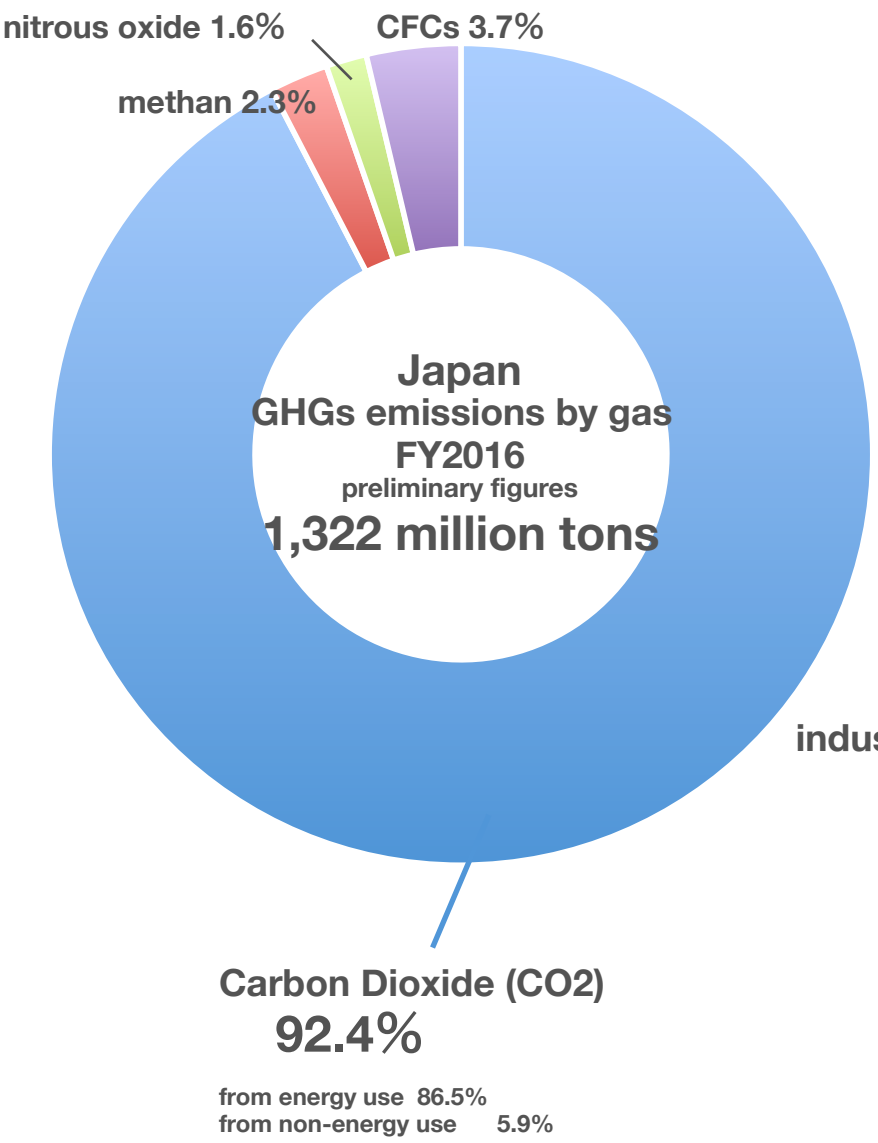
Advisory Panel to the Foreign Minister on Climate Change: Recommendations on Energy

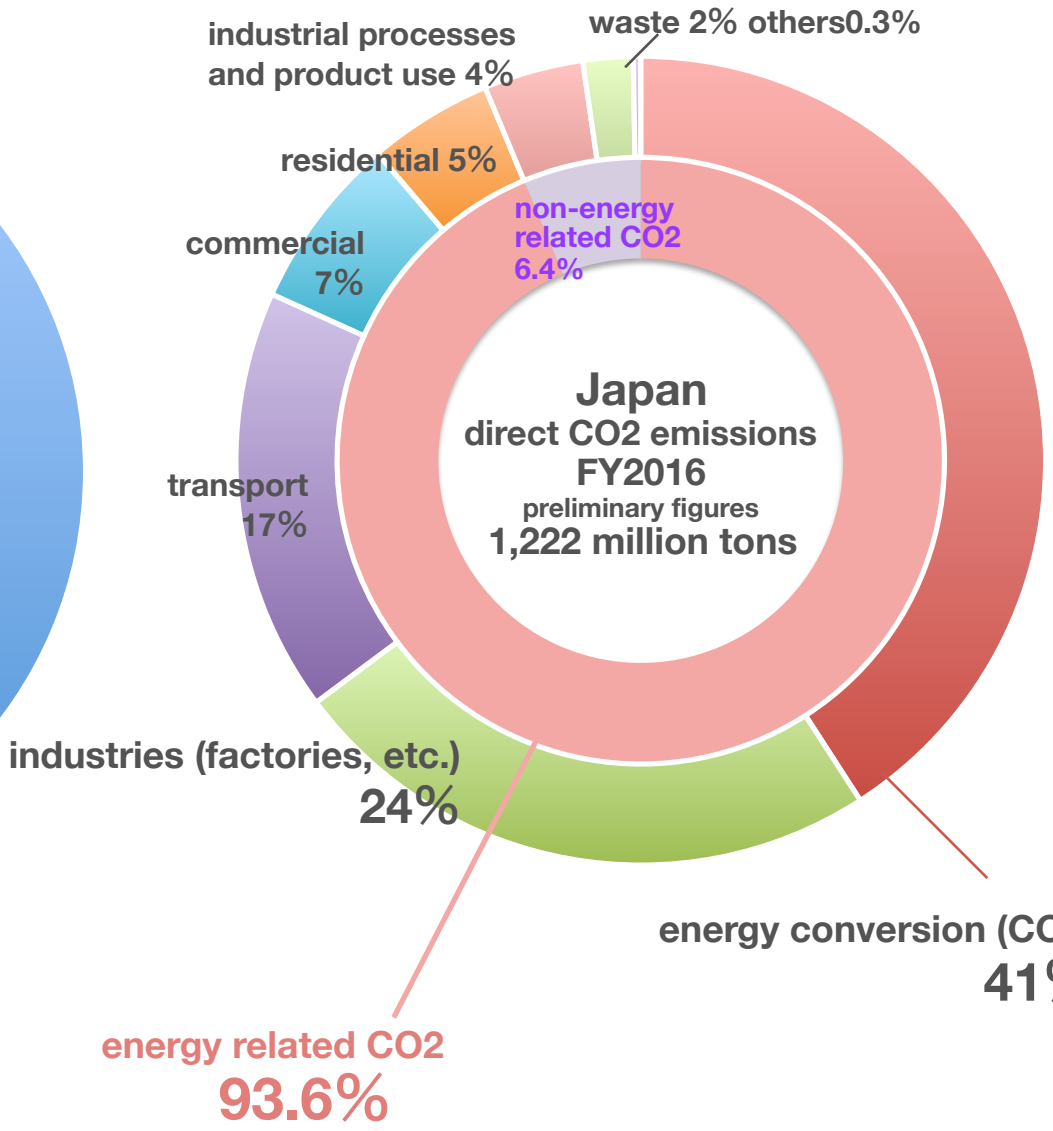
# Promote New Diplomacy on Energy through Leading Global Efforts against Climate Change

February 2018

SLIDE DECK

# Japan: GHGs emissions and percentage of CO2 from energy-use

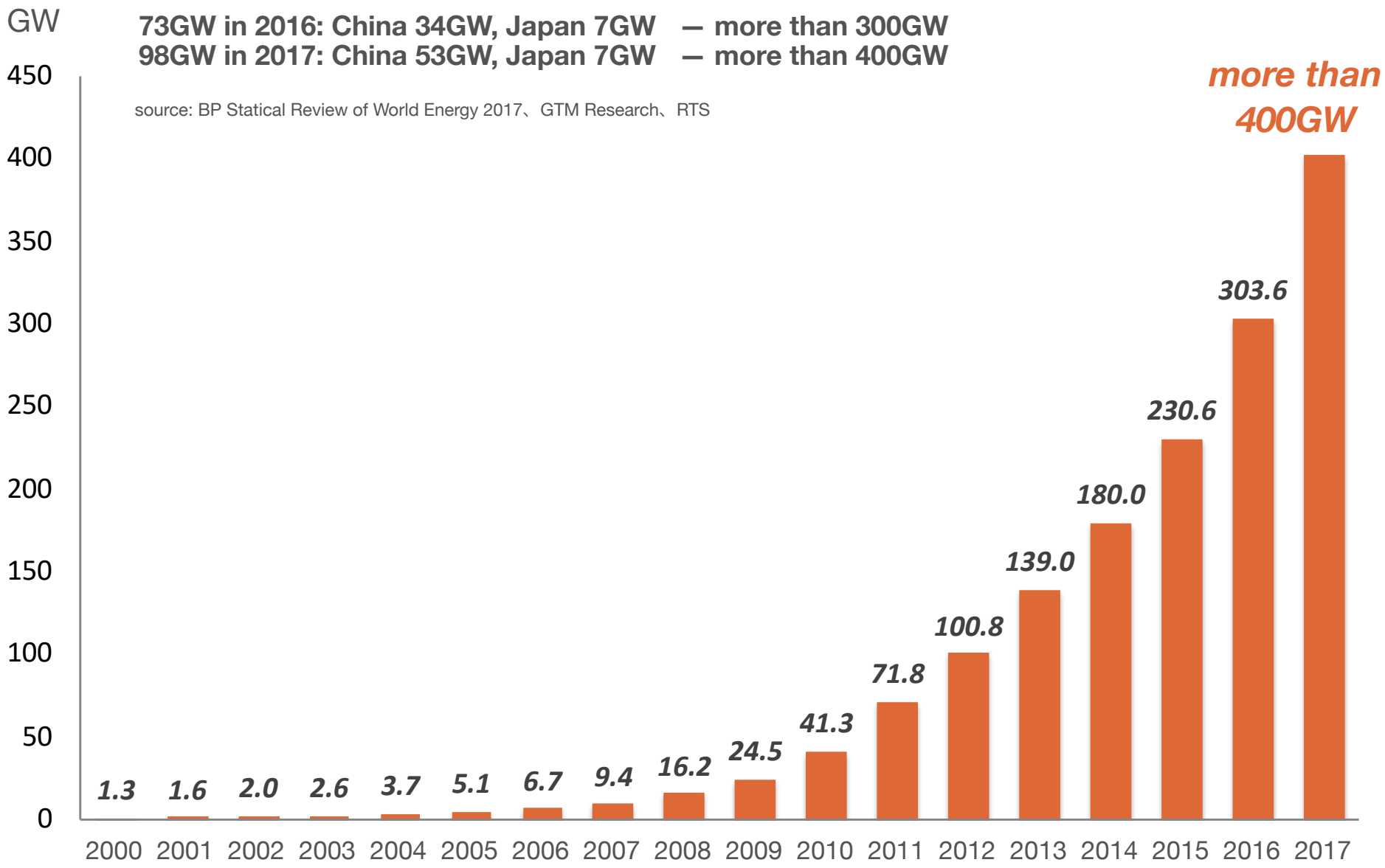


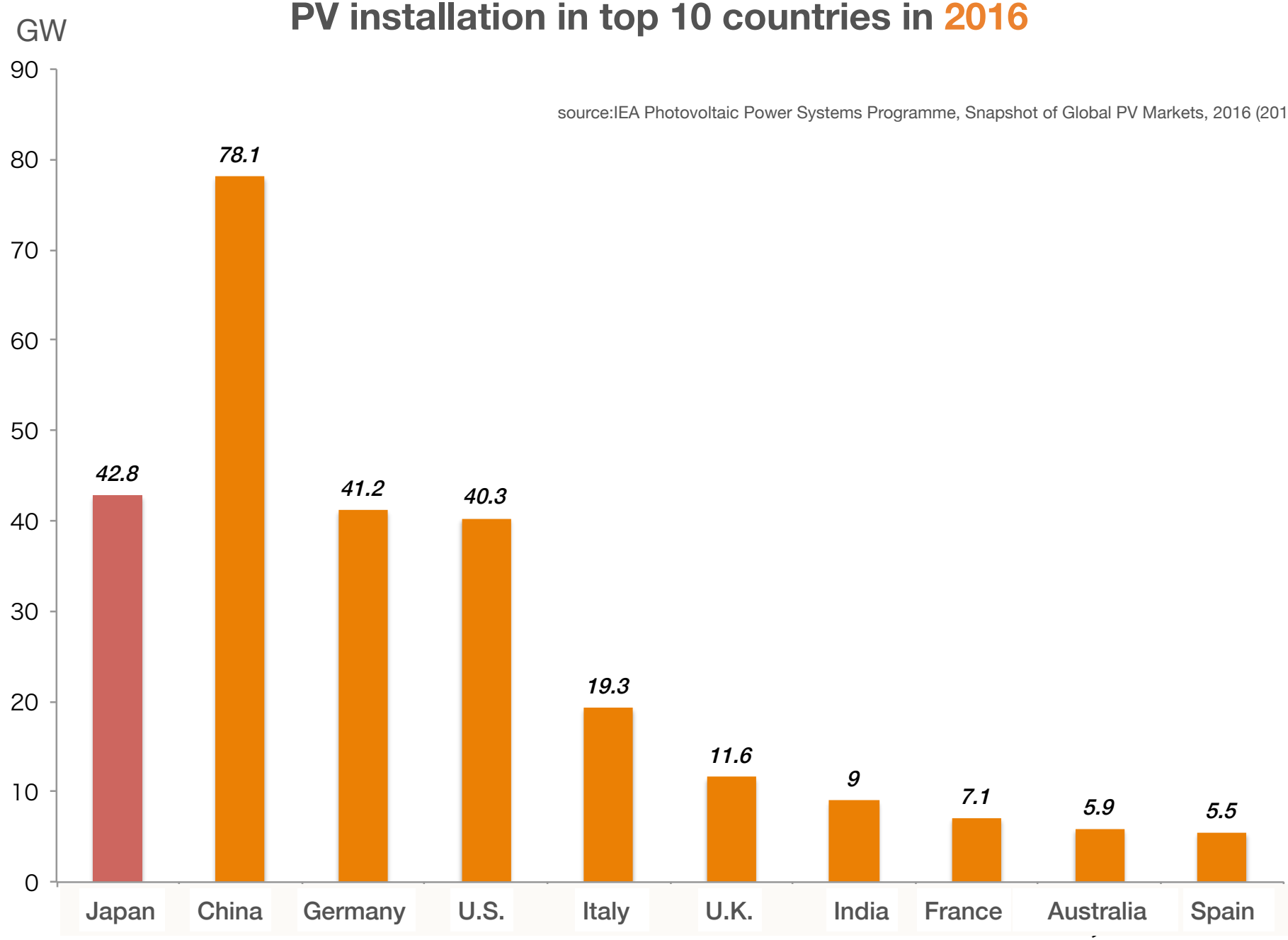



source: Ministry of the Environment (Japan), Preliminary figures for GHG emissions in FY2016

# Global PV expansion

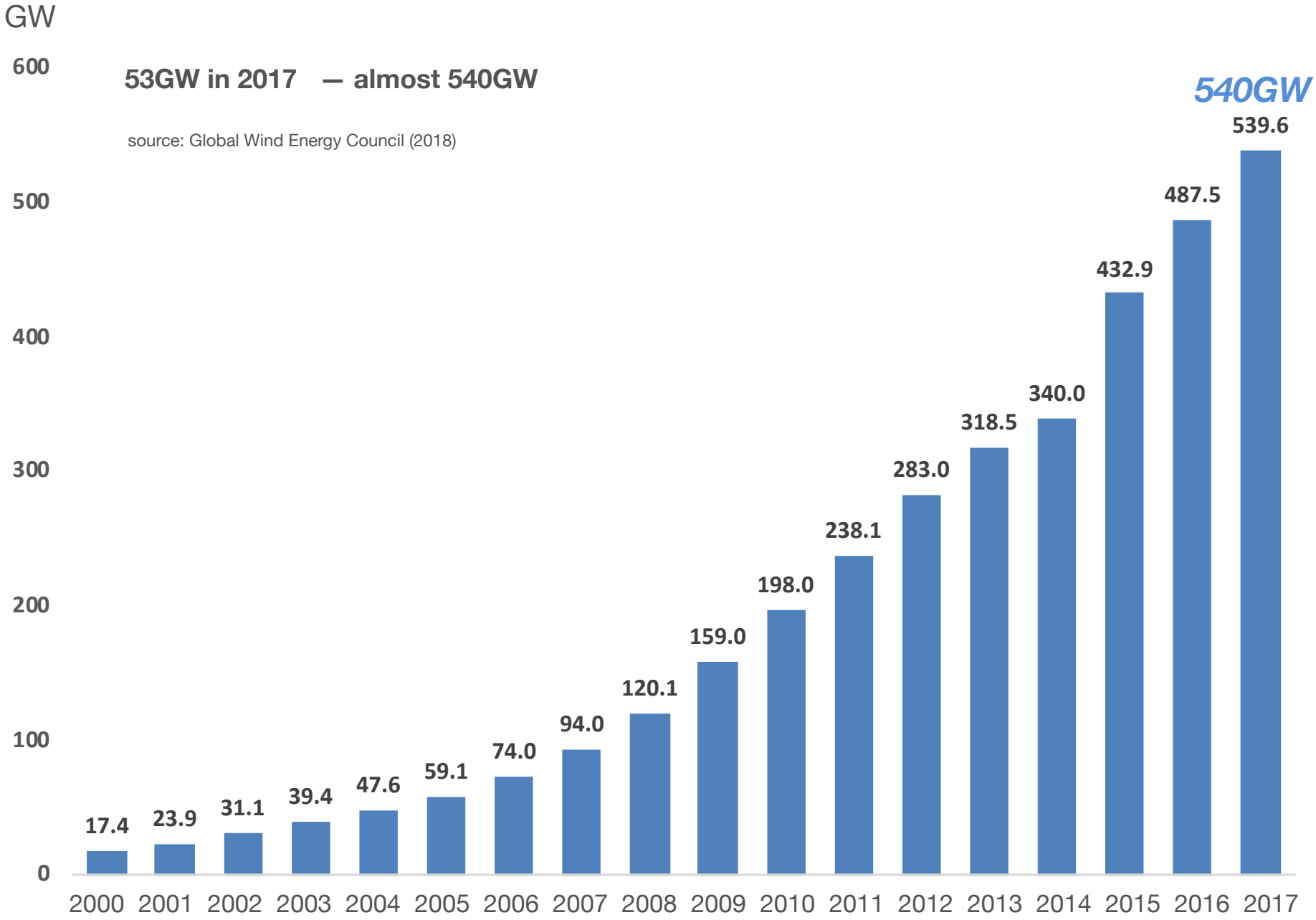


# PV installation in top 10 countries in 2016

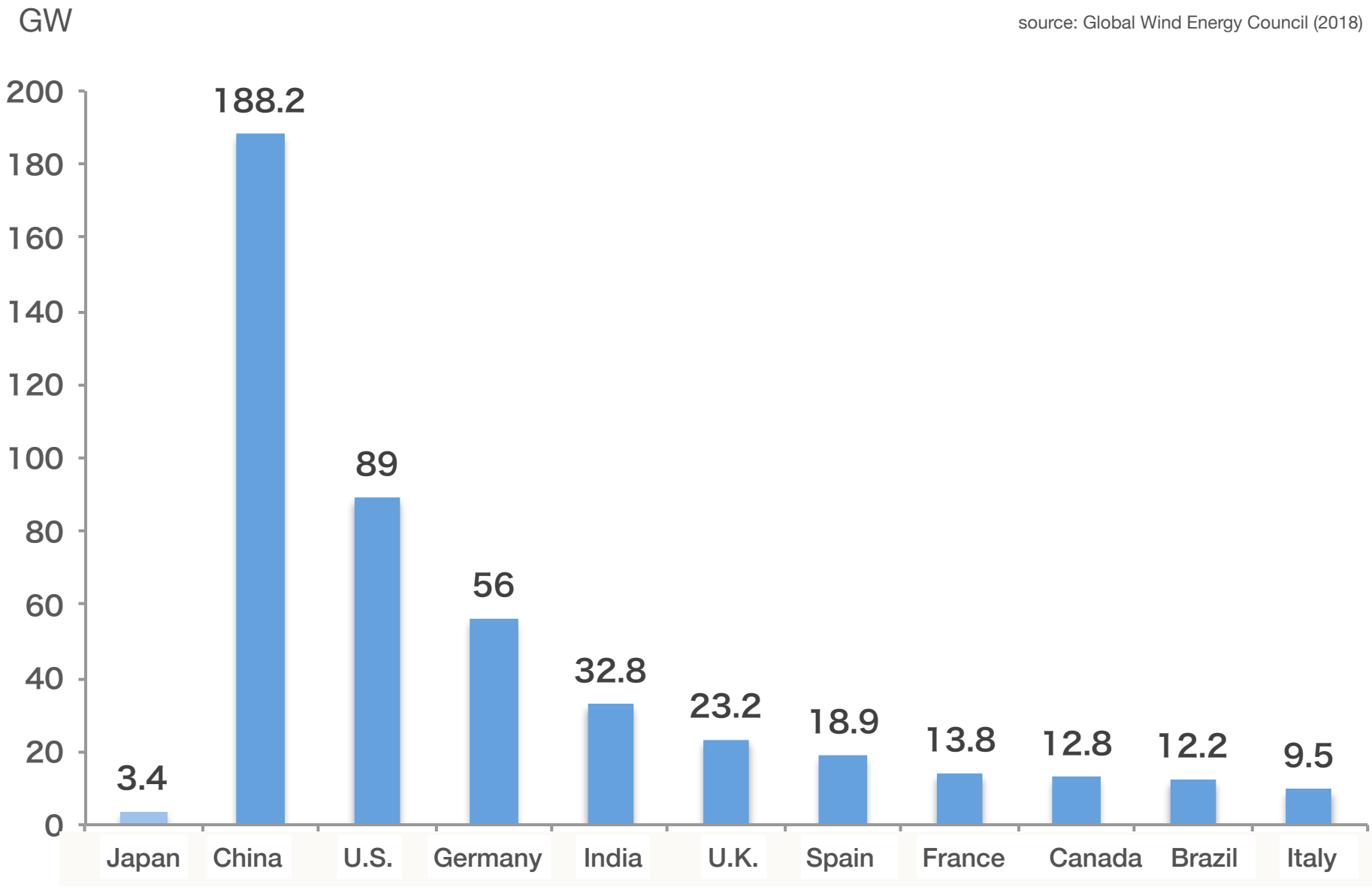



source:IEA Photovoltaic Power Systems Programme, Snapshot of Global PV Markets, 2016 (2017).

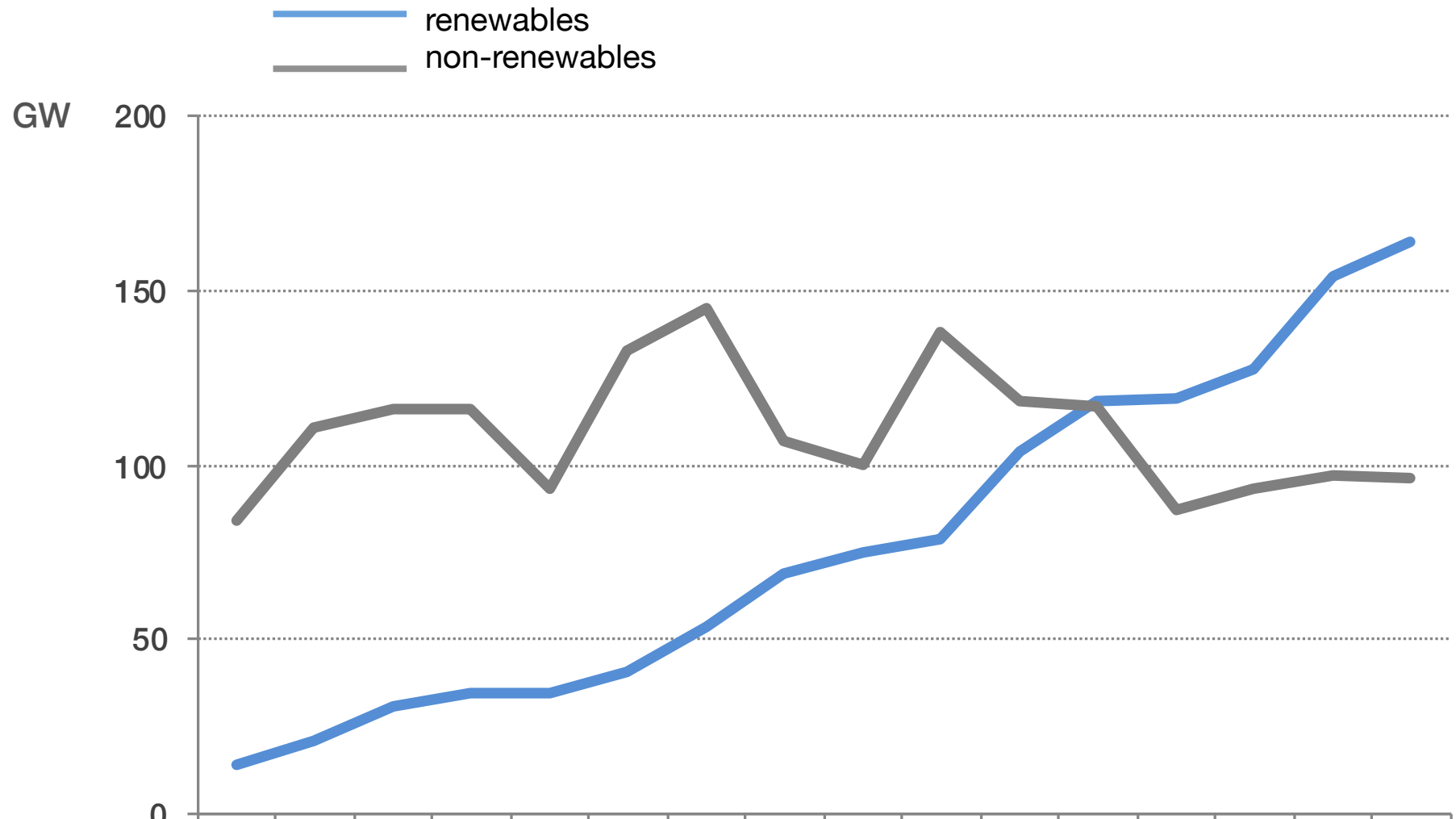
# Global wind expansion



# Wind installation in top 10 countries and Japan in 2017



# Global annual additional capacity of Renewables VS. Non-renewables



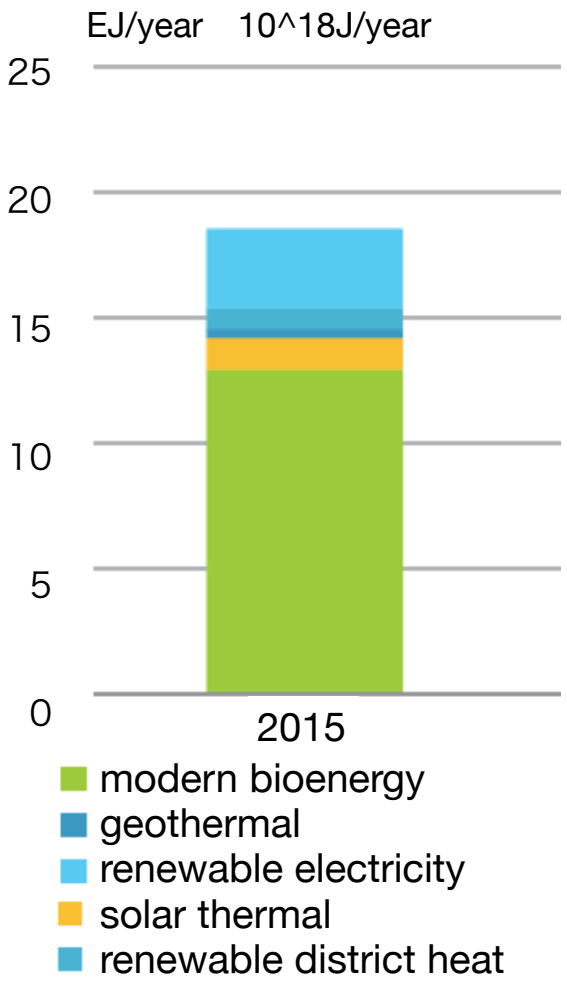

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Renewables | 14 | 21 | 31 | 35 | 35 | 41 | 54 | 69 | 75 | 79 | 104 | 118 | 119 | 127 | 154 | 164 |
| Non-Renewables | 84 | 111 | 116 | 116 | 93 | 133 | 145 | 107 | 100 | 138 | 118 | 117 | 87 | 93 | 97 | 96 |



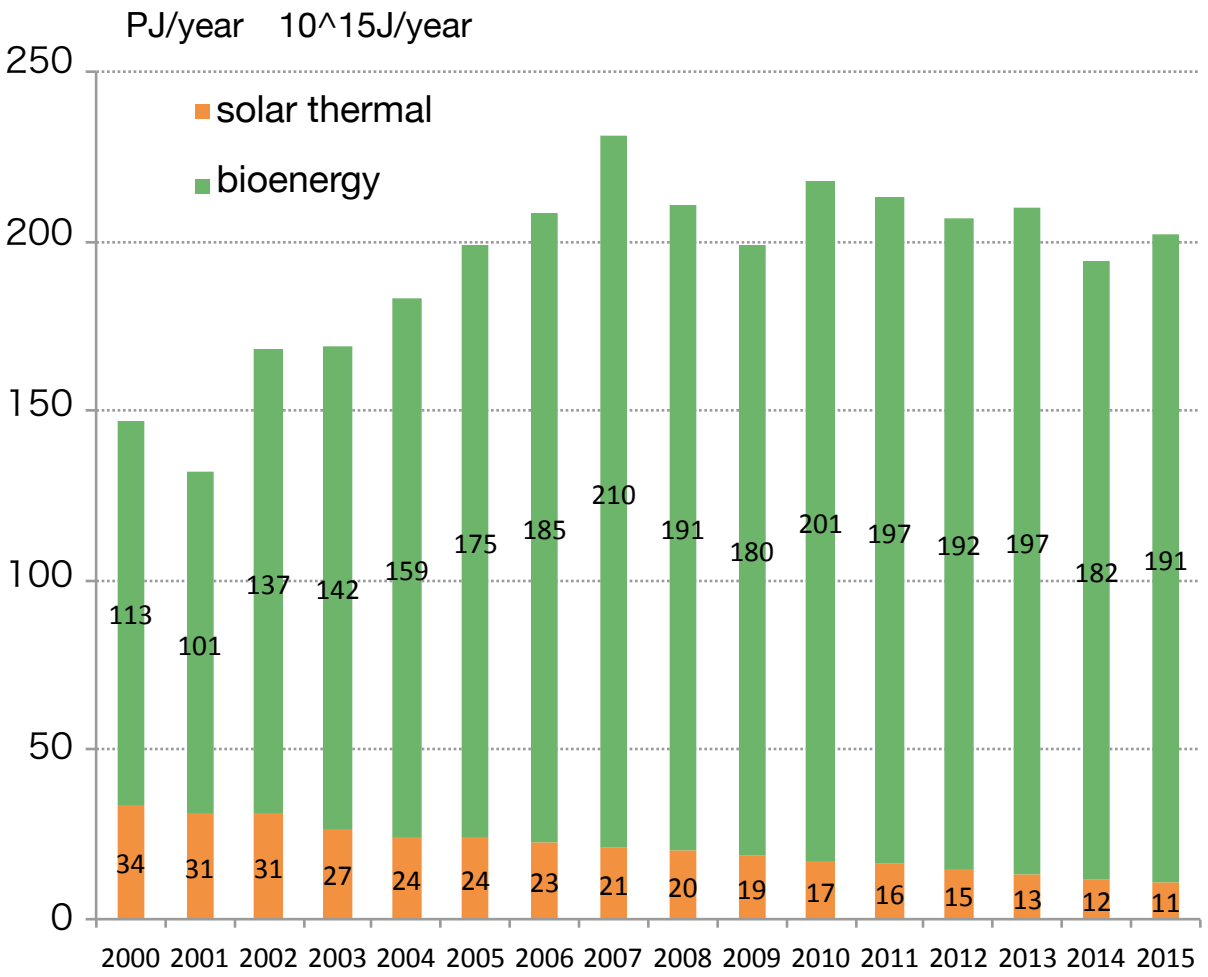
source: IRENA (2017), REthinking Energy 2017: Accelerating the global energy transformation, REN21 (2017) Global Status Report 2017, World Nuclear Association

# Global renewable heat use World and Japan

## World



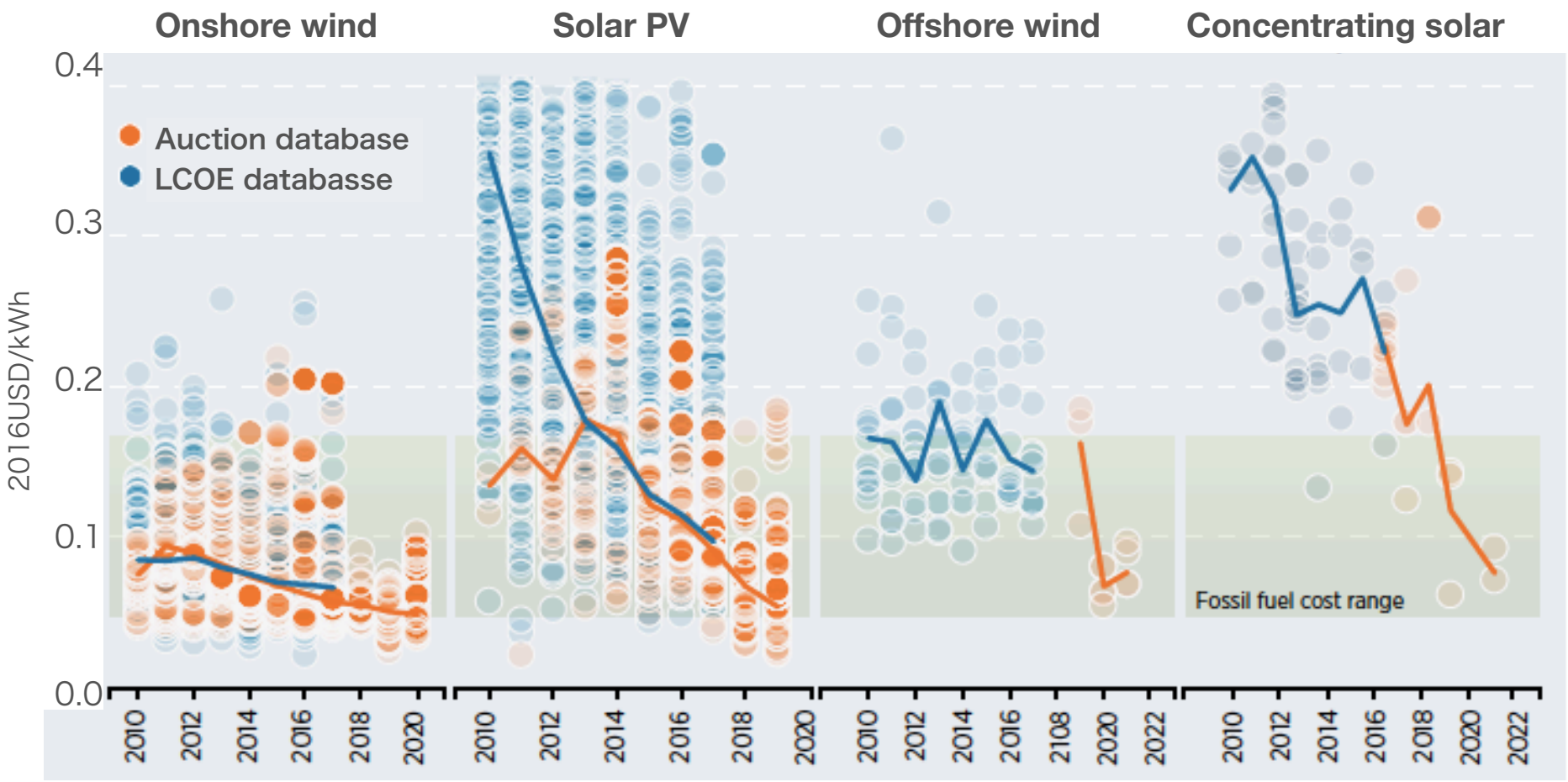

## Japan






sources:IEA (2017), Renewable 2017, METI "Energy Statistics" (22nd November, 2017)

# The levelized cost of electricity for projects and global weighted average values for CSP, solar PV, onshore and offshore wind, 2010-2022



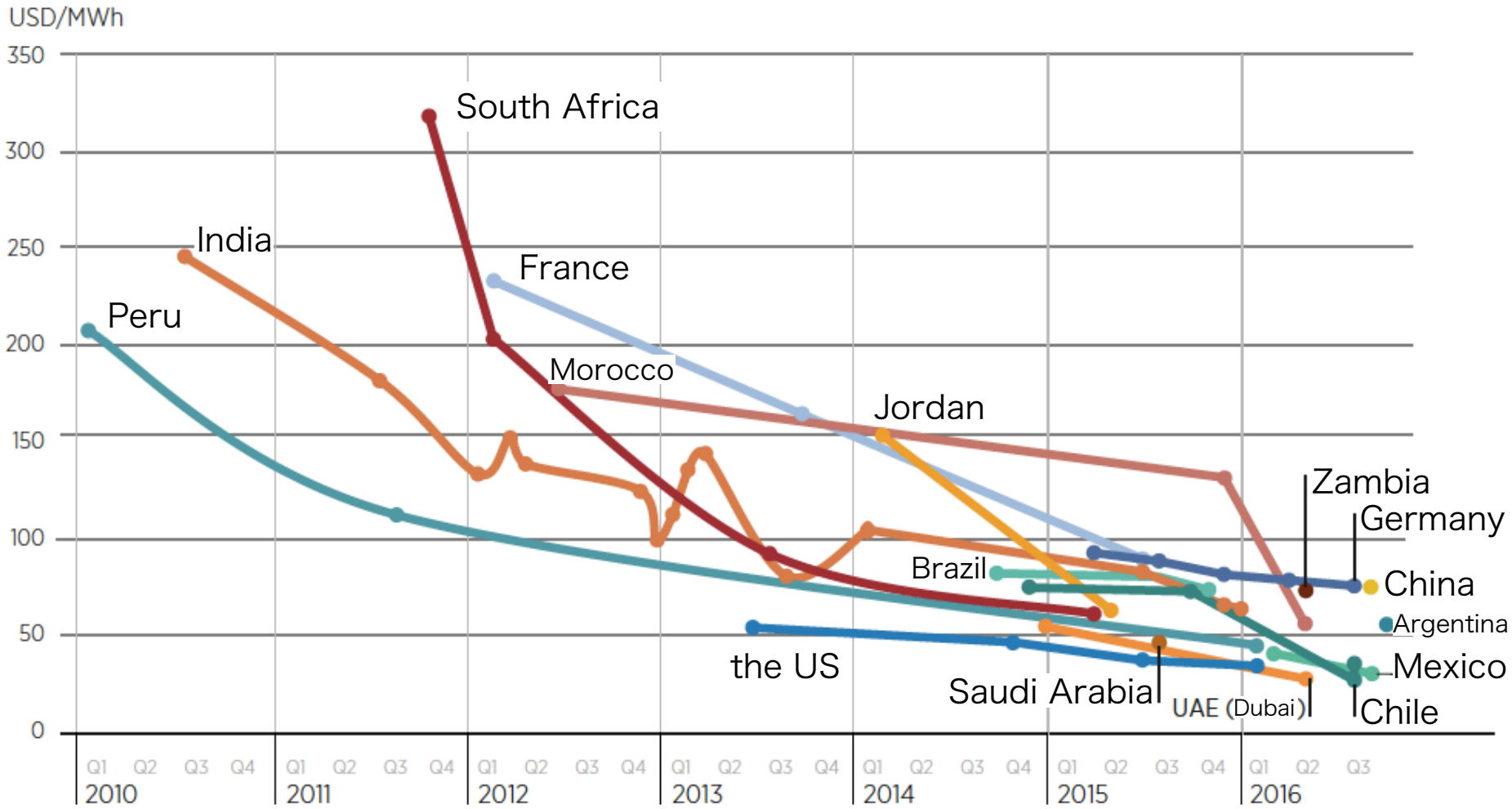

*source: IRENA Renewable Cost Database and Auctions Database.*
*note: Each circle represents and individual project or an auction result where there was a single clearing price at auction. The centre of the circle is the value for the cost of each project on the Y axis. The thick lines are the global weighted average LCOE, or auction values, by year. For the LCOE data, the real WACC is 7.5% for OECD countries and China, and 10% for the rest of the world. The band represents the fossil fuel-fired power generation cost range.*



Source: IRENA (2018), Renewable Power Generation Cost in 2017

# Decreasing bidding prices for utility-scale solar

## Sharp decline of bidding prices for utility-scale solar
## Recently, below 2 cents/kWh.

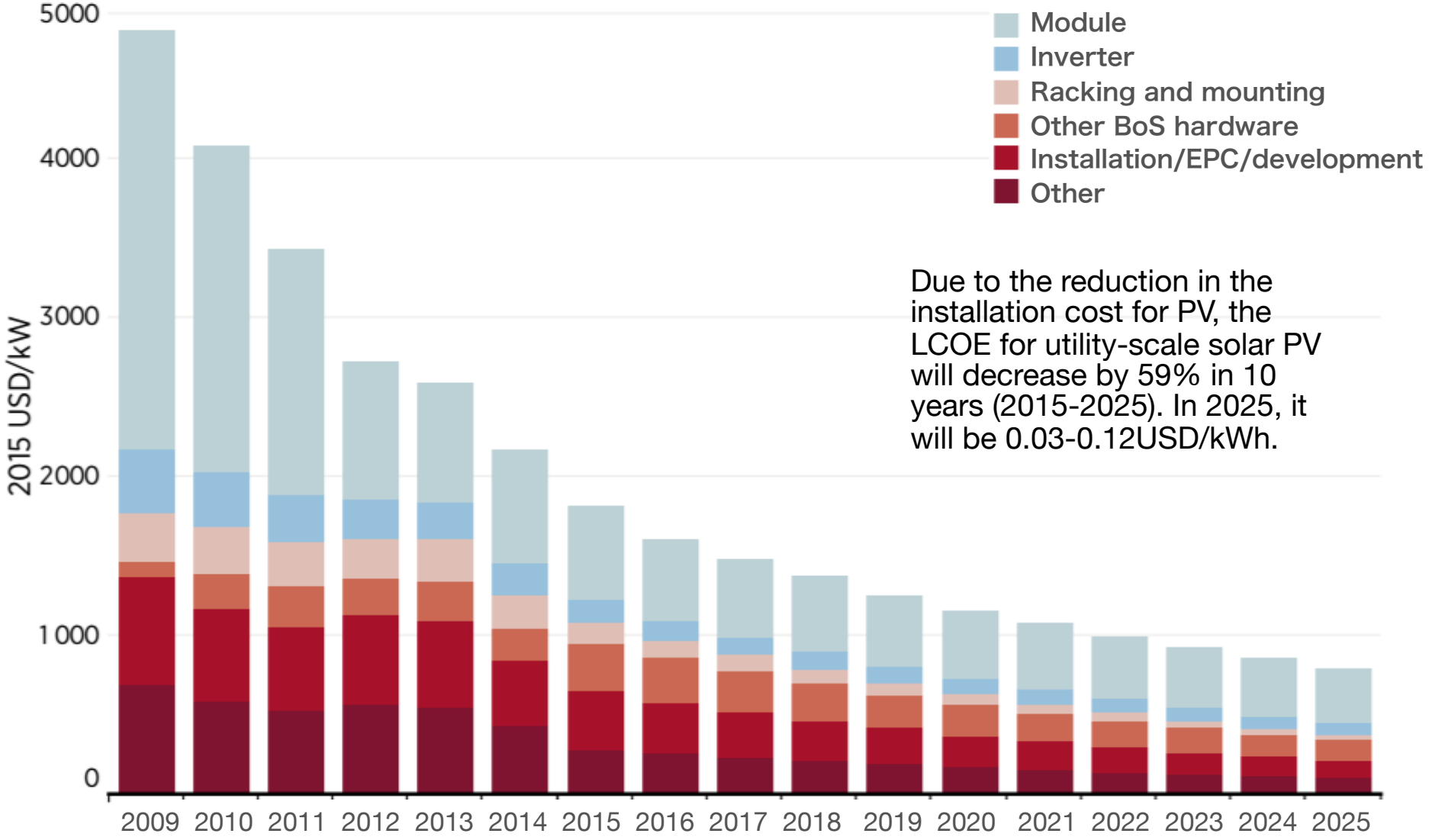





source: IRENA (2017), REthinking Energy 2017: Accelerating the global energy transformation

# Solar PV projected cost reduction until 2025

## from 2015 to 2025 the cost of PV is expected to be reduced by 59%

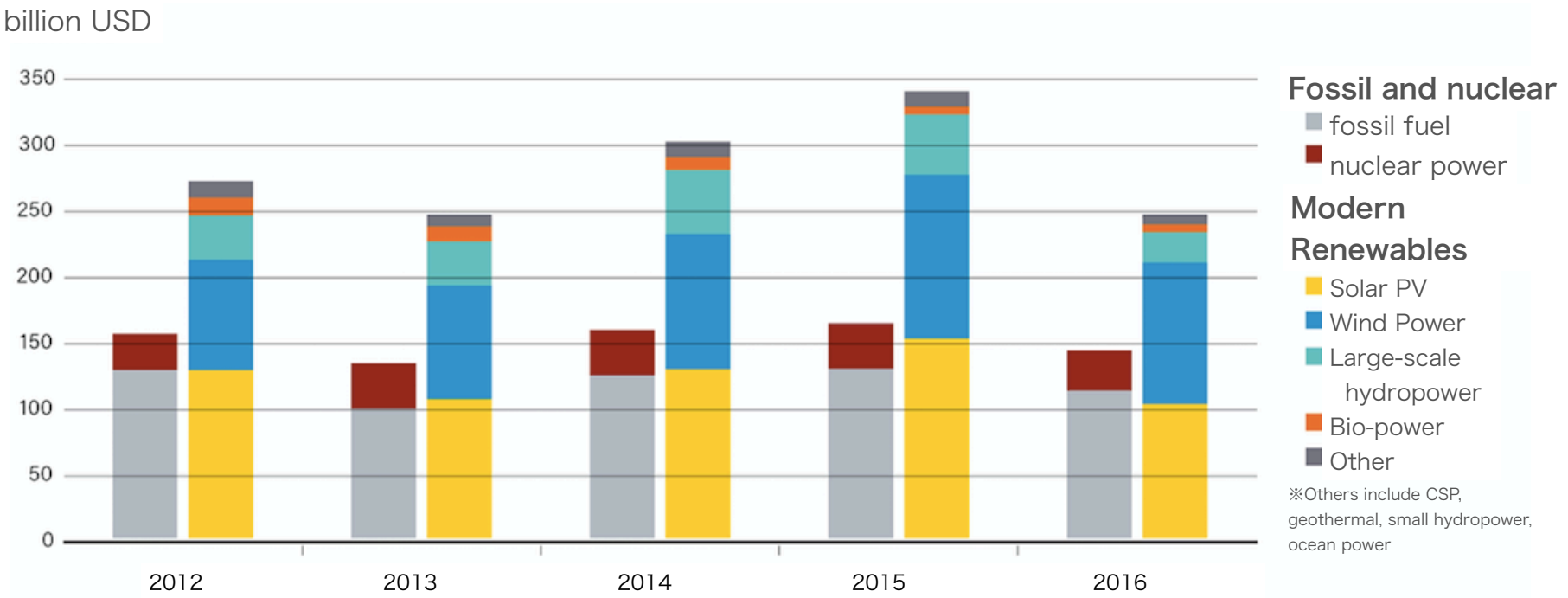



Due to the reduction in the installation cost for PV, the LCOE for utility-scale solar PV will decrease by 59% in 10 years (2015-2025). In 2025, it will be 0.03-0.12USD/kWh.

source:IRENA (2016), The Power to Change: Solar and Wind Cost Reduction Potential to 2025

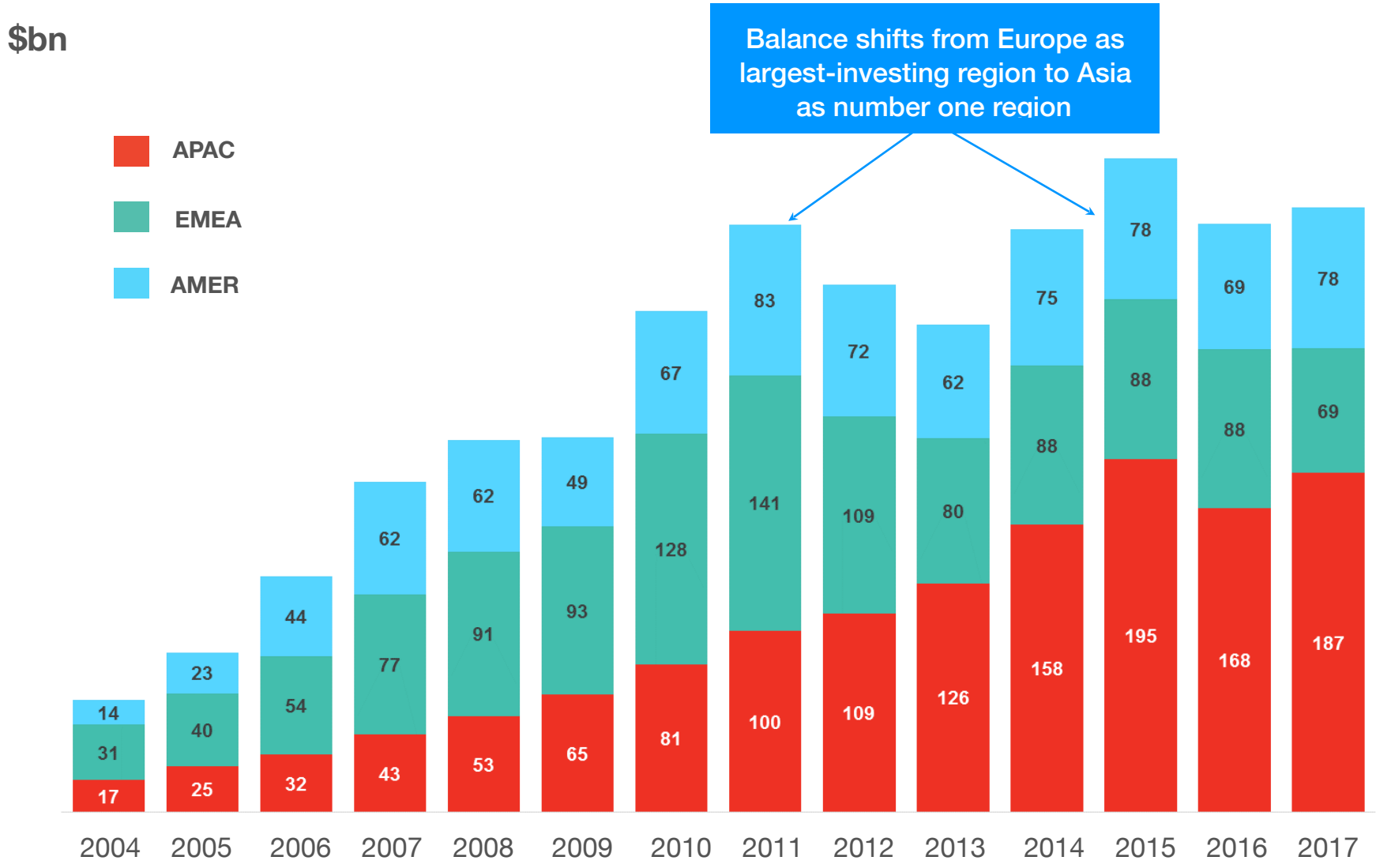
# Global Investment in Power Capacity, by Type, 2012-2016

## Renewable Energy, Fossil Fuel, Nuclear Power




source: Bloomberg New Energy Finance 2017

# Clean Energy Investment by Region 2004-2017

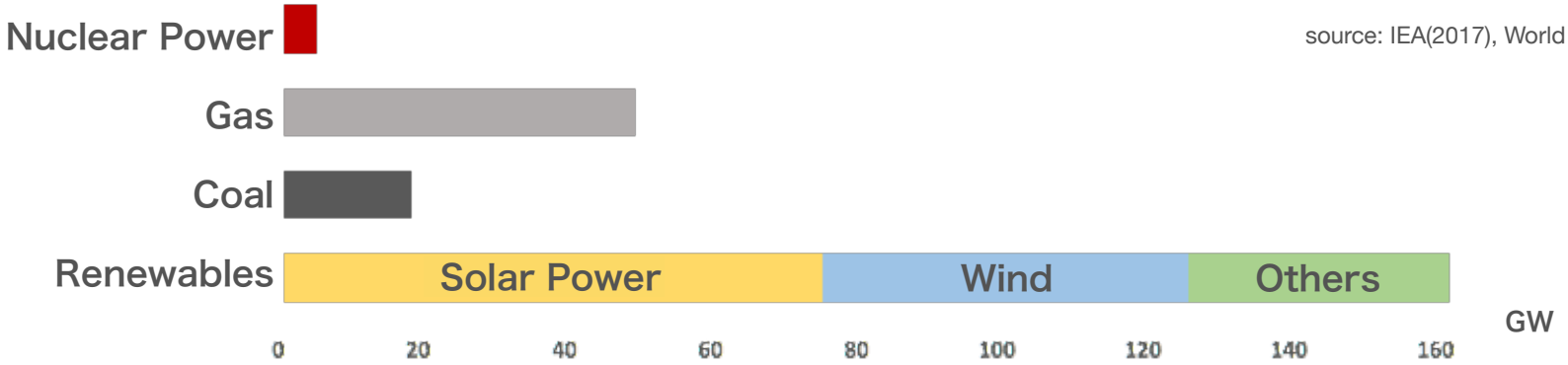



Version WF18.01
All values nominal

source:Bloomberg New Energy Finance, 2017

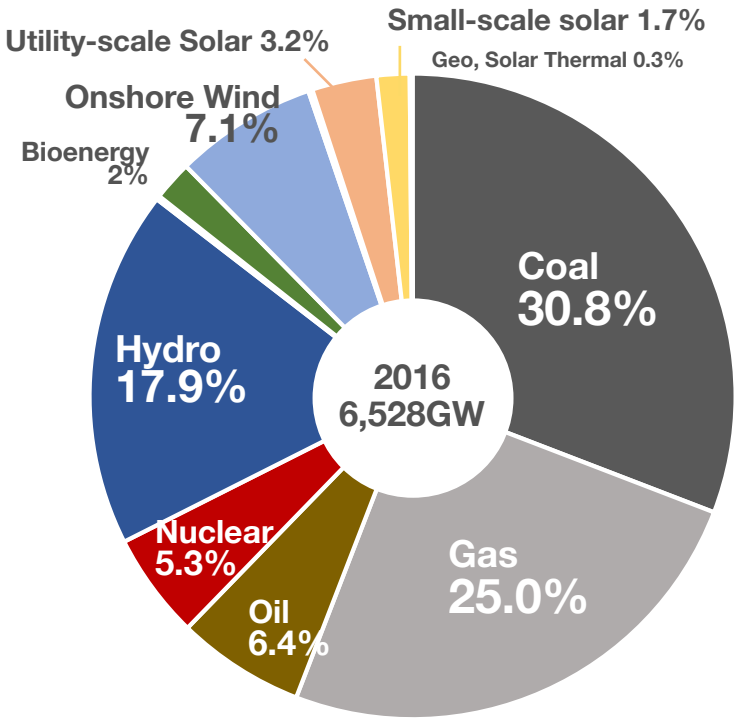
# Outlooks for power capacity expansion in 2040

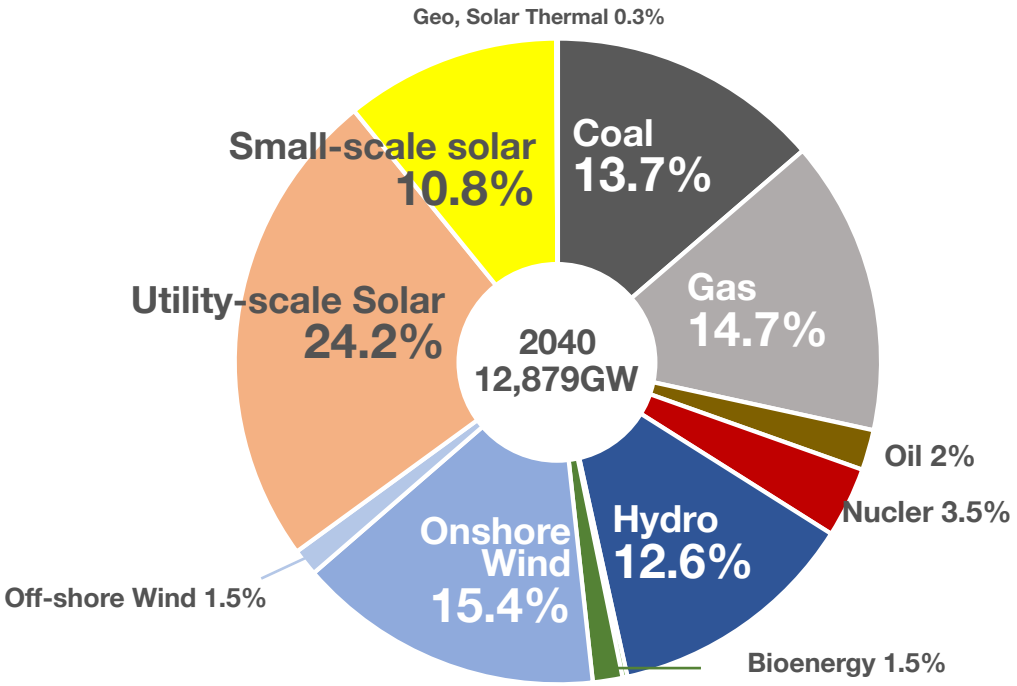
IEA: Global average annual net capacity additions by type 2017–2040, renewables will be significantly expanded




source: IEA(2017), World Energy Outlook 2017

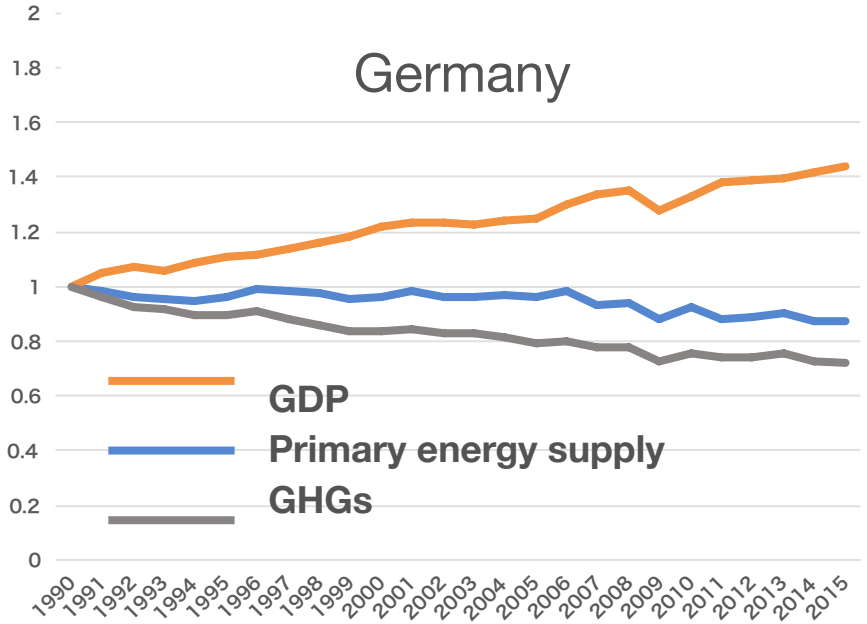
Bloomberg: Renewable Energy will dominate the electric power mix in 2040

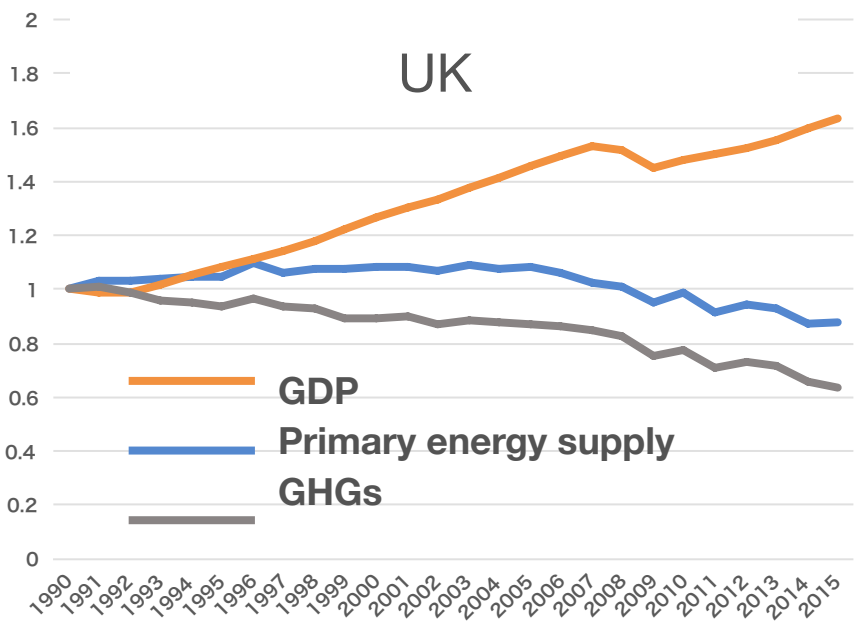


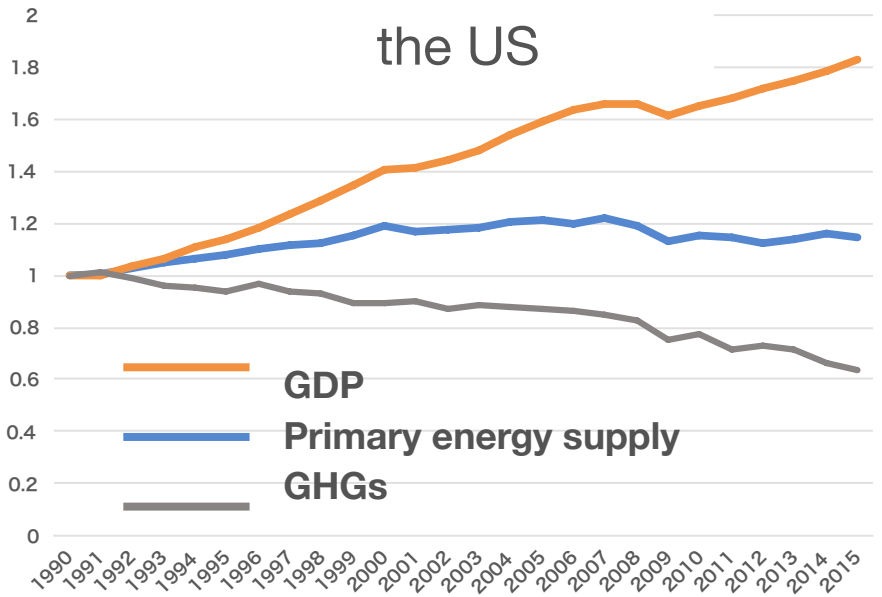



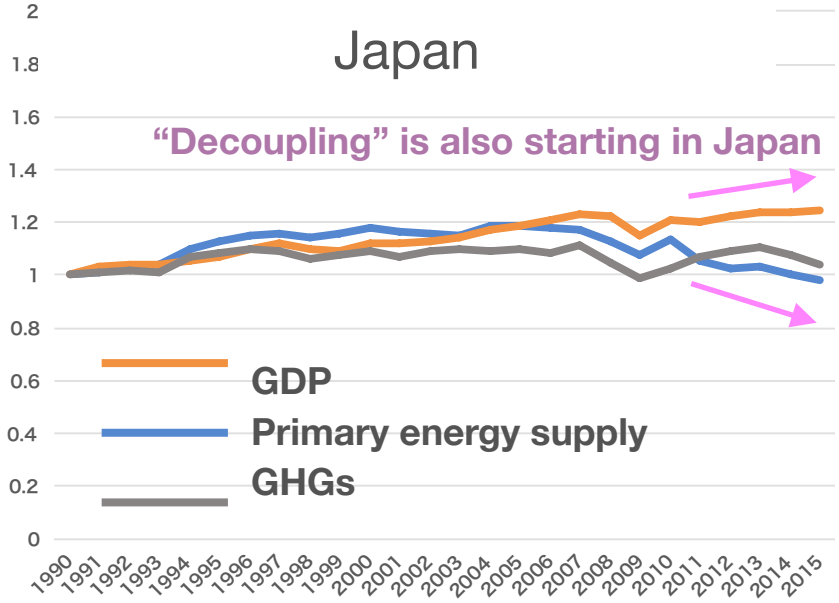

source: Bloomberg(2017), NEO

# Examples of “decoupling” in the world



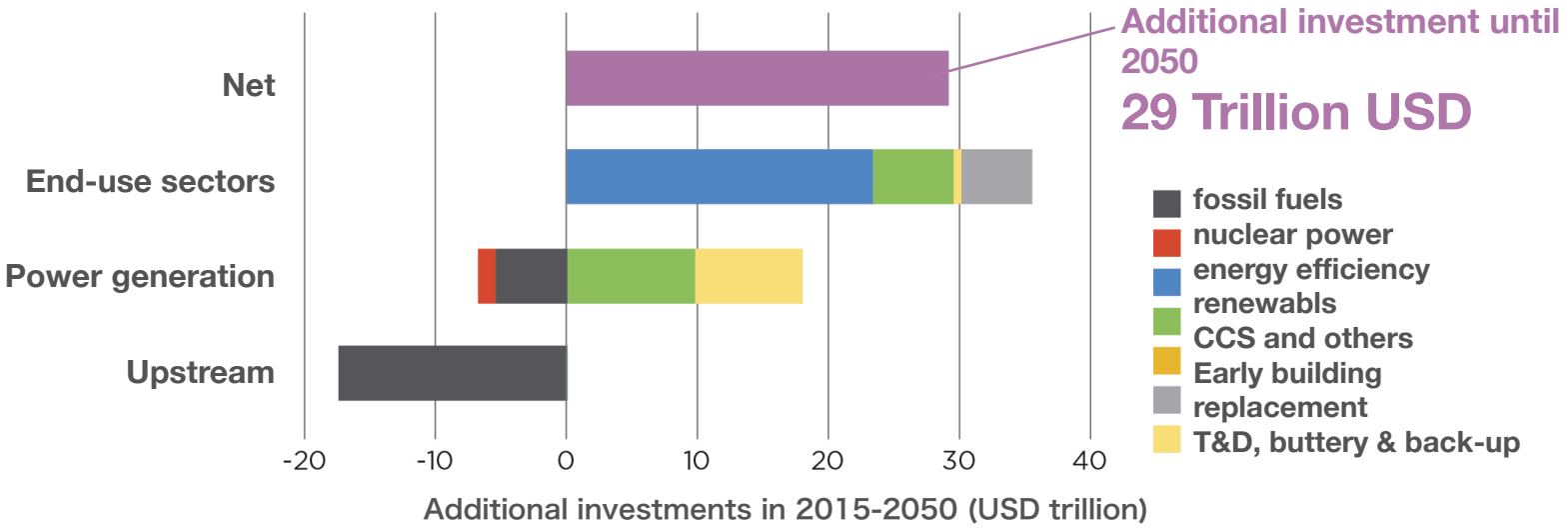



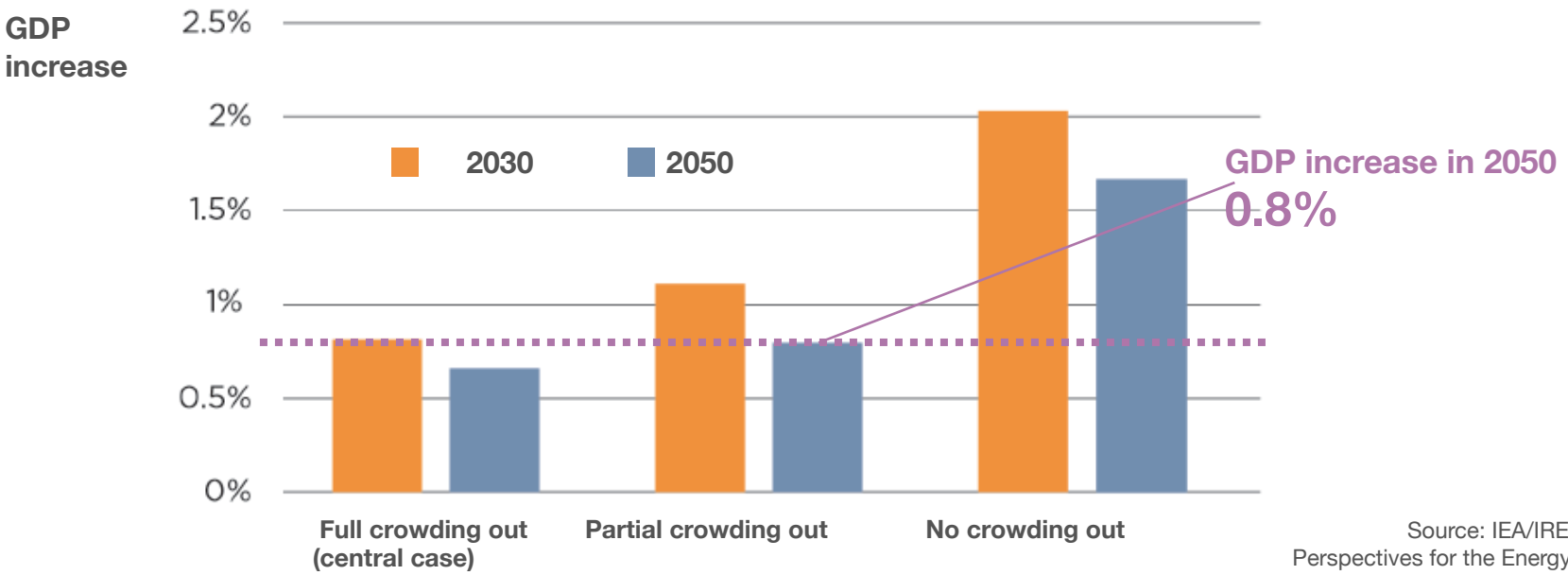



Source: Primary Energy Supply・GDP：OECD/IEA（2017） CO2 emission from fuel combustion, GHG

# Relationship between clean energy investment and GDP until 2050

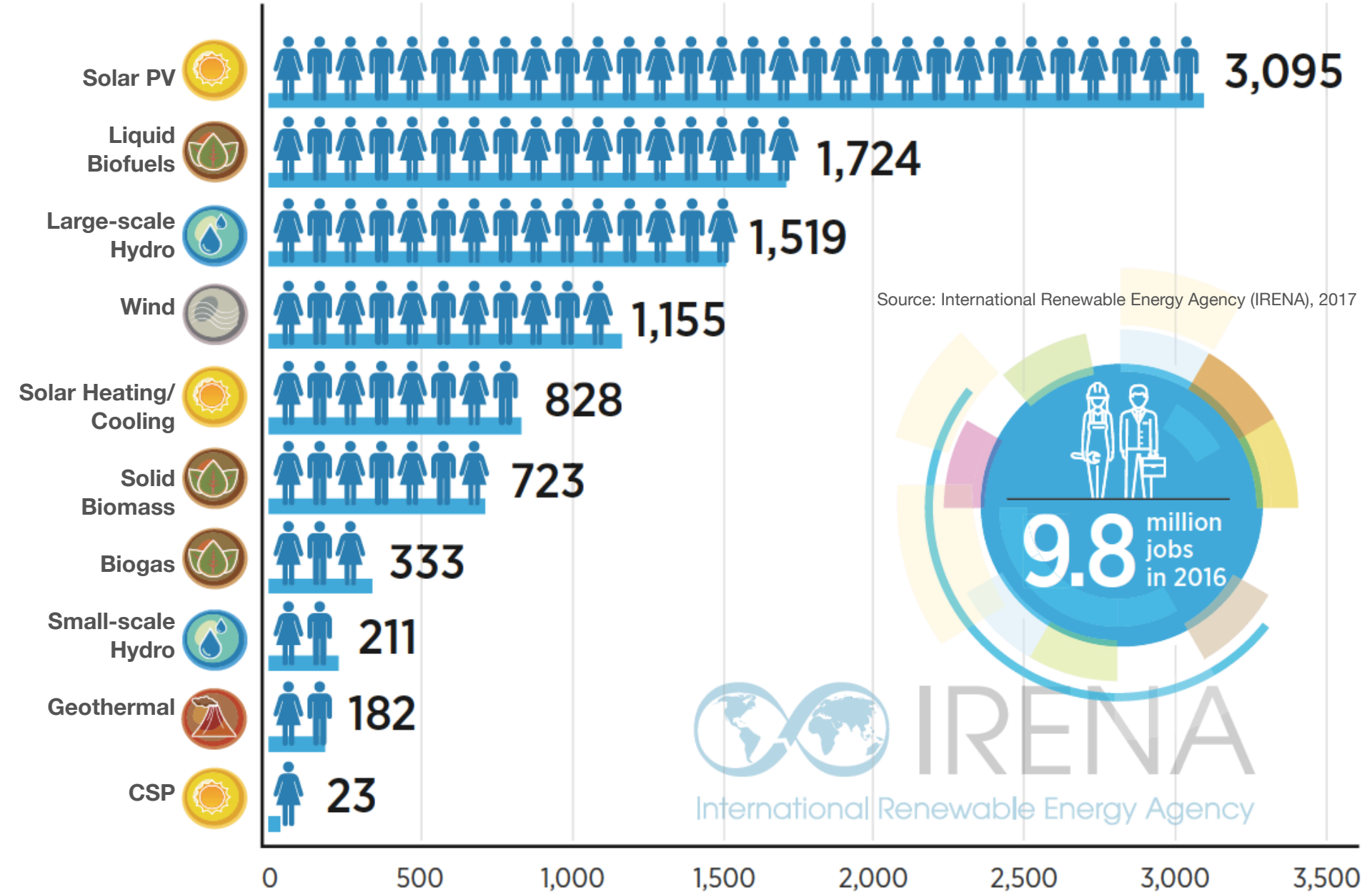
If energy conversion measures (REmap scenario) for decarbonization to achieve the 2 degrees target are implemented, 29 trillion USD will be required as additional investment until 2050. GDP will be boosted by 0.8%.



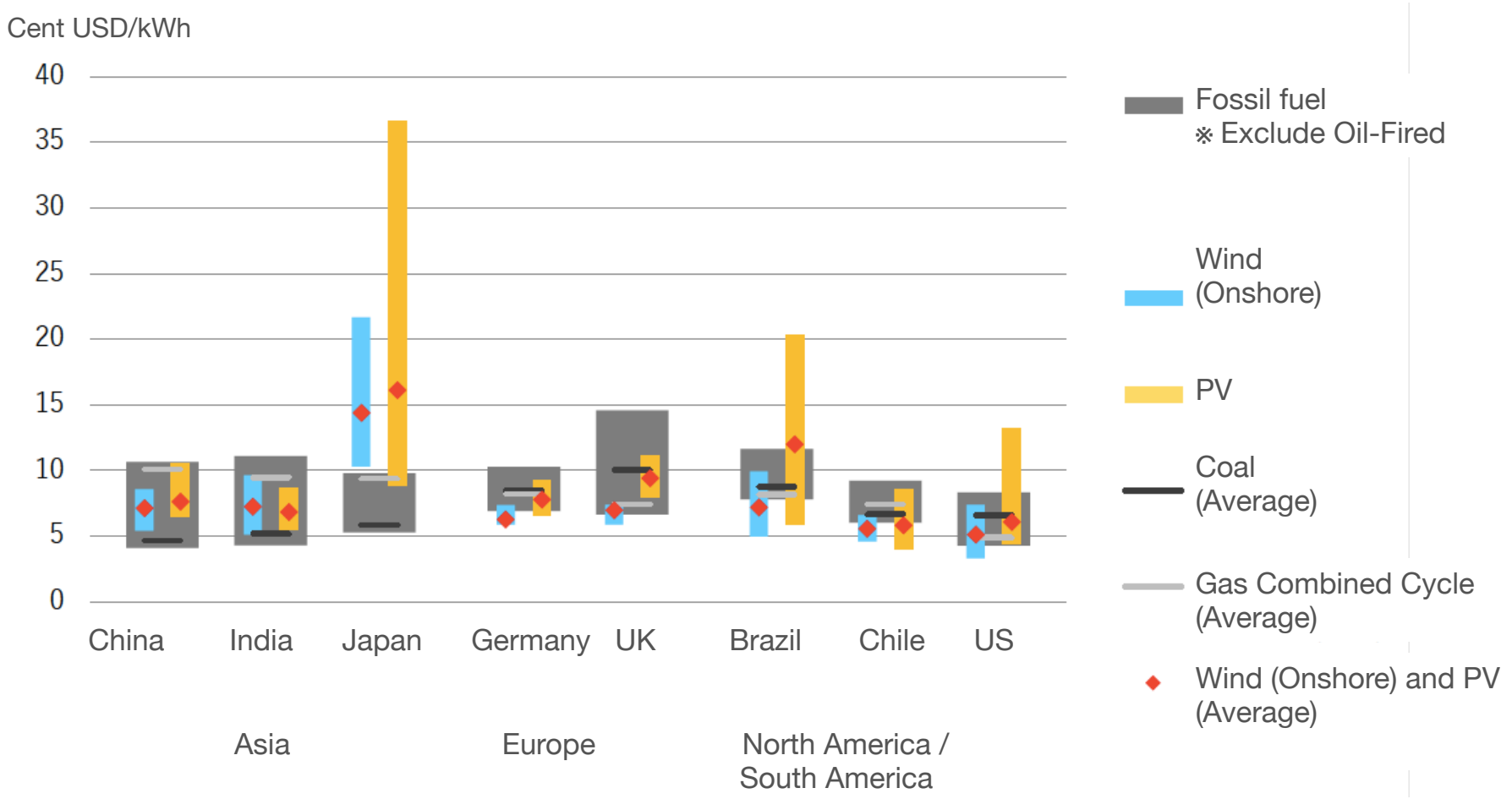

Source: IEA/IRENA (2017), Perspectives for the Energy Transition

# Jobs in renewable energy around the world in 2016



# Comparison power generation cost among major countries

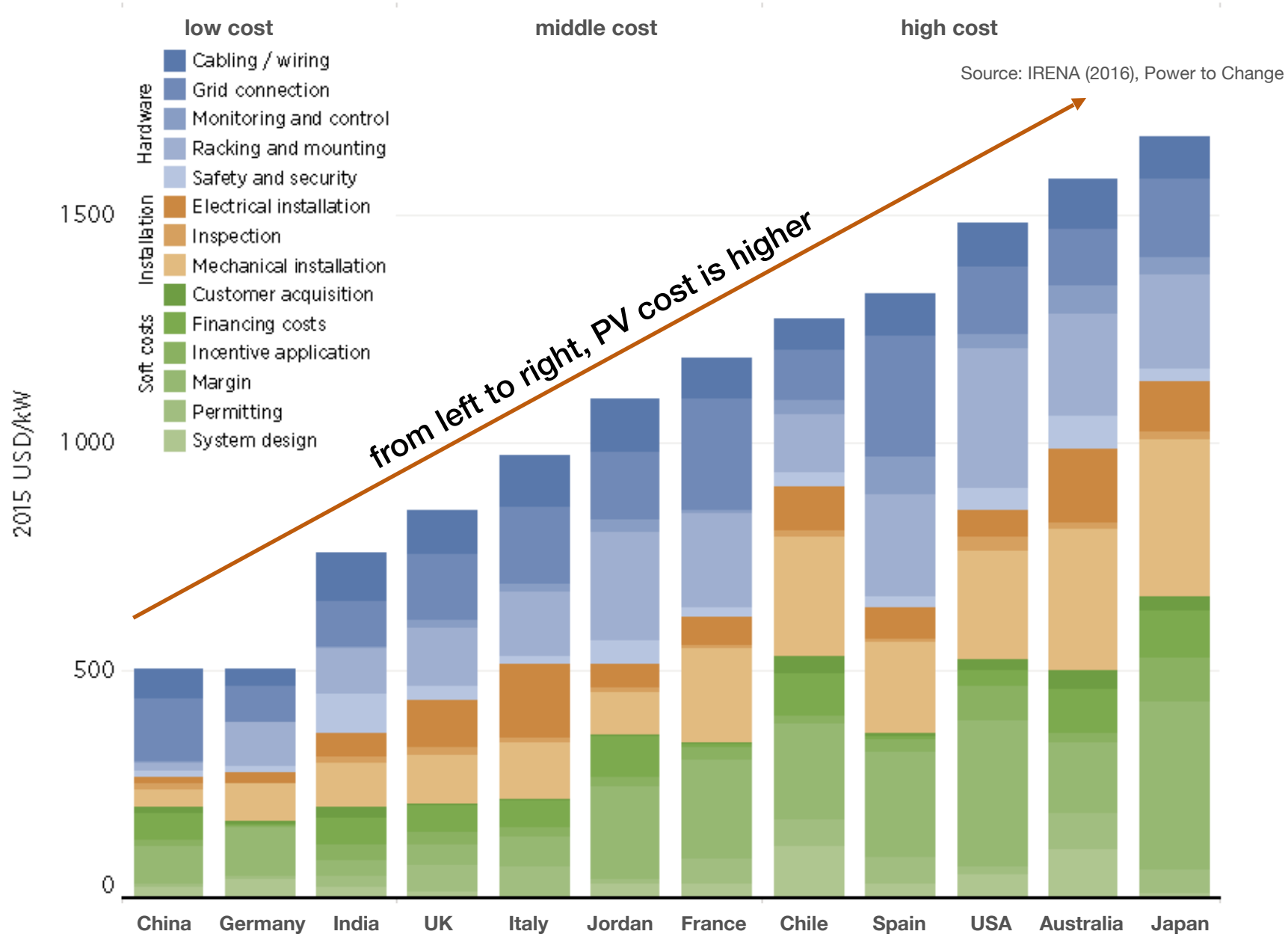
## Comparison Power Generation Cost among Major Countries (LCOE, 2017 First Half)






source: ：BNEF（2017）、Levelized Cost of Electricity

# Comparison of PV costs in the world

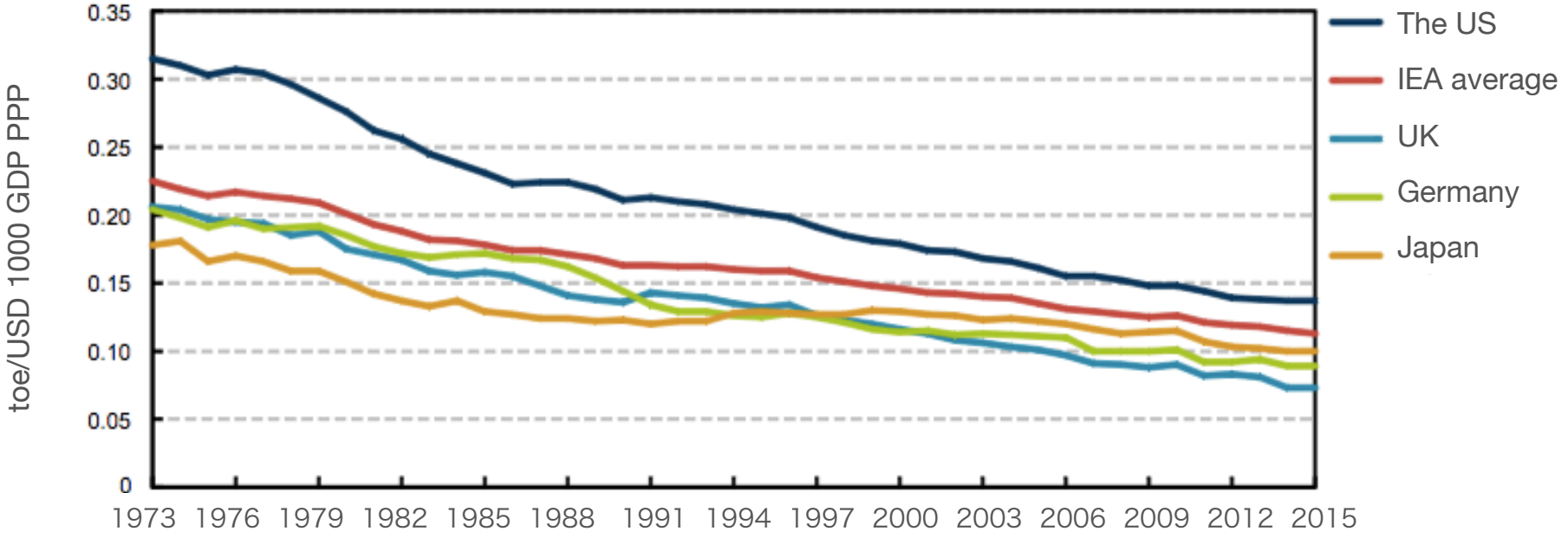


# Energy Efficiency Status in Japan

## Summary of IEA Recommendations on Energy Efficiency for Japan: General, Buildings, Transport, District Heating and Cooling, including Co-generation

- Continue to develop policies that will deliver energy efficiency improvements in small and medium-sized enterprises.
- Move forward with the design and implementation of ambitious energy efficiency standards for new buildings by 2020, with the aim of realising zero-energy buildings as soon as possible, and an effective enforcement regime.
- Adopt a comprehensive strategy for identifying and realising the energy-saving potential in the existing building stock. Consider implementing an effective labelling scheme for buildings to be applied when a building is sold or rented.
- Continue the successful policy to introduce stricter fuel efficiency standards and efforts to promote next-generation vehicle technology.
- Build on the success of the Top Runner Programme, expanding the range of products covered particularly in the commercial and industrial sectors.
- Investigate increased use of district heating and cooling (including co-generation) for more integration of renewable energy sources, increased resilience of the electricity supply system, and for wider use of municipal waste while also building international collaboration with countries featuring high penetration of DHC.
- Ensure that operators of co-generation plants receive a remuneration on excess electricity sales that is in line with the avoided costs resulting from the injection of this electricity into the grid.

Energy intensity in Japan and in other selected IEA member countries, 1973-2015






Source: IEA(2016), Energy Policies of IEA Countries, Japan 2016 Review

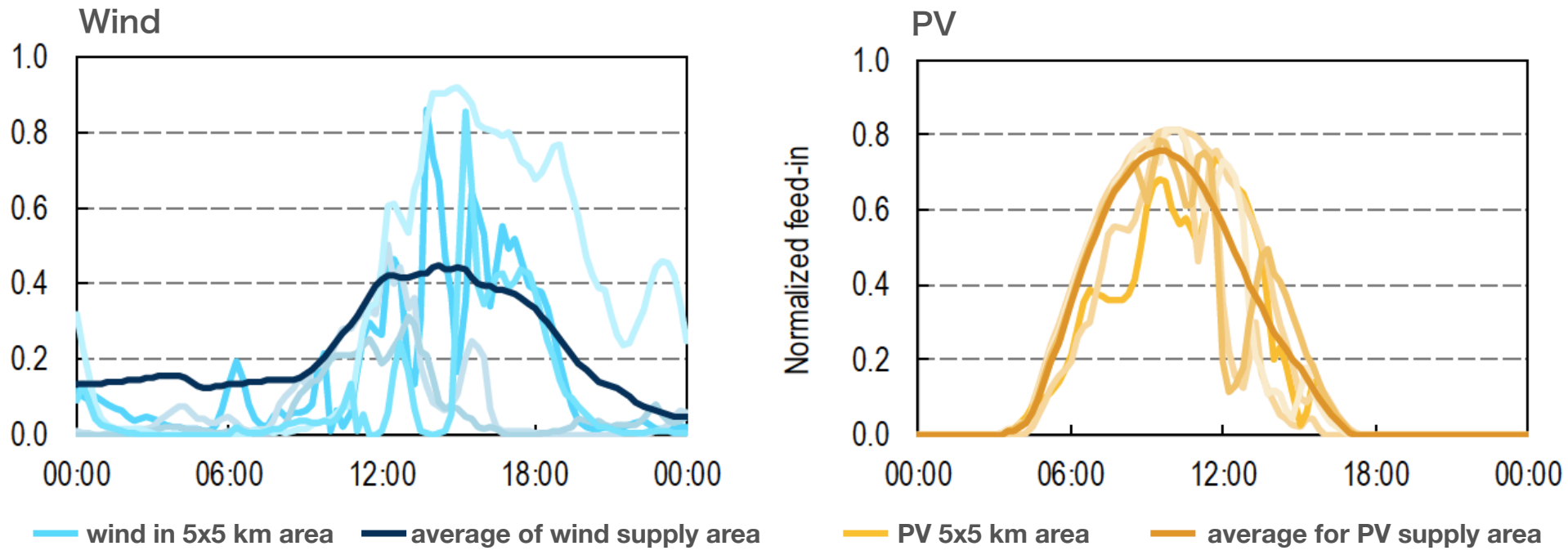
# Smoothing effect of renewable energy widespread deployment

Electricity generation from variable renewables (VRE) such as wind and solar fluctuates more on a small geographical scale than on a wider geographical scale this is the “smoothing effect.”

IEA: “[…] If power plants are well dispersed, such fluctuations will be gentler and slower.”

– Getting wind and solar onto the grid, 2017

The dispersal of VRE power plants makes their output easier to accommodate

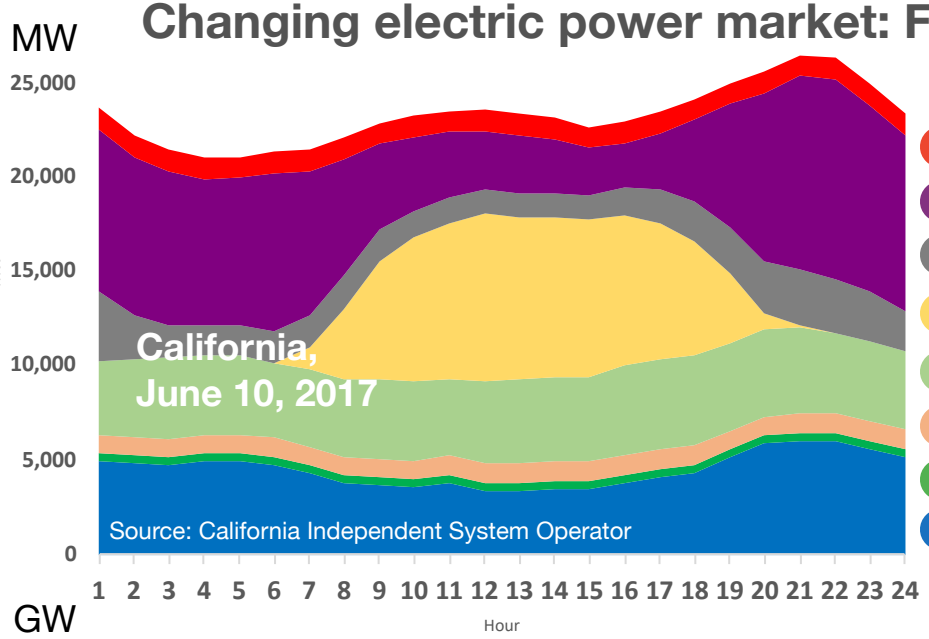



CSIR(2016), Aggregation Investigation for Wind and PV in South Africa



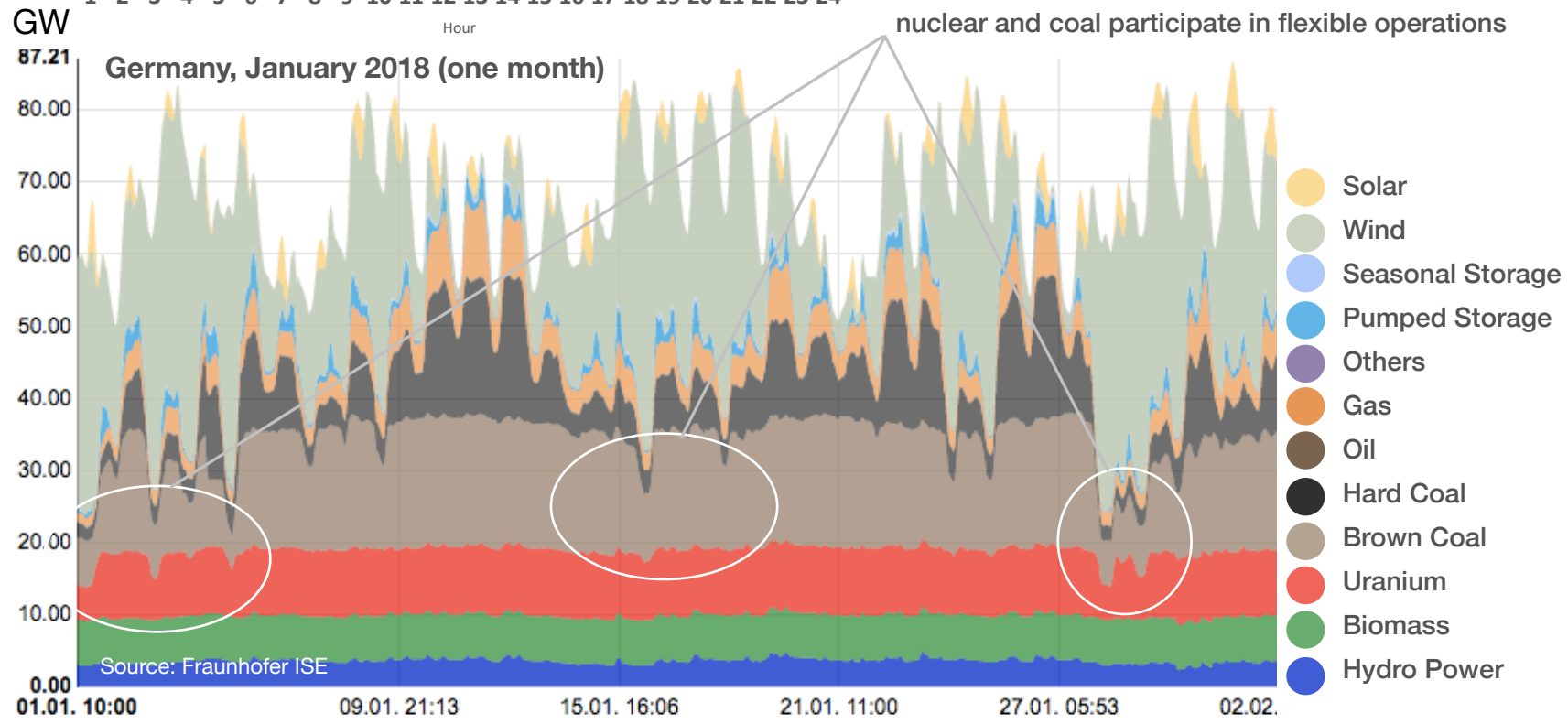
Source: IEA, Getting Wind and Sun onto the Grid, 2017

# Changing electric power market: From baseload to flexible power supply




When looking at the whole area in a day, the variability in electricity generation from renewables is not "saw-toothed" type.

To match electricity demand, close to zero marginal cost renewables are dispatched first and, then, the output from other sources is adjusted to cover the net (residual) demand.



# Renewables and coal power policy of major countries

| | Share of coal | Policy | Major developments |
|---|---|---|---|
| **EU** | **41%→28%→12%<br>[target in 2030 is 9.1%]** | At least 27% for renewables by 2030<br>(approx. 50% in total electricity generation) | ・Setting a standard for subsidies for new fossil generation<br>・EU-ETS application<br>・CCS directives in 2009 |
| **UK** | **65%→37%→ー<br>[target in 2030 is 0%]** | Coal phaseout by 2025 | ・Published a draft legislation for CO2 emission standard<br>・EU-ETS subject country, unilaterally set a lower limit<br>・2 projects for CCS, CCS ready regulation already in place |
| **France** | **8%→4%→ー<br>[target in 2030 is 0%]** | Coal phaseout by 2021 | ・Promulgated a directive not to approve construction without CCS<br>・EU-ETS subject country<br>・CCS-ready regulation already in place |
| **Germany** | **59%→47%→ー** | Policy to pay compensation for shutting down lignite coal power plants under consideration | ・Ban construction of new lignite coal-fired power plants for 5 years<br>・EU-ETS subject country<br>・Levy electricity as a part of environment tax<br>・CCS-ready regulation already in place |
| **US** | **53%→40%→26%<br>[target in 2030 is 7%]** | Review policy of previous administration including CPP and related regulations based on the President's decree (suspend, amend and abrogate, if necessary) *some research bodies foresee no increase in coal power due to less pricey shale-gas compared with coal. | ・CO2 emission standard already in place (it will be reviewed according to the President's decree)<br>・North-east introduced emission trading scheme<br>・CCS project underway with 3 projects in planning<br>(Note) Subsidies for coal and nuclear power that Trump's administration tried to introduce was denied by the Federal Energy Regulatory Commission unanimously and the draft was unsuccessful. |
| **Canada** | **17%→10%→ー** | Coal phaseout (without CCS) by 2030 | ・CO2 emission standard is in place<br>・Quebec state already introduced emissions trading scheme<br>・One CCS project is underway |
| **China** | **72%→75%→51%** | Deterring new construction of coal-fired power plants and partly cancelled construction plans | ・Setting an emission coefficient target by major power utilities<br>・Start of emissions trading scheme on national scale in 2017<br>・2 CCS projects in planning |
| **India** | **65%→73%→58%** | No new coal plants by 2027 except those already under construction | ・Introduction of clean energy tax on coal and others (tax increase in Feb 2016 and renamed as clean environment tax) |
| **Japan** | **13%→33%→27%<br>[target in 2030 is 26%]** | | ・Targets of Energy Save Act/Upgrading Act were set. Strengthening of operations.<br>・Introduction of global warming countermeasure tax, increase to the final tax rate was completed in April 2016. |



source: Institution Presentation Materials

# Decarbonisation trend of international financial institutions and others

## Suspension of investment in coal and divestment trend

| | | |
|---|---|---|
| June 2013 | US | President's climate action plan : appeal for suspension of public finance support for new coal-fired power plants construction abroad. |
| July 2013 | World Bank Group | Announced a guideline for energy sector financing with a principle of no financial support for coal-fired power plants construction. |
| July 2013 | EIB | Announced an emissions standard to be used when providing finance to a fossil-fired power plant. |
| September 2013 | Denmark, Finland, Iceland, Norway and Sweden | Suspended new financing to coal fire construction in principle and appealed to do the same to other countries and multilateral financial institutions. |
| October 2013 | US | Treasury announced a guideline on public financing support by international development financing institutions on coal-fired power plants projects in developing countries. |
| November 2013 | UK | Announced its agreement to the US policy. |
| December 2013 | US Ex-im bank and EBRD | Announced suspension of financing coal-fired power plants without exceptions. |
| March 2014 | Netherlands | Announced its agreement to the US policy. |
| September 2014 | Germany | Announced limiting its support for new coal-fired power plants within KfW group. |
| November 2014 | France | Announced its agreement to the US policy. |
| November 2015 | OECD countries | Agreement on limiting public support for coal fire to USC and others at the export credit arrangement group meeting. |
| December 2017 | World Bank Group | Announced suspension of financing in upstream oil and gas after 2019. Committed to disclose GHG emission amount of World Bank supported energy related projects after 2018. |
| December 2017 | MDBs | Announced a joint statement on providing support along the Paris agreement target to realise zero-emission in the latter half of this century. |



source: Institution Presentation Materials

# Global trend toward decarbonisation

## Inauguration of “Powering Past Coal Alliance” aiming at phasing out coal power

- The UK and Canada jointly established the Alliance on 16 November 2017, during the COP 23 period, with the goal of rallying support for phasing out coal power in collaboration with governments, municipalities and companies.
- In the declaration, a quote was made from a research that “in order to implement the Paris agreement, the OECD and EU by 2030 and others by 2050, need to get rid of coal power.” The group aims at increasing the number of participating countries to 50 by COP 24.

※at the time of inauguration, 27 countries and municipalities participated in. By the Paris One-planet summit on 12 Dec, this number increased to 58 countries and municipalities including France and Italy.

member countries

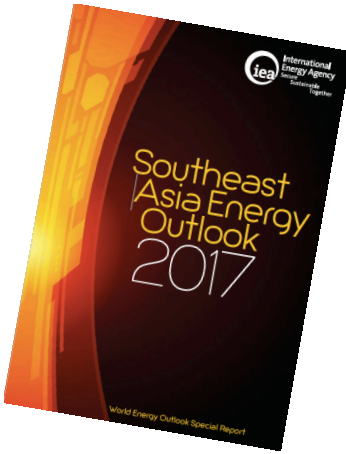
1. Canada
2. United Kingdom
3. Austria
4. Angola
5. Belgium
6. Costa Rica
7. Denmark
8. El Salvador
9. Ethiopia*
10. Fiji
11. Finland
12. France
13. Italy
14. Latvia*
15. Liechtenstein*
16. Luxembourg
17. Marshall Islands
18. Mexico
19. Netherlands
20. New Zealand
21. Niue
22. Portugal
23. Sweden*
24. Switzerland
25. Tuvalu*
26. Vanuatu*

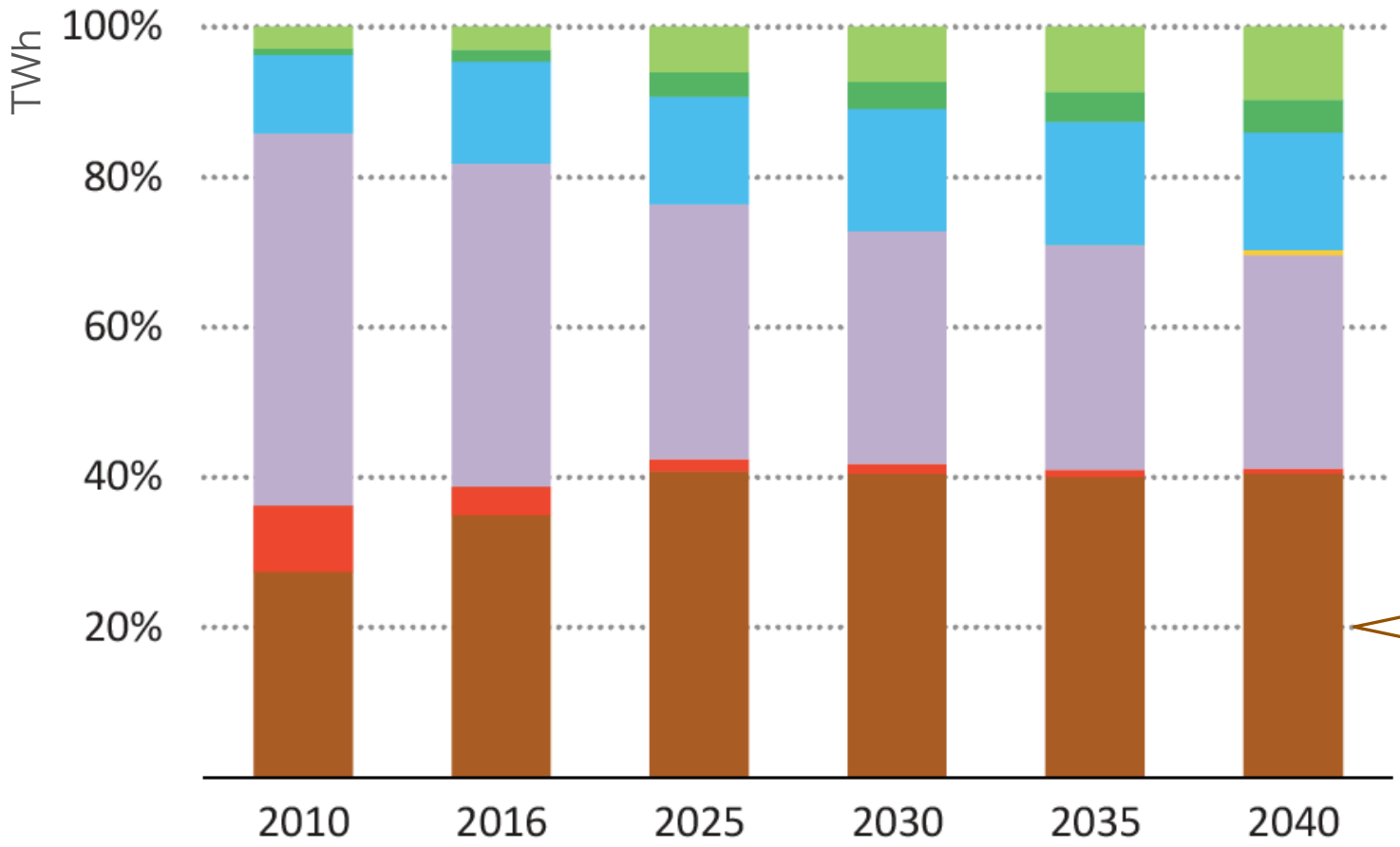
*Partners who joined the Alliance at the One Planet Summit

# Changing energy landscape in Asia

IEA's publication "Southeast Asia Energy Outlook" notes, "Challenges remain to expand coal-fired capacity , not least public opposition in some countries. Additional challenges involve financing the high upfront coats when many international development banks are limiting lending to coal projects and ensuring availability of skilled operators to achieve efficient output in plant operation."

"Solar and wind power generation grows especially quickly, at an annual average rate of around 15% between 2016 and 2040. Geothermal power generation almost triples by 2040, reflecting its substantial potential in some parts of Southeast Asia and supportive government policies"



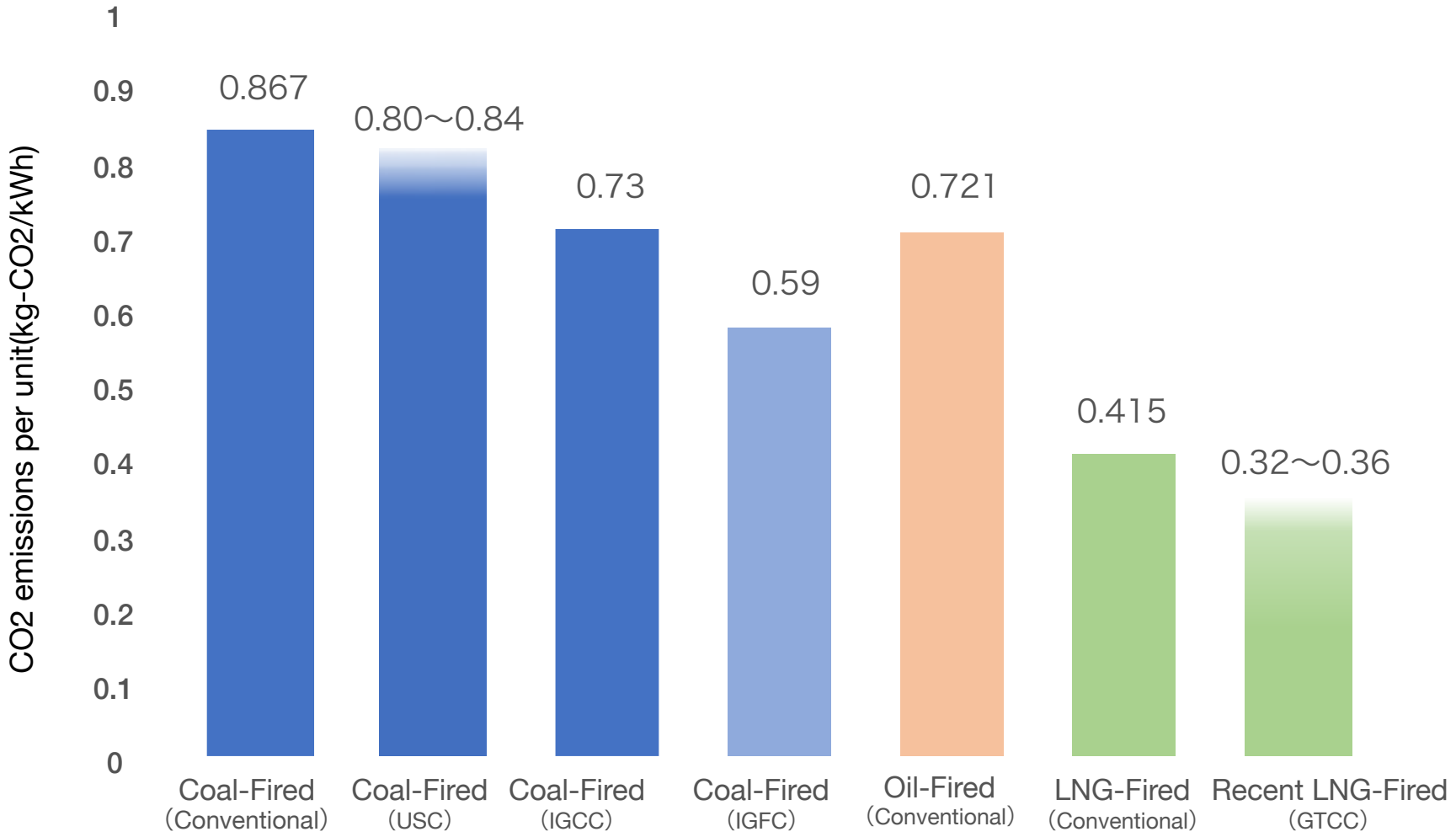

"Reflecting recent policy developments that favour renewables and the multiple challenges in building coal-fired plants, the contribution of coal in the power generation mix in 2040 is lower by almost ten percentage points at 40% than in our Southeast Asia Energy Outlook - 2015 (IEA 2015)."



Source：IEA (2017), Southeast Asia Energy Outlook 2017

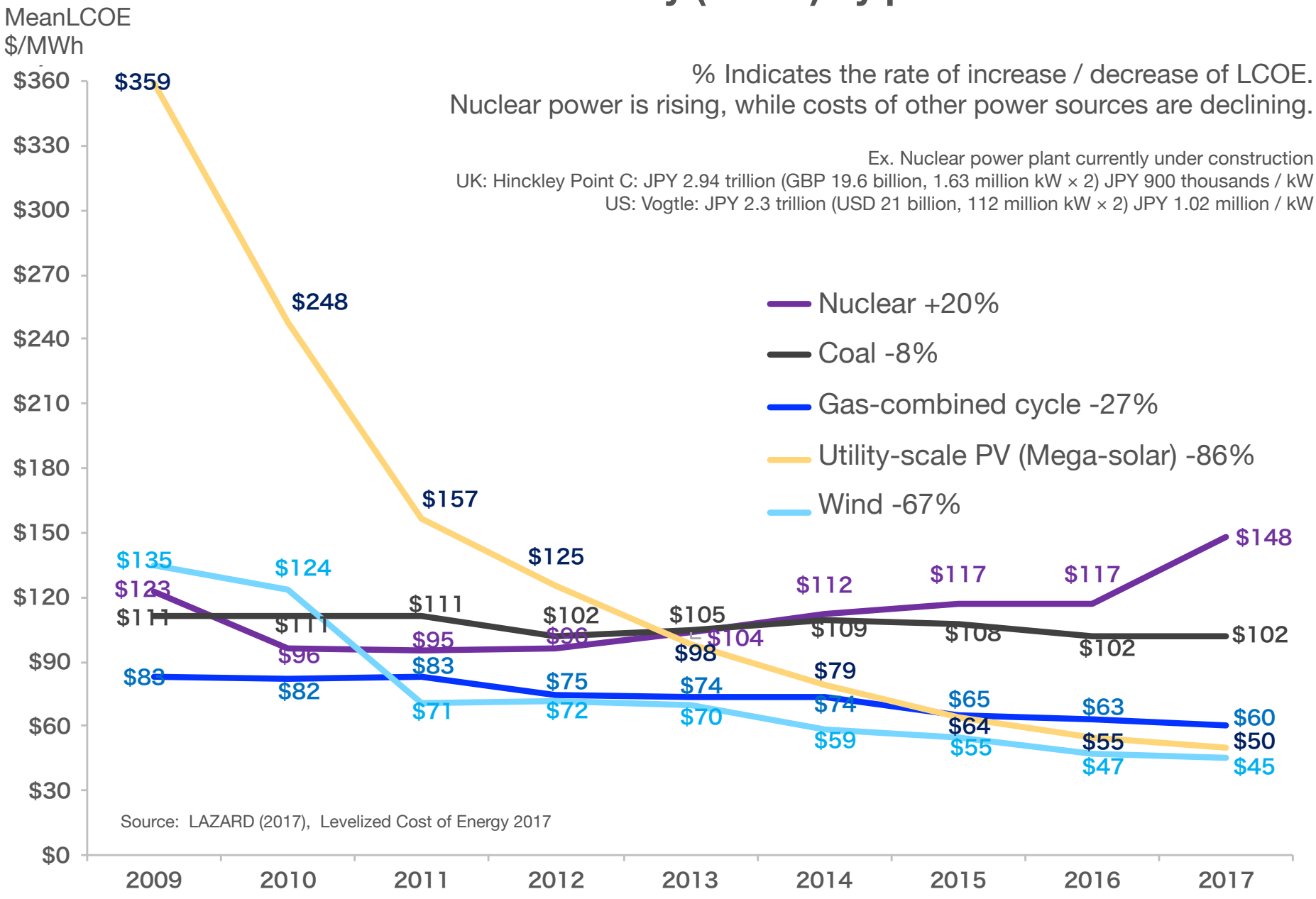
# Amount of CO2 emissions from different types of fossil-fired power plants

Even the most advanced coal plant emits more than double the CO2 amount of a LNG plant




source: Ministry of the Environment 「Working Group for Carbon Pricing」 2nd of June, 2017

# Levelized Cost of Electricity (LCOE) by power source

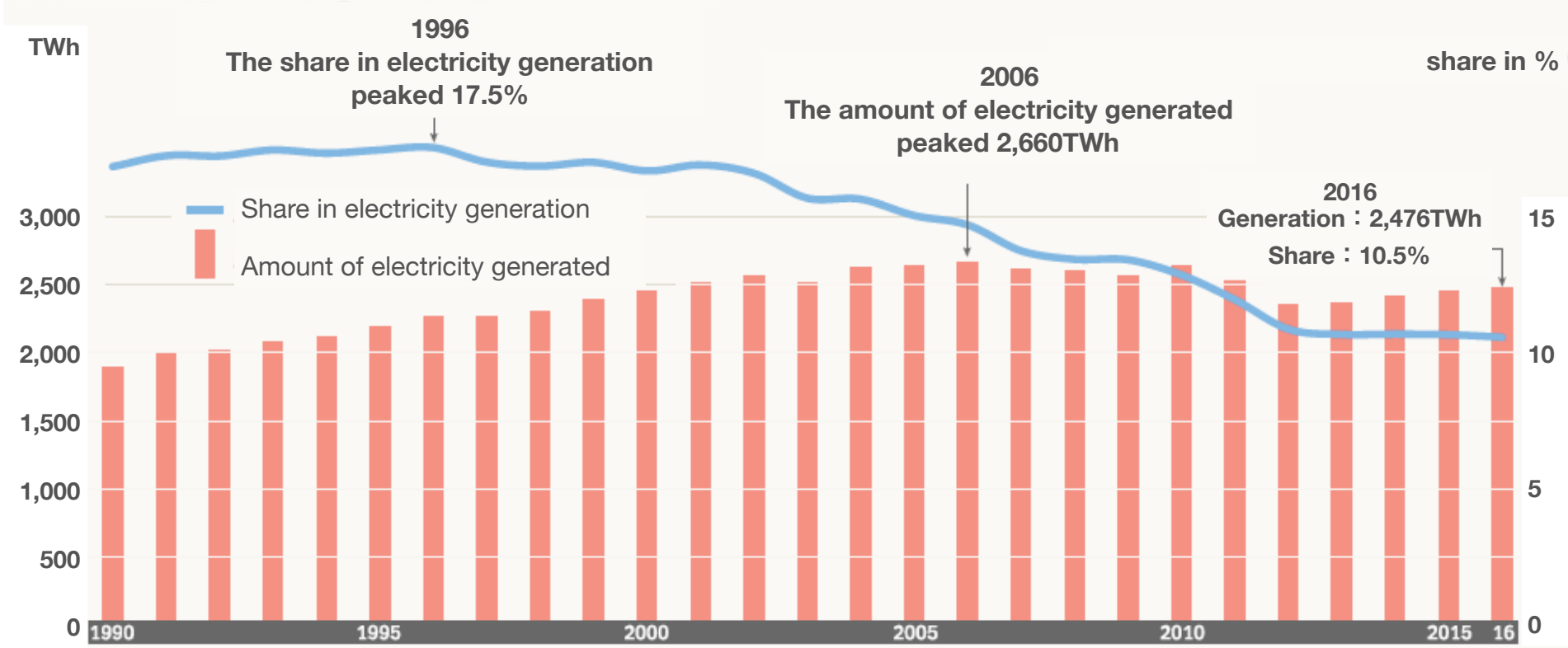


# Current status of nuclear power

## The amount of electricity generated from nuclear power in the world (1990-2016)

Unit: TWh (net) and share in generation (gross)

The share in electricity generation peaked in 1996, the amount of electricity generated peaked in 2006

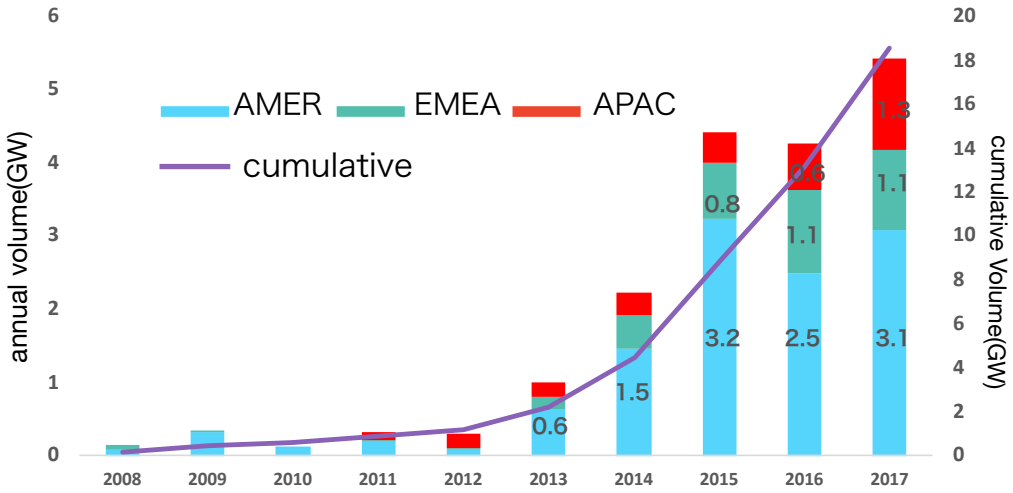




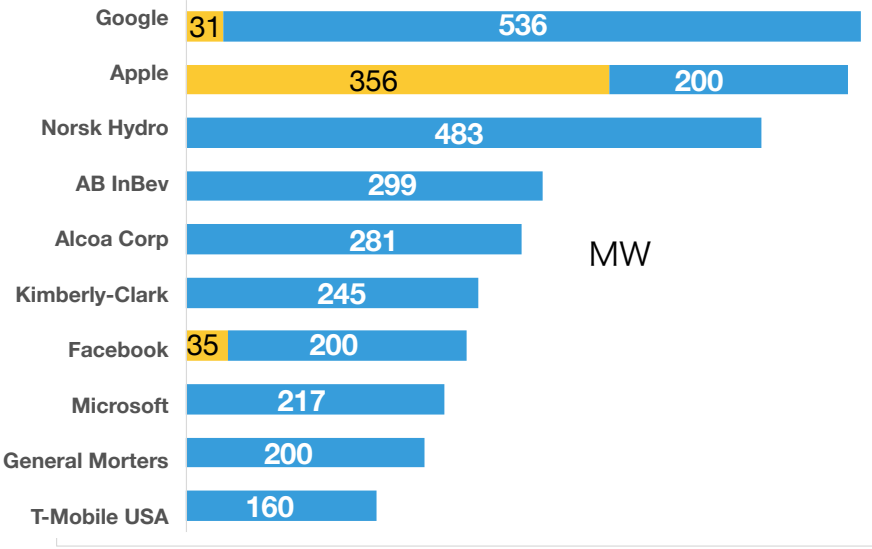

Source: WNISR (2017), World Nuclear Industry Status Report

# Business leads decarbonization

## Global corporate PPA volumes, by region



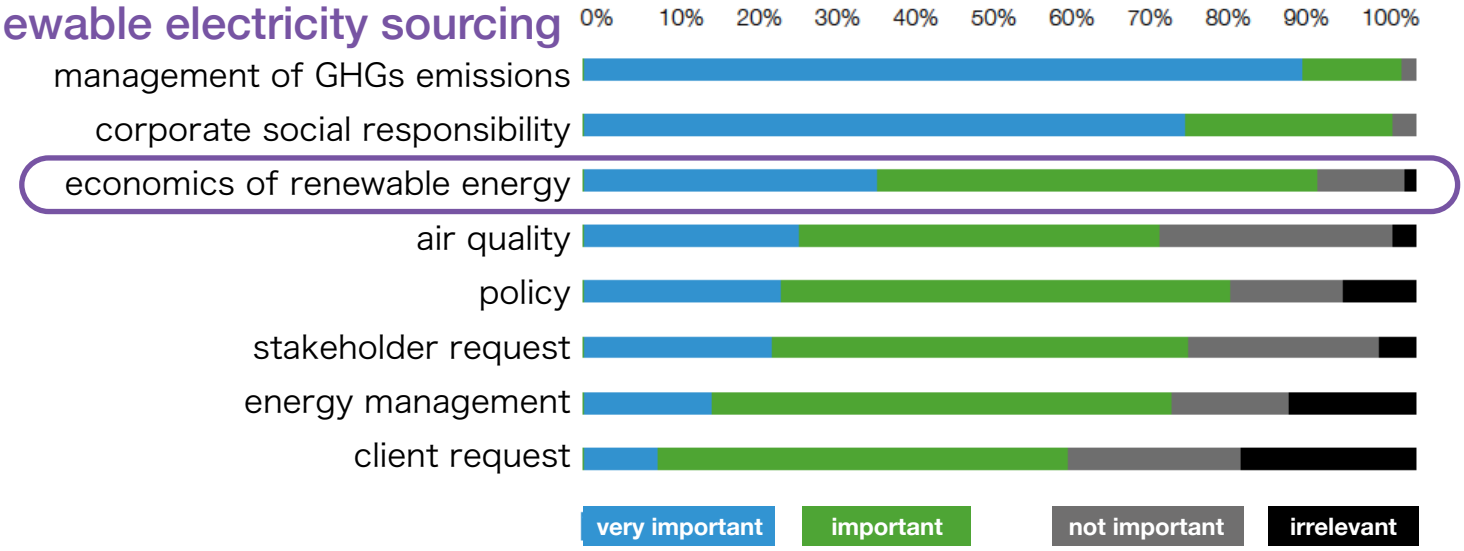

## Top corporate off takers, 2017




Source: Bloomberg New Energy Finance Note: Onsite PPAs not included. APAC number is an estimate. Pre-market reform Mexico PPAs are not included. These figures are subject to change and may be updated as more information is made available.

Questionnaire to member companies of RE 100

## Drivers for renewable electricity sourcing




Source: Climate Group/CDP (2018), RE100 Progress and Insights Report, January 2018

# Business sector is leading decarbonisation

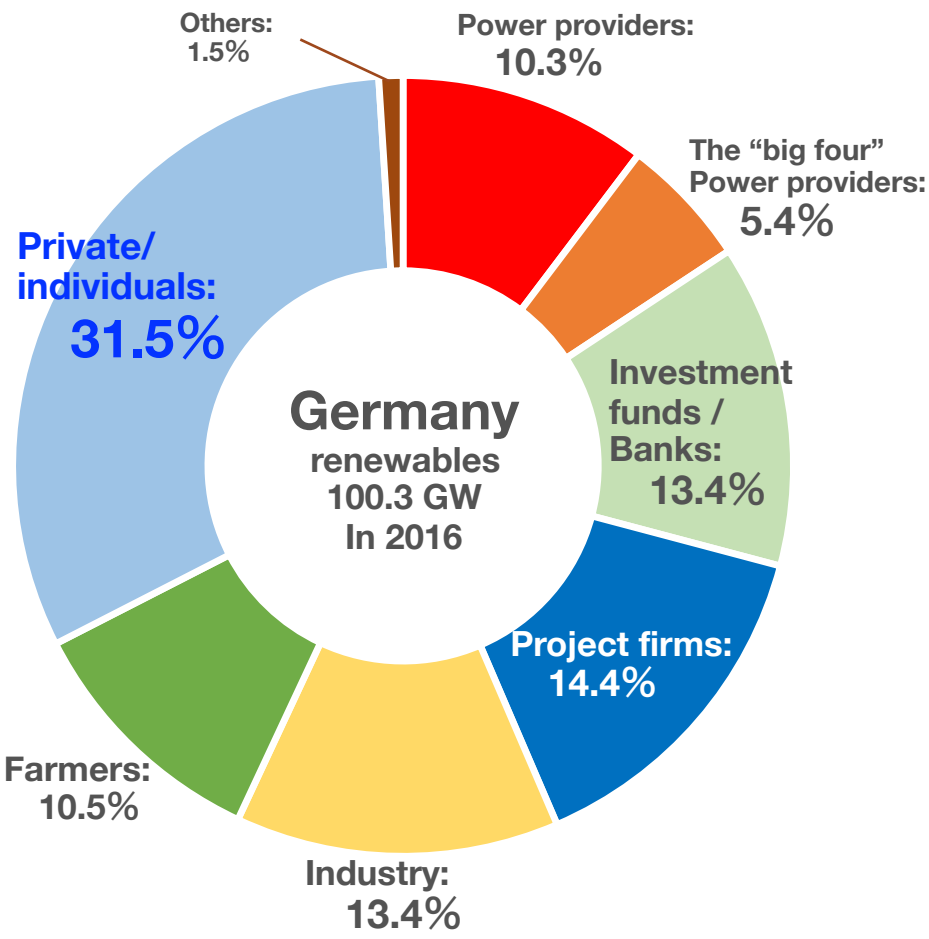
The “RE100” programme (in the UK, led by Climate Group and CDP) has 122 global companies as its members which aim to meet 100% of their electricity needs with renewables. From Japan, three companies; Ricoh, Sekisui House and ASKUL are participants.

Total electricity consumption of member companies amounts to 159 TWh (15.9 billion kWh). 51 TWh (5.1 billion kWh) of which is generated from renewable energy - that is more than the electricity consumption of Portugal (as of December 2017).


source：Study meeting on non-fossil value trading market, February 6, 2018, the material of CDP Japan etc.

# Support for Renewable energy: Expansion of activity by regional actors

## Ownership distribution of installed RE capacity for power production in Germany

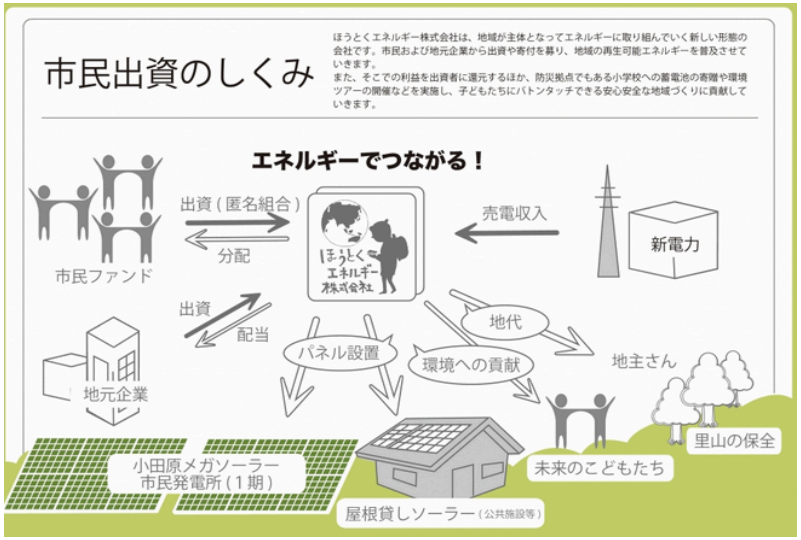



source: Renewable Energy Agency- Agentur für Erneuerbare Energien (2018)

Renewable energy is a resource rooted in the regions, and it is dispersed in each region. Therefore, efforts to expand the use of renewable energy in the regions are important.

In Japan, following the Great East Japan Great Earthquake in 2011, many power generation renewable energy-based projects have been created in local communities as well as many municipal power purchase producers.

In particular, the citizen-centered initiative called "community power" is not only for collecting funds for constructing renewable energy projects from citizens and returning electricity sale revenues to investors, but also to invest in and return to the community.




source: the Hotoku Energy website (2018) http://www.houtoku-energy.com/

# Renewable energy related assistance by the Japanese government

**The Government of Japan (GoJ) has provided more than USD 2 billion in total to support renewable energy related projects from 2012 to 2016.**

**Amount of support by the Japanese Government for renewables related projects for the last 5 years.**
**(Commitment base, unit: million USD)**

| | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|---|---|
| Amount of support | 44.33 | 565.983 | 655.369 | 203.773 | 619.029 | 2088.484 |

※Total amount of 232 cases of DAC CRS code, Energy Generation, renewable sources, code before 2014 is 230 cases.

**Projects for capacity building on geothermal**

The GoJ has organized and hosted a series of capacity building activities to provide opportunities for government officials from Africa, Latin America and Southeast Asia to introduce regulatory incentives of Japan and other countries to promote geothermal electricity generation through seminars and trainings. Government officials and experts from Kenya, Ethiopia, Djibouti, Ecuador, among others, have benefited from these capacity building opportunities on geothermal related topics such as “geothermal executives,” “geothermal resources engineering,” “bowling management.”

**Bolivia Laguna Colorada geothermal power station construction**

Project to build Laguna Colorada geothermal power station with 100,000 kW generation capacity. This project is the first geothermal project in the world on a highland of 5,000 meters above sea level.

**Kenya : Olkaria IV and V geothermal power generation project**

The GoJ supports a project of 140,000 kW geothermal power station construction in Olkaria geothermal area located in a volcano belt 75km north-west of the capital Nairobi.

**Energy efficiency improvement cooperation with Vietnam, Oman, Iran and others**

Cooperation for initiatives such as “saving energy national plan” including setting a national target for energy saving, adoption of energy manager qualification system, star-labelling scheme to identify good products with superior saving energy effects and suggestions for better management of energy consumption data, standardisation of high efficient electrical appliances and deployment, as well as measures to enlighten the public for energy savings.

Kenya :
Olkaria IV and V
geothermal power generation project

# Renewable energy related assistance by companies and NGOs

Japanese companies and organisations from the civil society (e.g. NGOs) also contribute to the country's efforts by providing important support activities to developing countries. Their activities include providing medical services, irrigation, agricultural supports as well as various assistance related to human rights, poverty, human-tracking and others. In recent years, focused efforts on renewable energy is gaining wider ground from a point of view of climate change and UN's Sustainable Development Goals (SDGs).


**Panasonic : Solar-lantern project**

In cooperation with NPO/NGO and international organisations, the project is to provide solar- lanterns charged with solar power to developing countries for free. Starting from Myanmar in 2013, more than 100,000 (102,716) solar lanterns were offered for the last 5 years to countries in Asia, Africa and north-central America, in total 30 countries and 131 organisations. In addition, Panasonic has been giving a set of solar panels with a storage and a management system all on board of a transportation container, called "life-innovation container".

source: Panasonic http://panasonic.net/sustainability/jp/lantern/trajectory/

**WASSHA : "Electricity by scale" service**

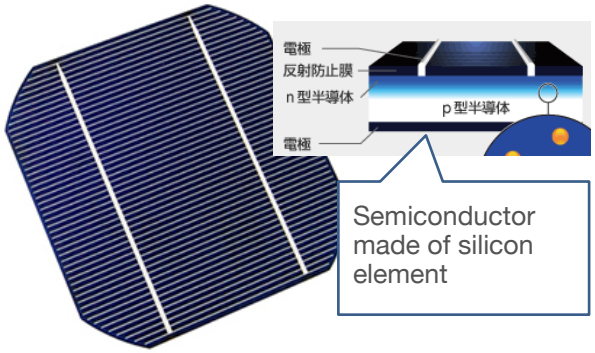
Combining remote control technology to send electricity as a packet just like mobile data transmission and mobile money technology (remittances between mobile phones) by remotely operate a digital rooter via internet, a system was developed to provide a unit of electricity corresponding to an amount paid by mobile money. The service is provided in villages yet to be electrified in Tanzania and others. Basic electrical appliances are rent out and the system enables a consumer to pay for its own electricity to be consumed.

source: WASSHA http://wassha.com/index_en.php

# Japan's technology development

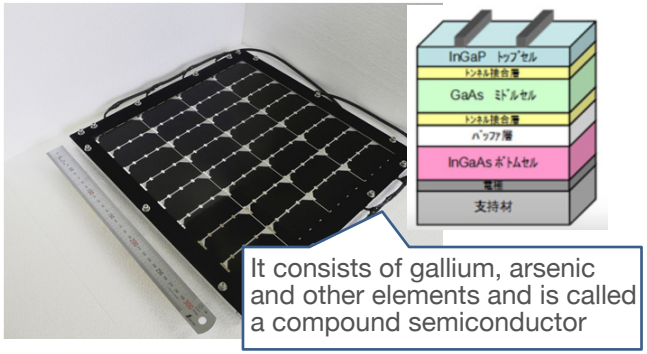
**In crystalline silicon-based solar cells, Japanese company achieved the highest conversion efficiency of 26.6% in a cell basis and 24.4% in a unit module basis.**

PV of today : crystalline silicon-based PV



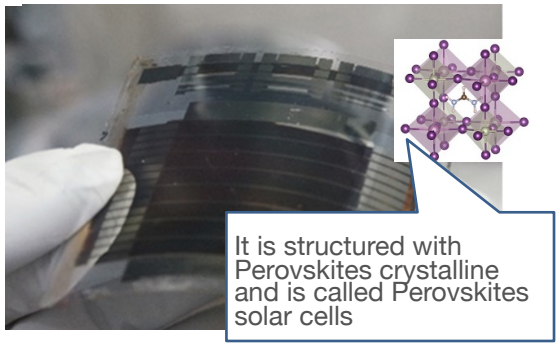

Achieved the conversion efficiency of 24.4% (Kaneka corp)

PV of future : Compound semiconductor based solar cells




Achieved the conversion efficiency of 31.17% (Sharp Corp)

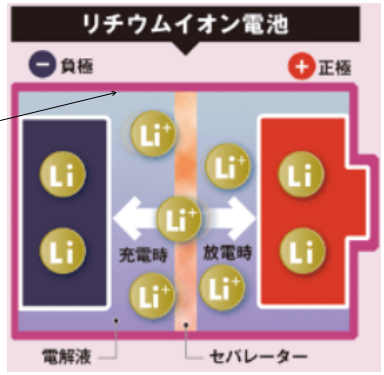
PV of future : "Printable" Perovskites PV




Achieved the conversion efficiency of 21.6% within three years. It can be printed to be a film-like form

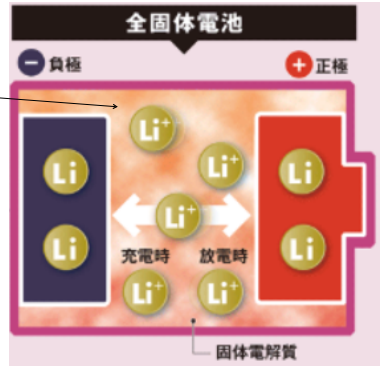
**In the area of storage, "all-solid battery" with much longer mileage and quantum safety improvement was developed by a Japanese university (Tokyo Institute of Technology). Commercial application is underway with a manufacturer.**

Lithium battery of today




Ionised material between electrodes is organic solvent and is flammable with safety risk of potential leakage. (However, its production process is established and is deployed in current EV)

Future of "all-solid battery"




Safety is improved by replacing an ionised part with solid material. Tokyo institute of Technology discovered a material with similar ion conductivity. Toyota aims at its commercialisation in 2020's.

Merits: **double energy intensity and triple output intensity**

1. **高い安全性**
   有機系電解液は揮発して発火、爆発する恐れがあるが、固体ならばそのリスクが低い
2. **設計自由度が増す**
   リチウムイオンが意図しない電極に流れないのでセル内での多層化や直並列の設計が容易となる
3. **広い動作温度域**
   リチウムイオン電池は高温や低温で出力が低下する。全固体電池なら広い温度域で性能が安定

http://business.nikkeibp.co.jp/atcl/report/15/226265/051700123/?P=2

# References


**Global Trend and Japan**

**1. The global trend toward energy transition**

1) Global Solar PV: BP(2017), Statistical Review of World Energy, https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html, Annual installation capacity of 2017, BNEF(2018), Insights, 2018. Global Wind Power: Global Wind Energy Council (2018), http://gwec.net/global-figures/graphs/

2) Cost reduction of renewables: IRENA(2018), Renewable Power Generation Costs in 2017, http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf

3) Prediction to 2040: IEA(2017), World Energy Outlook 2017, https://www.iea.org/Textbase/npsum/weo2017SUM.pdf : BNEF(2017), https://about.bnef.com/new-energy-outlook/

4) Decoupling: IEA(2016), Decoupling of global emissions and economic growth confirmed, https://www.iea.org/newsroom/news/2016/march/decoupling-of-global-emissions-and-economic-growth-confirmed.html, Investments for realizing 2 degrees by 2050：IRENA(2017), Perspectives for the Energy Transition - Investment needs for a low-carbon energy system, http://www.irena.org/publications/2017/Mar/Perspectives-for-the-energy-transition-Investment-needs-for-a-low-carbon-energy-system

**2. World shifting rapidly toward a decarbonized society**

1) Powering Past Coal Alliance: UK Government(2017), Powering Past Coal Alliance: DECLARATION, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/660041/powering-past-coal-alliance.pdf

2) Norway Government Pension Fund Global: Norwegian Embassy to Japan, https://www.norway.no/ja/japan/norway-japan/news-events/news/5/ , “Engagement” : California Public Employees’ Retirement System CalPERS(2017), the importance of Corporate Engagement on Climate Change, https://www.calpers.ca.gov/docs/corporate-engagement-climate-change.pdf

3) Corporate procurement of renewables: BNEF(2018), Corporations Purchased Record Amounts of Clean Power in 2017, https://about.bnef.com/blog/corporations-purchased-record-amounts-of-clean-power-in-2017/ , the Climate Group (2018), Approaching a New Tipping Point - How corporate users are redefining global electricity markets, https://www.theclimategroup.org/news/approaching-tipping-point

**Japan in the world in terms of energy**

**1. Slow shift to decarbonization**

1) Solar PV in Japan: RTS (2018)

2) Cost reduction of renewables: IRENA(2018), Renewable Power Generation Costs in 2017, http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf

4) Energy efficiency/saving status: IEA(2016), Energy Policies of IEA Countries JAPAN 2016, https://www.iea.org/publications/freepublications/publication/EnergyPoliciesofIEACountriesJapanReview2016Japaneseversion.pdf

6) Decreased role of nuclear power: World Nuclear Association (2017), World Nuclear Performance Report, http://world-nuclear.org/getmedia/b392d1cd-f7d2-4d54-9355-9a65f71a3419/world-nuclear-performance-report-2017.pdf.aspx, World Nuclear Industry Status Report 2017, https://www.worldnuclearreport.org/

Cost of nucear power: LAZARD(2017), Levelized Cost of Energy 2017, https://www.lazard.com/perspective/levelized-cost-of-energy-2017/、US EIA(2017), Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook,

**2. Rulemaking of green business without Japan**

1) the Climate Group (2018), Approaching a New Tipping Point - How corporate users are redefining global electricity markets, https://www.theclimategroup.org/news/approaching-tipping-point, Apple(2017), Supplier Clean Energy Program Update, https://www.apple.com/environment/pdf/Apple_Supplier_Clean_Energy_Program_Update_April_2017.pdf, Walmart (2017) Project Gigatone, https://www.walmartsustainabilityhub.com/project-gigaton