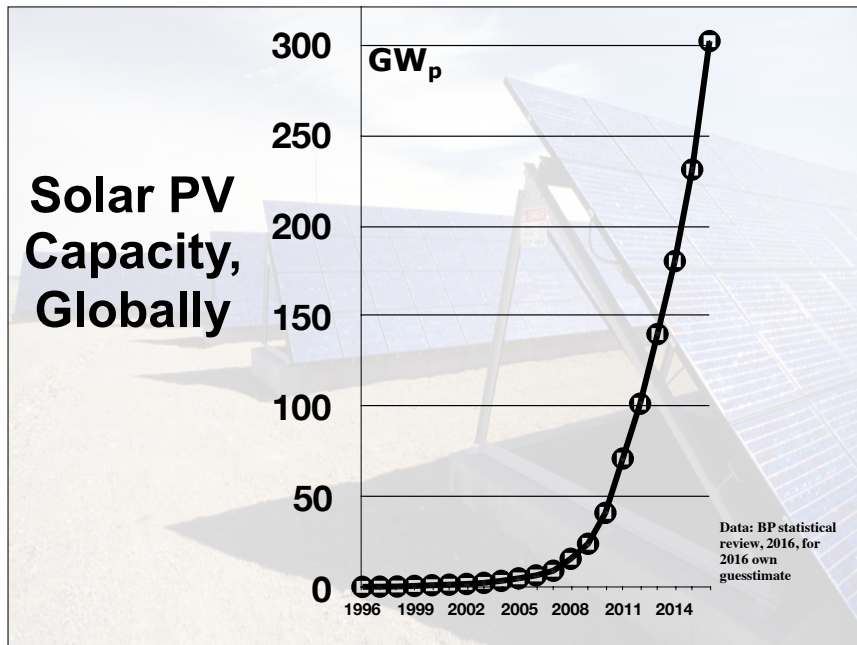
Solar in Mexico will now grow by 521 percent in 2016.

by Mohit Anand
April 05, 2016

Mexico just concluded its first Clean Energy Auction for energy, power and Clean Energy Certificates for purchase by CFE, Mexico's only utility. The results are stunning -- 11 PV projects have been awarded contracts worth 4 million megawatt-hours (DC) per year. That translates to 1,860 megawatts of capacity (using an average capacity factor of 33.6 percent). Additionally, all 11 projects have won contracts for a combined 4 million Clean Energy Certificates (CELS).

Mexico defines clean energy quite broadly, so the auction was open to competition from wind, hydro, cogeneration, combined-cycle gas, and geothermal, as well as PV. Out of a total 5.38 million megawatt-hours of energy that was awarded, PV won 74 percent and wind won the remaining 26 percent, with no contracts won by any of the other technologies.

...\$68 a megawatt-hour in the auction, Shah said. Two wind farms bid \$79 a megawatt-hour, and a solar-thermal plant with storage offered power at \$97. Coal power was offered for \$85 in the same event.



SUN & WIND ENERGY

The Platform for Renewable Energies

PHOTOVOLTAICS SOLAR THERMAL WIND ENERGY ARTICLE DOWNLOAD

Danish bidders win cross-border PV tender

Photovoltaics

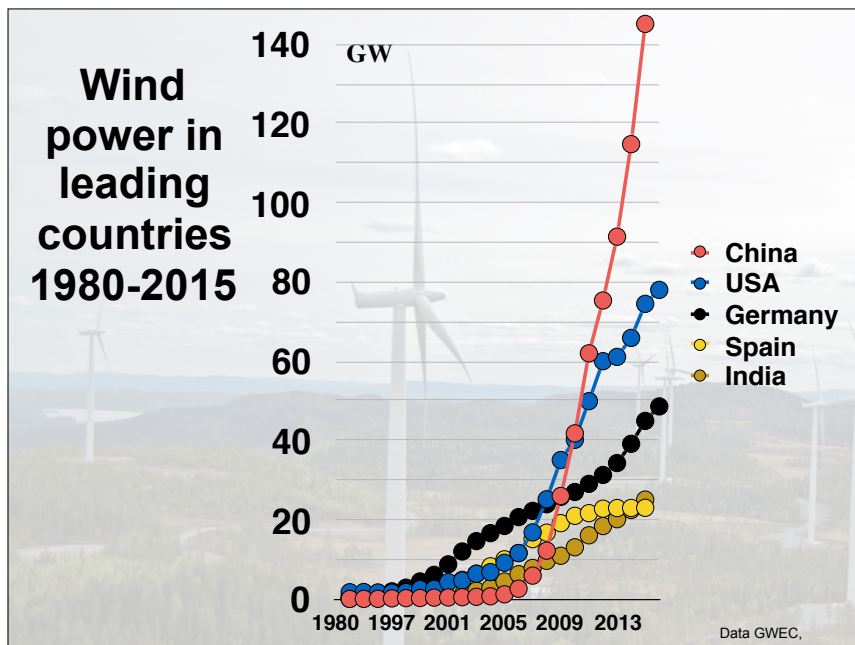
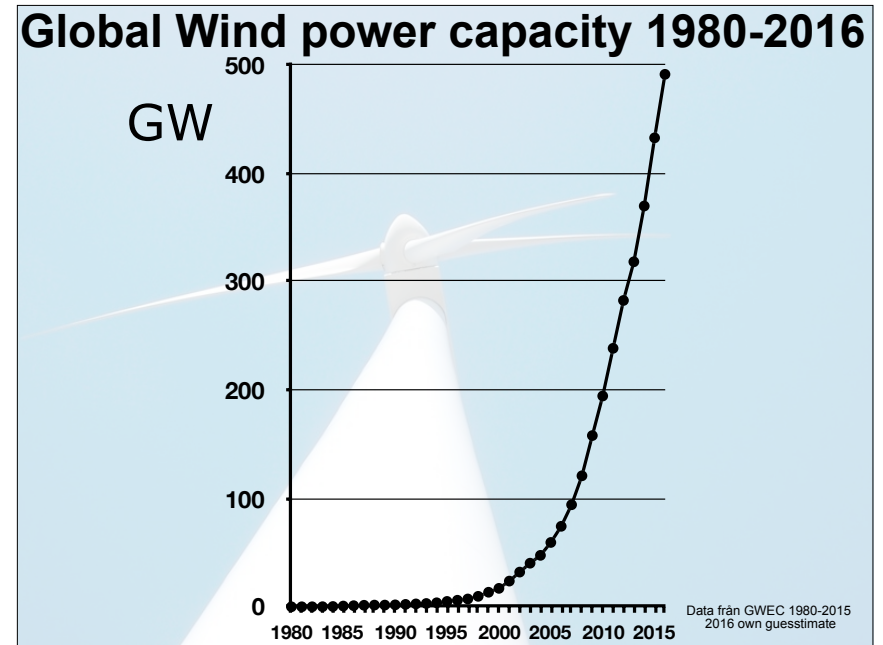
30.11.2016

In the first cross-border tender for ground-mounted PV plants in Germany and Denmark, Danish projects were awarded contracts for the entire expansion volume of 50 MW. The auction price was 5.38 cents/kWh.

The German Federal Network Agency was able to announce an auction price for the five successful projects that is almost 2 cents lower than the average price in the last national tender round (7.25 cents). Unlike Germany, Denmark allows agricultural land to be used for PV projects, and this is also the case with the installations that the successful Danish bidders are planning. Agricultural areas are considered much easier to develop than conversion areas, which the German Renewable Energies Act (EEG) confines project developers in Germany to.



Danish project developers will be supplying solar power to Germany at 5.38 cents/kWh. (Photo: iStock)



New low for wind energy costs: Morocco tender averages \$US30/MWh

By Giles Parkinson on 17 January 2016

The north African country of Morocco has achieved a new low for wind energy costs, securing average bids of just \$US30/MWh from its tender for 850MW tender of large-scale wind energy projects, with the lowest at around \$US25/MWh.

The pricing – revealed by its energy ministry at a ministerial round table at the International Renewable Energy Summit in Abu Dhabi on Saturday – sets a new low for wind energy pricing in the world, and is boosted by the remarkable wind energy resource sourced from Atlantic trade winds, and some concessional finance.

Abderrahim El Hafidi, vice minister of energy and environment, described the result as "extraordinary" and "amazing" and said it pointed to a "real revolution" in the means of producing energy. Some bids in the US have been in and around \$US25/MWh, although these have been boosted by a 30 per cent production tax credit.



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12

Offshore wind costs hit record low



Published on 06/07/2016, 10:57am

Two 350MW arrays in the Netherlands will supply power at €87/MWh, beating the next cheapest project by miles

By Megan Darby

Dong Energy has set a record low price for offshore wind power in a winning bid to build two arrays off the coast of the Netherlands.

The Danish company committed to supply electricity at €72.70/MWh (US\$80.40), not including transmission costs. The cables will add about €14/MWh, experts say.

That beats an industry goal of bringing costs below €100/MWh by 2020. The closest any rival had previously come was €103/MWh by Vattenfall in Denmark last year.

"It was a result that was well beyond anyone's expectations," said Oliver Joy, spokesperson for the European Wind Energy Association.

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New record for cheapest offshore wind farm



The costs of offshore wind have fallen significantly in recent years
CREDIT: BLOOMBERG

By Emily Gosden, ENERGY EDITOR

14 SEPTEMBER 2016 - 7:35AM

The cost of building offshore wind farms has fallen to a new low, with Sweden's Vattenfall winning contracts to build two projects in Danish waters for just over €60 (£51) per megawatt-hour (MWh).

13

New record for...



7.33 AM CET / 9-Nov-2016 / Vattenfall (STO:ONOT)

Vattenfall wins tender to build the largest wind farm in the Nordics

Today, Vattenfall has won the tender to build Danish Kriegers Flak, a 600 MW offshore wind farm in the Baltic Sea. The winning bid was EUR 49.9 per MWh, which is among the lowest costs in the world for offshore wind power.

"The announcement is an essential milestone for our ambition to increase our production of renewable power. We are already the second largest offshore player globally. The winning bid of EUR 49.9 per MWh proves that Vattenfall is highly competitive and brings down the costs for renewable energy", says Magnus Hall, CEO Vattenfall.

Kriegers Flak will be Denmark's largest offshore wind farm and can supply 600,000 Danish households with renewable energy – corresponding to 23 percent of all households in Denmark. Vattenfall's investment in Kriegers Flak will be EUR 1.1 – 1.3 billion, pending a final investment decision.

"This is exciting news. I'm very proud of our people in the Wind organisation who once again delivered a winning bid. Vattenfall has won the three latest offshore wind tenders in Denmark; Horns Rev 3, Danish Near Shore and Kriegers Flak, equivalent to the energy consumption of 55 percent of the Danish households", says Gunnar Groebler, Head of Vattenfall Wind.

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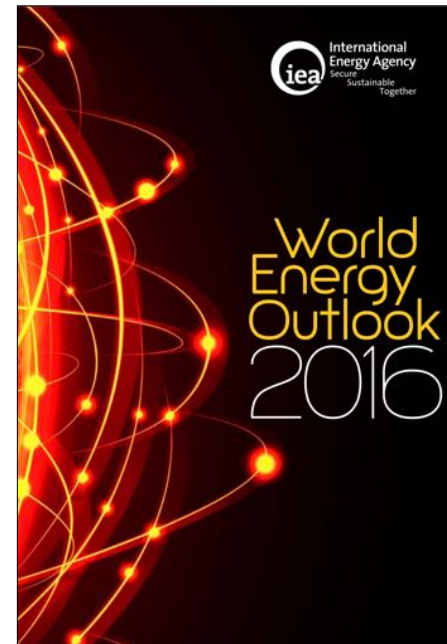
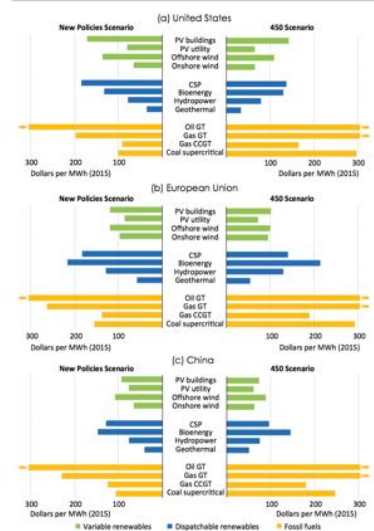
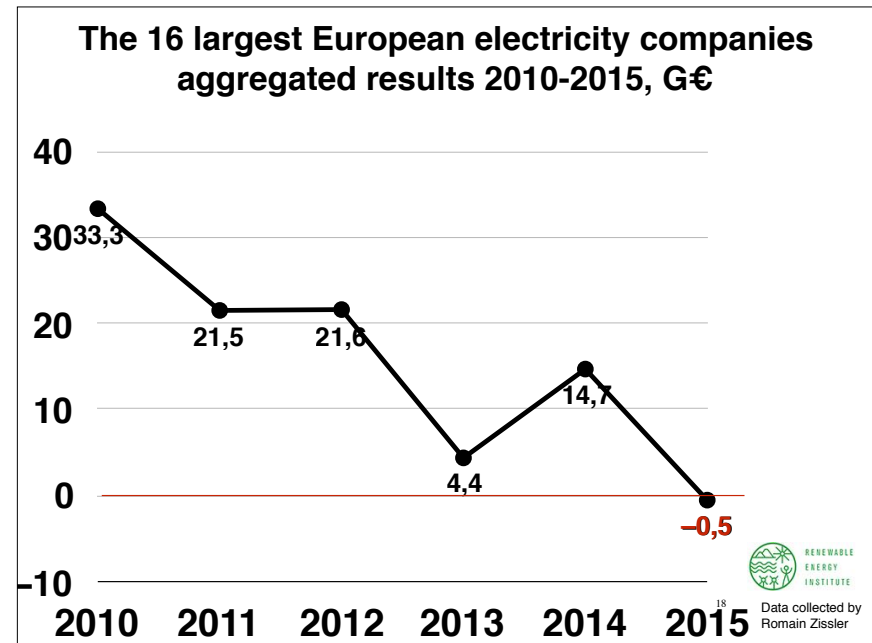
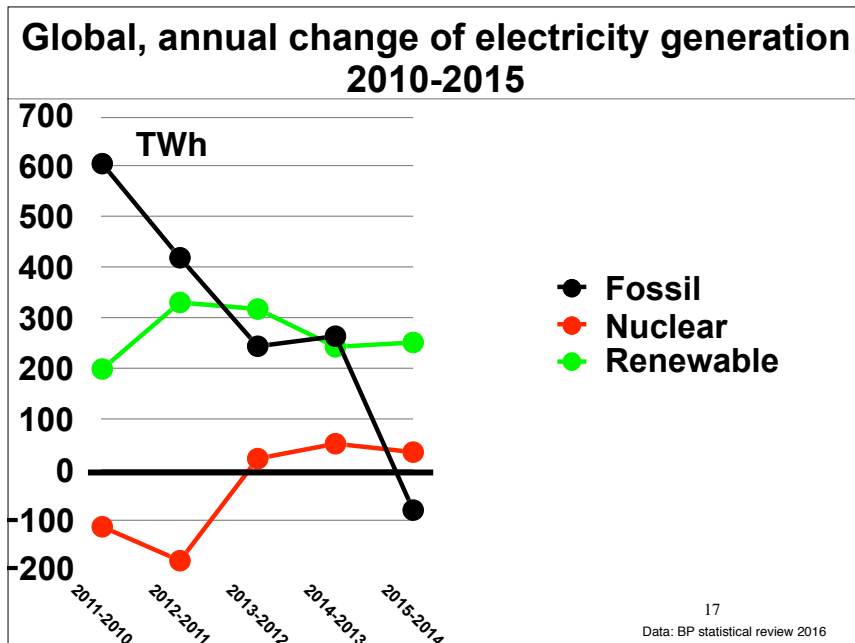
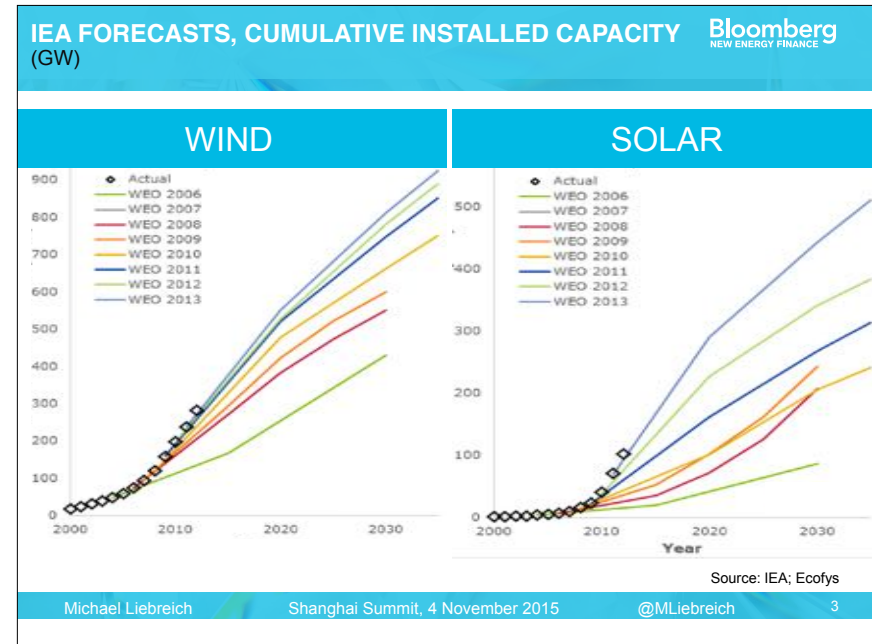
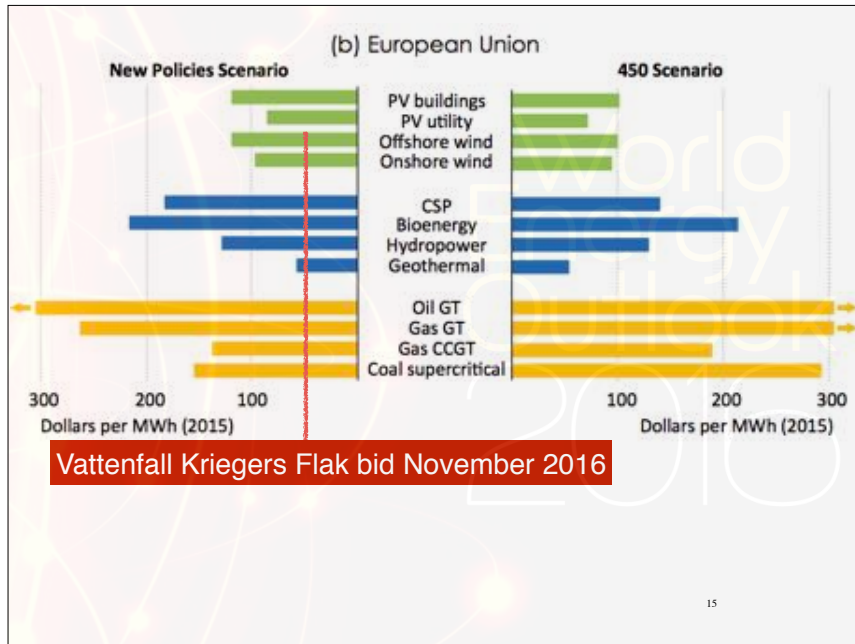


Figure 11.8 - Average levelised costs of electricity by region, technology and scenario, 2040



Continued overleaf...



THE WALL STREET JOURNAL. BUSINESS

TOP STORIES IN BUSINESS

High Court Backs Airlines on Frequent-Flyer Miles

Asian Gas Demand Spawns Floating Super...

Business
Tesla Breaks Norway's All-Time Sales Record
 Company Sold 1,493 Electric Model S Sedans to Norwegians in March

By JOHN D. STOLL
 April 2, 2014 11:37 a.m. ET



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THE WALL STREET JOURNAL. BUSINESS

Aussies Introduce 1000 Kilometer Electric Bus

November 1st, 2015 by Steve Hanley



Australian company Brighsun, headquartered in Melbourne, has developed an electric bus with a certified range of 1,004 kilometers — enough to make the trip from Melbourne to Sydney without stopping to recharge and with more than 100 kilometers of range left over.


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Electromobility

Aussies Introduce 1000 Kilometer Electric Bus

Setting a Course for Carbon-Free Shipping

www.siemens.com/innovation/en/home/pictures-of-the-future/mobility-and-motors/electromobility-electric-vehicles



In conjunction with Fjellstrand, a Norwegian shipyard, Siemens has developed the technology for the world's first electrically-powered car ferry. The fact that the electric ship, which will enter service in 2015, causes no carbon dioxide emissions is in part due to the electricity mix in Norway.

As silently as a crocodile, the white giant approaches the shore. It opens its "mouth," which is several meters across. Suddenly the silence is broken by the roar of engines as a stream of trucks and people emerge from the opening. Odd Moon, an engineer who is responsible for ship solution sales at Siemens Norway, smiles. If everything goes as planned, this vision of an electrically-powered ferry sailing across Norway's fjords will become a reality at the beginning of 2015. Making hardly a sound and producing absolutely no emissions, it will be the first and only ferry of its kind in the world.

A Century of Battery-Powered Service

For more than 100 years, there have been battery-powered submarines that run solely on electricity.

19

Electromobility

Aussies Introduce 1000 Kilometer Electric Bus

Setting a Course for Carbon-Free Shipping

ABB powers world's largest emission-free electric ferries

Tue 21 Jun 2016 by Paul Fanning



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Tycho Brahe — along with Aurora — will operate completely on battery power between Helsingør (Denmark) and Helsingborg

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Electromobility **Aussies Introduce 100% Emission-** an/ and-



AIRBUS PUTS ELECTRIC E-FAN TRAINER INTO PRODUCTION IN PAU

▲ Dave Calderwood ○ May 1, 2015

Airbus is to put its two-seat E-Fan powered by electric motors into serial production in Pau, France. Construction on a new plant will start in 2016 and Airbus has set a target for entry-into-service for the E-Fan 2.0 of the end of 2017 or beginning of 2018.

Electromobility **Aussies Introduce 100% Emission-** an/ and-

AIRBUS GROUP SEARCH MENU

Towards electric aircraft
Collaboration with Siemens

NEW CHAPTER IN E-MOBILITY | NEW MATERIALS LAB

GROUP & VISION | INNOVATION & CITIZENSHIP | INVESTORS & SHAREHOLDERS | NEWS & MEDIA | PEOPLE & CAREERS

Explore great Airbus Group stories

... serial production in Pau, ... 2016 and Airbus has set a target for entry-into-service for the E-Fan 2.0 of the end of 2017 or beginning of 2018.



BloombergBusiness News Markets Insights Video

Fossil Fuels Just Lost the Race Against Renewables

This is the beginning of the end.



by Tom Randall

10:27 PM CEST
April 16, 2015

The race for renewable energy has passed a turning point. The world is now adding more capacity for renewable power each year than coal, natural gas, and oil combined. And there's no going back.


The shift occurred in 2013, when the world added 143 gigawatts of renewable electricity capacity, compared with 141 gigawatts in new plants that burn fossil fuels, according to an analysis presented Tuesday at the Bloomberg New Energy Finance annual summit in New York. The shift will continue to accelerate, and by 2030 more than four times as much renewable capacity will be added.

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REN21 Renewable Energy Policy Network for the 21st Century

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presented, with own additions, by
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2016

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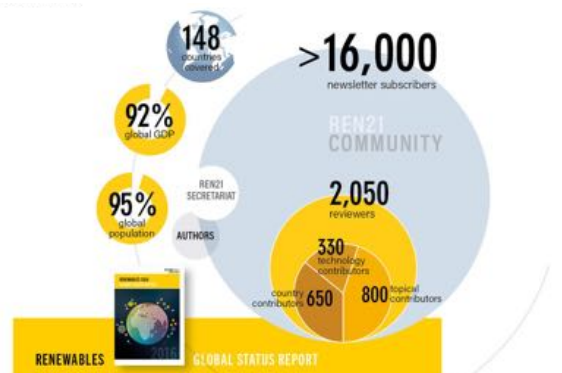


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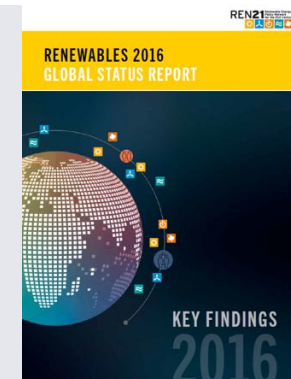
→ The report features:

- Global Overview
- Market & Industry Trends
- Distributed Renewable Energy for Energy Access
- Investment Flows
- Policy Landscape
- Energy Efficiency
- Feature: Community Energy

→ The report covers:

- All renewable energy technologies
- Power, heating & cooling, and transport sectors

→ Country data available on REN21 Renewables Interactive Map: www.ren21.net/map



RENEWABLES 2016 GLOBAL STATUS REPORT



An extraordinary year for renewable energy

- 147 GW of renewable power capacity added in 2015 - the largest annual increase ever
- Renewable heat capacity increased by 38 GW_{th}
- Total biofuels production also rose

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	795
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	95.3
Biofuel production (annual)	billion litres	35.4	35.1

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Renewable Energy “Champions” Annual investment/capacity additions/production

	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

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Renewable Energy “Champions” Total capacity

	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
Bio-power 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	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

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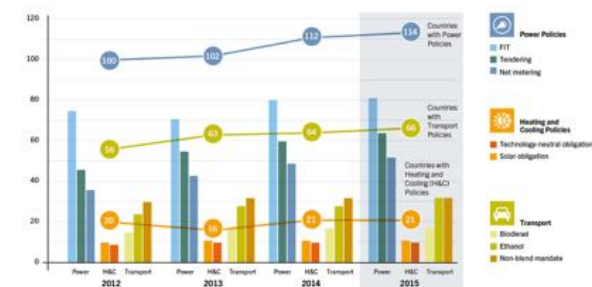
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Renewable Energy Policy Landscape

- 173 countries had renewable energy targets, and an estimated 146 countries had renewable energy support policies:
- 114 countries with power policies
- 66 countries with transport policies
- 21 countries with H&C policies

Number of Renewable Energy Policies and Number of Countries with Policies, by Type, 2012–15



Note: 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).

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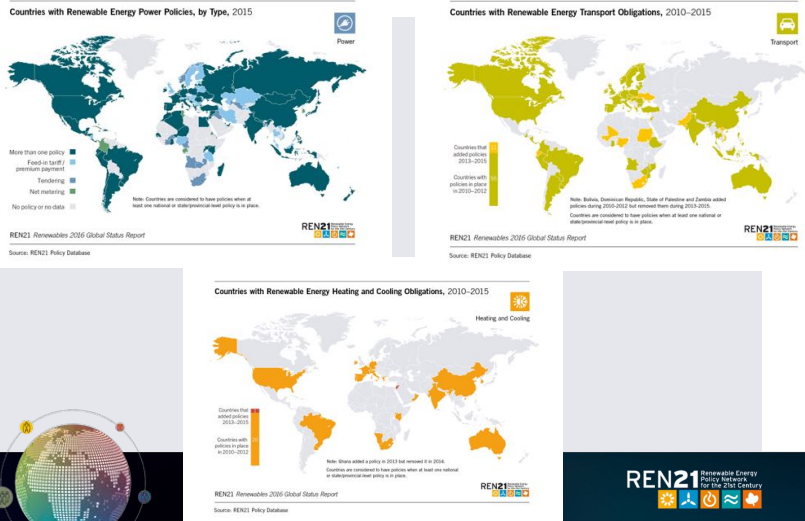


Source: REN21 Policy Database

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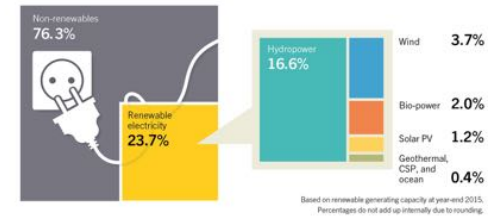


Renewable Energy Policy Landscape



Power Sector

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



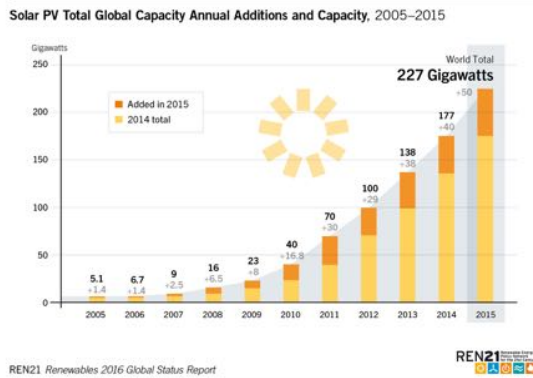
- Renewables accounted **28.9%** of global power generation capacity and **23.7%** of global electricity demand
- Renewables made up for **60%** of net additions to global power capacity
- Total RE power capacity: **1,849 GW**, an increase of almost 9% over 2014

Solar PV

Capacity added: **+50 GW**

Total capacity: **227 GW**

Annual PV market in 2015 was nearly **10 times** the world's cumulative solar PV capacity of a decade earlier



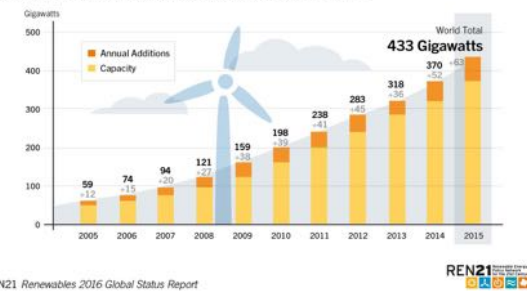
Wind Power

63 GW of capacity were added

Total capacity: **433 GW**

Offshore, an estimated **3.4 GW** of grid-connected capacity was added in 2015, for a world total exceeding **12 GW**

Wind Power Global Annual Additions and Capacity, 2005-2015

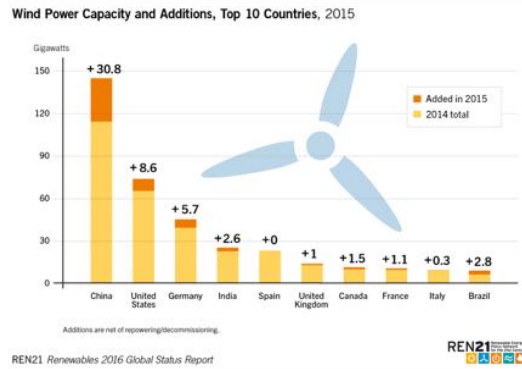


Wind Power

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

Wind power is playing a major role in meeting electricity demand in an increasing number of countries, e.g.:

- Denmark: 42% of demand
- Uruguay: 15.5%

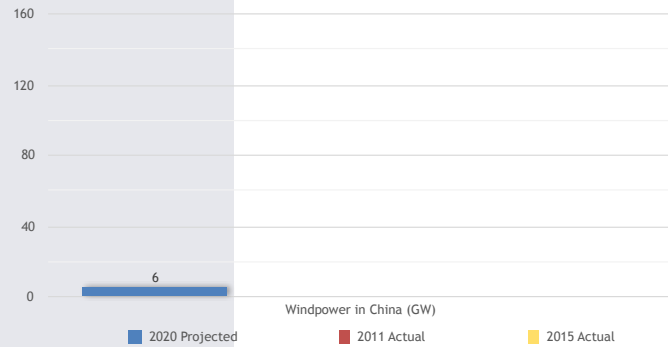


Historic Projections Fall Short...



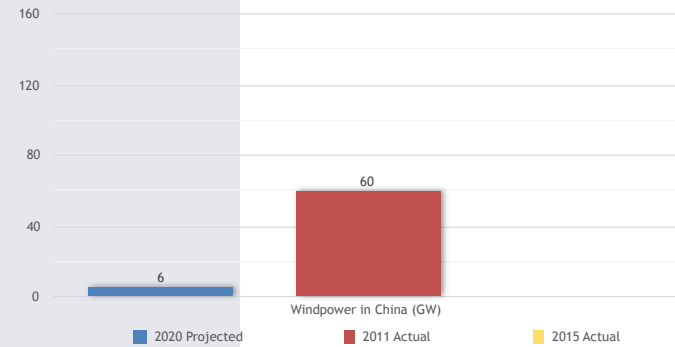
Historic Projections Fall Short...

World Bank (1997) - Projection



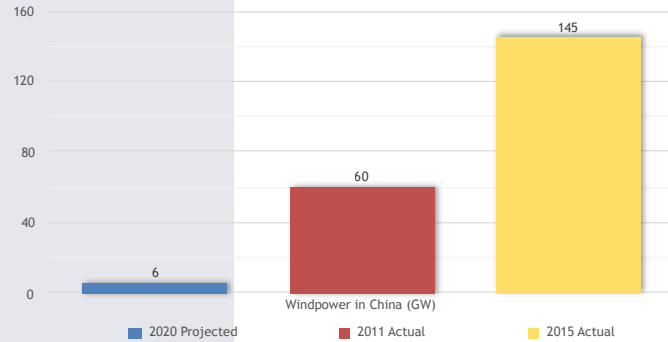
Historic Projections Fall Short...

World Bank (1997) - Projection



Historic Projections Fall Short...

World Bank (1997) - Projection



Jobs in Renewable Energy

Global employment continued to increase by 5% in 2015

An estimated 8.1 million direct and indirect jobs in the renewable energy industry

Leading employers in 2015 were China, Brazil, the United States, and India

Jobs in Renewable Energy



REN21 Renewables 2016 Global Status Report

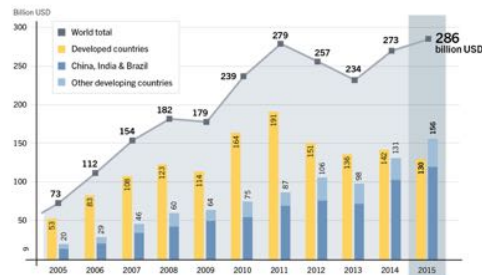
Source: IRENA

Global Investment in Renewable Energy

Global new investment in renewables estimated at USD 286 billion in 2015

- A new record high
- Increase of 5% from 2014
- Including hydropower: USD 328.9 billion

Global New Investment in Renewable Power and Fuels, Developed, Emerging and Developing Countries, 2005-2015



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Global Investment in Renewable Energy

Developing & emerging countries:

- USD 156 billion
- Increase of 19% compared to 2014

Developed countries:

- USD 130 billion
- Decrease of 8% compared to 2014

Global New Investment in Renewable Power and Fuels, by Country and Region, 2005-2015



Data include government and corporate R&D.

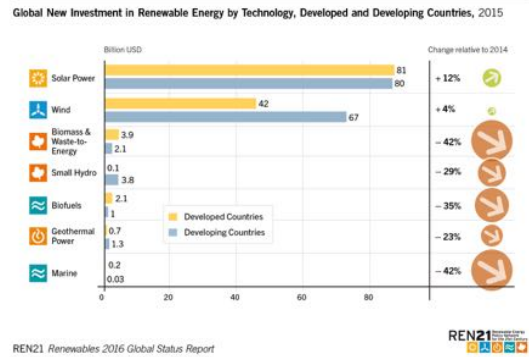
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Source: BNEF

Global Investment in Renewable Energy

Solar power leading sector for money committed during 2015, receiving more than 56% (USD 161 billion) of total new investment in RE

Wind power followed with USD 109.6 billion (38.3% of total, up 4%)



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Energy Efficiency

Increased emphasis on activities to improve energy efficiency in all sectors

- 146 countries with policies
- 128 countries with targets

Countries with Energy Efficiency Policies and Targets, 2015



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Community Renewable Energy

Consolidated data on community initiatives are very limited

Since 2008, there has been a marked rise in initiatives focused on community renewable energy, especially in Europe:

- Europe: more than 2800 energy co-operatives
- Germany: 772
- The Netherlands: 500



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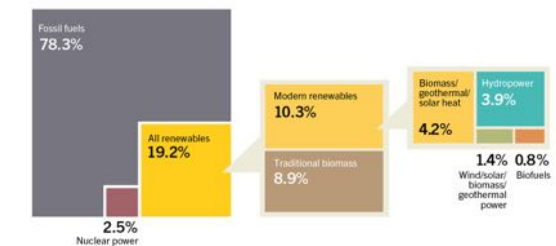


Renewable Energy in the World

Renewable energy provided an estimated 19.2% of global final energy consumption in 2014

Share of modern renewable energy increased to 10.3% while the share of traditional biomass was of 8.9%

Estimated Renewable Energy Share of Global Final Energy Consumption, 2014



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Conclusions

- Largest global capacity additions from renewables to date
- Second year in a row: global carbon emissions associated with energy consumption remained stable while the global economy grew
- Majority of remaining fossil fuel reserves need to be kept in the ground in order to reach 2° climate target
- More emphasis on renewable energy in the heating and cooling as well as transport sectors and on sector-coupling
- Need to build a smarter, more flexible system that accommodates both centralised as well as decentralised generation



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REN21 Renewables 100% Global Futures Report 2017

Great debates towards 100 % renewable energy

- Follow-up to 2013 edition of the REN21 Renewables Global Futures Report
- Based on over 115 interviews with global experts stemming from Australia Oceania, Africa, America, China, Europe, India, Japan
- Overview of current thinking of experts on the question of a 100% renewable energy supply globally by 2050
- Identification of key technology trends, bottle necks, challenges and barriers to a 100 % renewable energy world



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“
Looking back, the only mistake we made
was not dreaming big enough.
Let's dream big, let's look ahead, and make the world
a better place, a peaceful place, for all people.
”

Shimon Peres
1923 - 2016

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