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Accelerated Renewables Expansion in Japan

Prospects for renewables in an interconnected system

13 December 2019

Fraunhofer ISI + REI, COP25 Side Event, Madrid

Mika Ohbayashi, Director, Renewable Energy Institute

Global Energy Transformation

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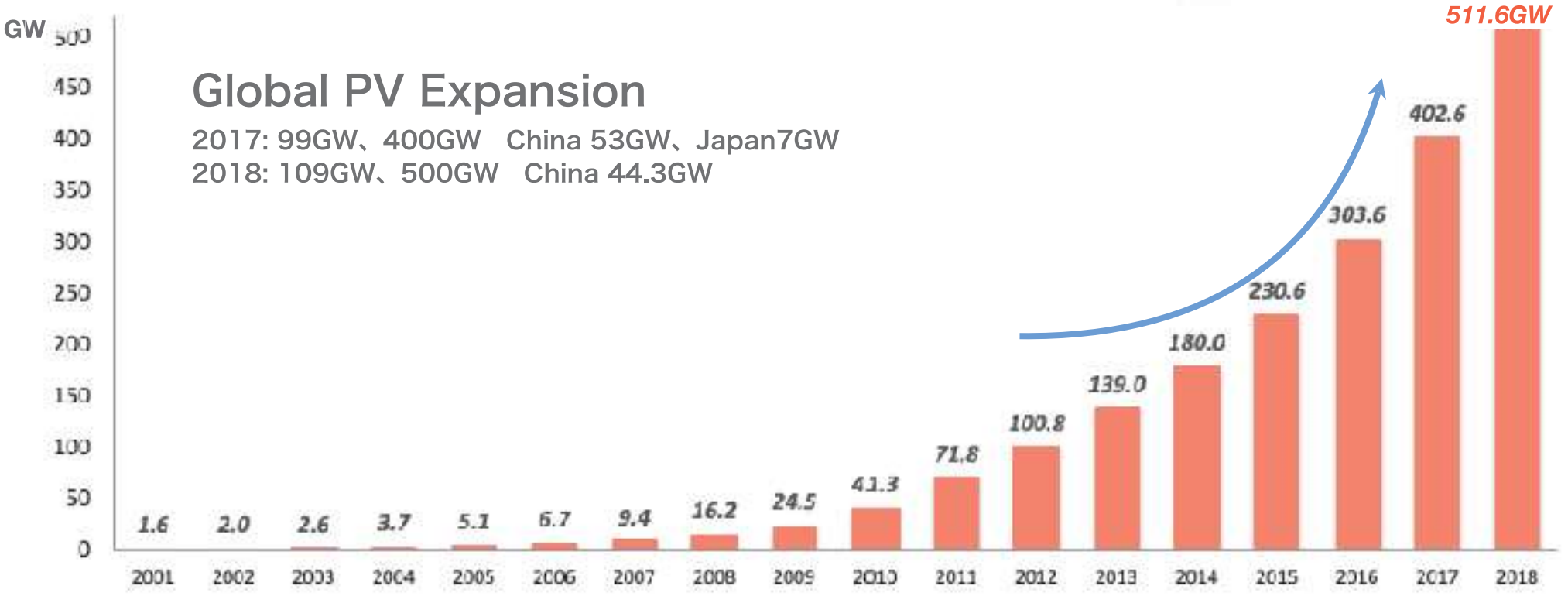
Global PV Expansion

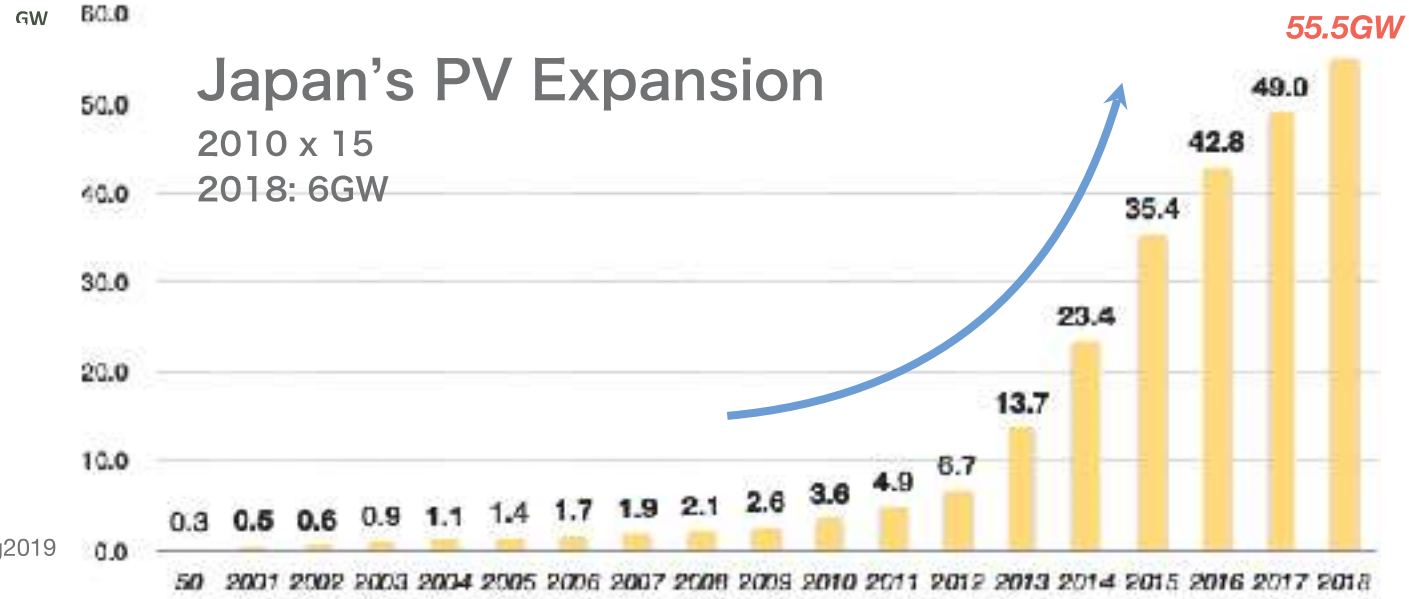
2017: 99GW、400GW　China 53GW、Japan7GW
2018: 109GW、500GW　China 44.3GW



World is changing
- **solar x 330 from 2001 reached 511GW**

Japan's PV Expansion

2010 x 15
2018: 6GW



source: BP Statical Review of World Energy 2018, Bloomberg2019

Global Energy Transformation

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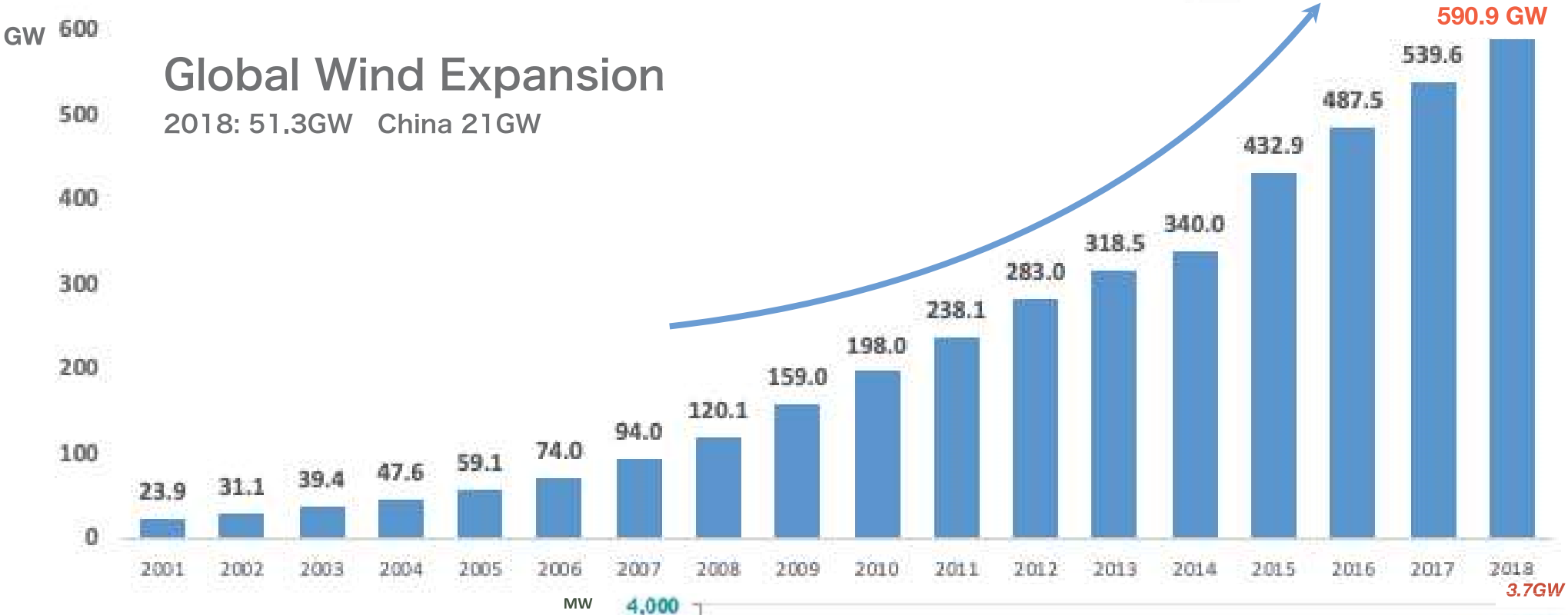
Global Wind Expansion

2018: 51.3GW　China 21GW



World is changing

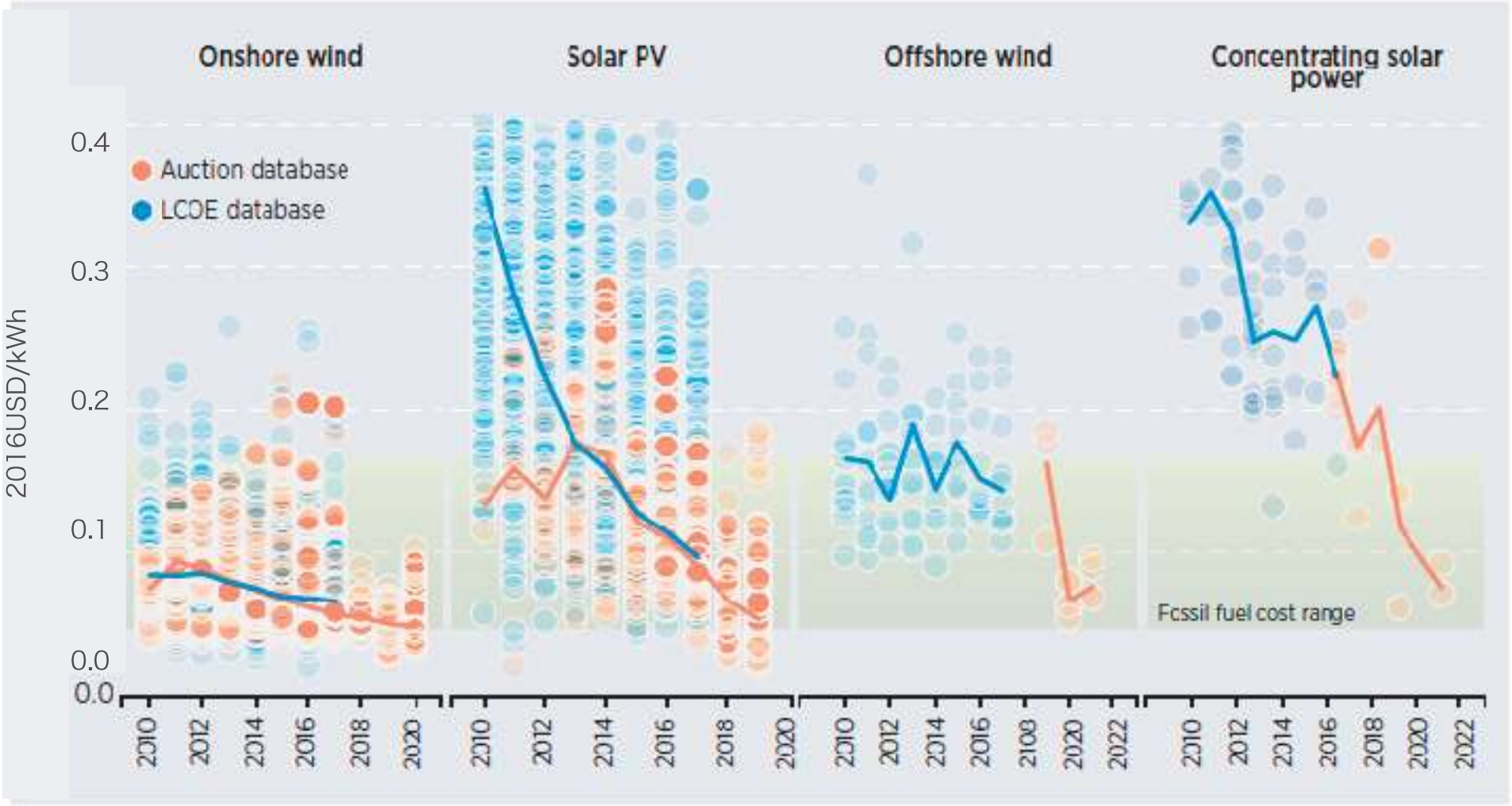
- wind x 25 from 2001 reached 590GW

source: Global Wind Energy Councilより自然エネルギー財団作成

Global Energy Transformation

RES becoming cheapest energy sources

The levelised cost of electricity for projects and global weighted average values for CSP, solar PV, onshore and offshore wind, 2010-2020



Source: IRENA Renewable Cost Database and Auctions Database.

Note: Each circle represents an 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.

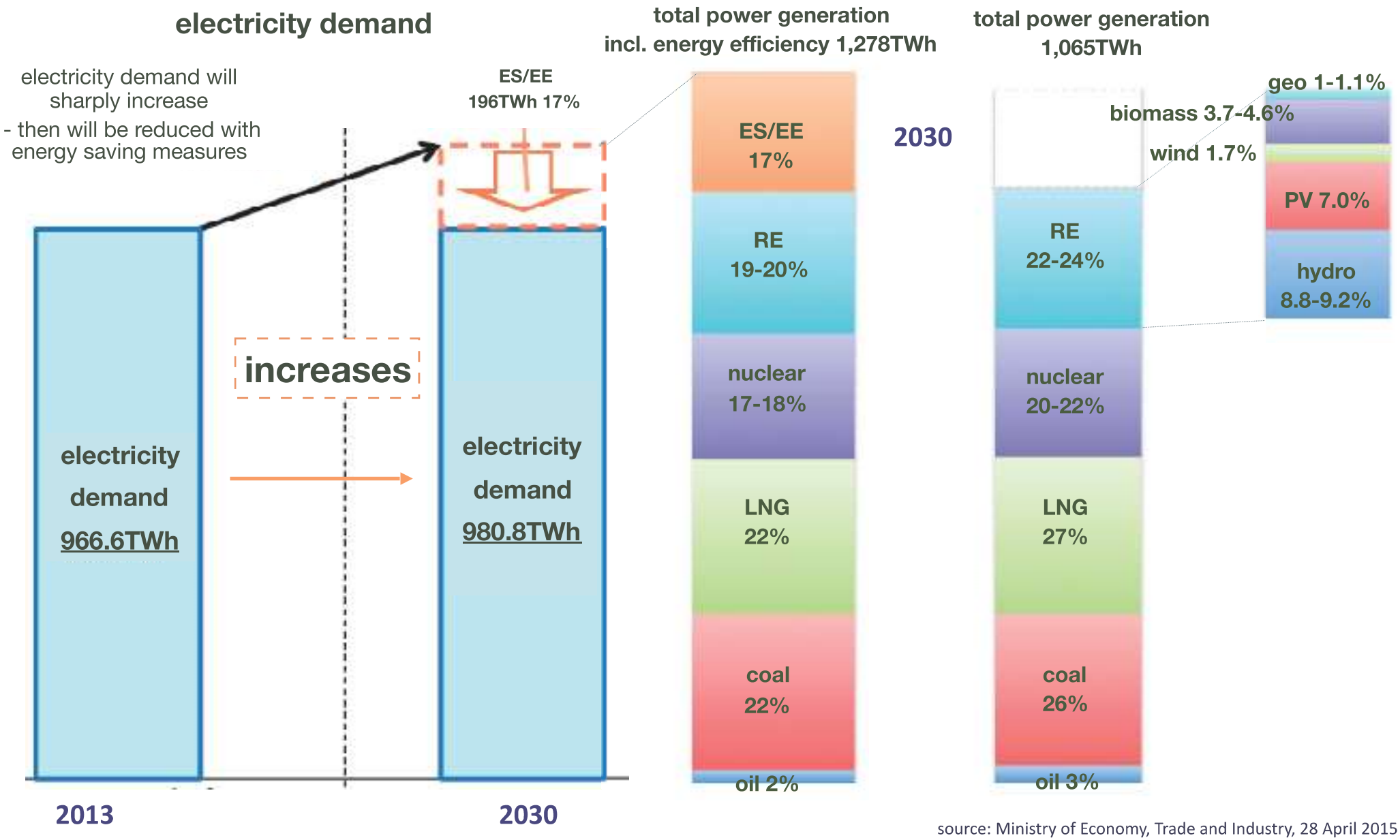
Renewable targets of countries/regions

countries/ regions	RE electricity targets (2050 is simulation) mid term	2050	reduction targets in 2030 (com. to 90)	reduction targets in 2050 (com. to 90)	target for coal power
GERMANY	65% by 2030 (cabinet agreement in 2018)	at least 80%	55% by 2035	80-95%	zero 2038
UK	30% by 2020		57% by 2032	at least 80%	zero 2025
FRANCE	40% by 2030		40%	75%	zero 2022
SPAIN	74% by 2030	100%	20% by 2030	100% by 2050	zero 2030
EU	55-60% in 2030 (32% in final energy consump.)	at least 80-97%	~~40%~~ at least 50% towards 55%	80-95%	
USA	CA 50% by 2030 Hawaii 70% by 2040	CA/Hawaii 100% by 2045	26-28% (from2005)	at least 80% (from 2005)	10-33% in all fossil fuel
Japan	22-24% by 2030		18%/26% (90/16)	at least 80% (from year ?)	26% in 2030 (56% in all fossil)

source: from each countries policies

Japan: energy transformation

Japan's electricity mix in 2030: gas 27%, coal 26%, oil 3%, nuclear 20-22%, renewables 22-24%
GHGs emission reduction : 26% by 2030 from 2013 level = 18% reduction from 1990 level

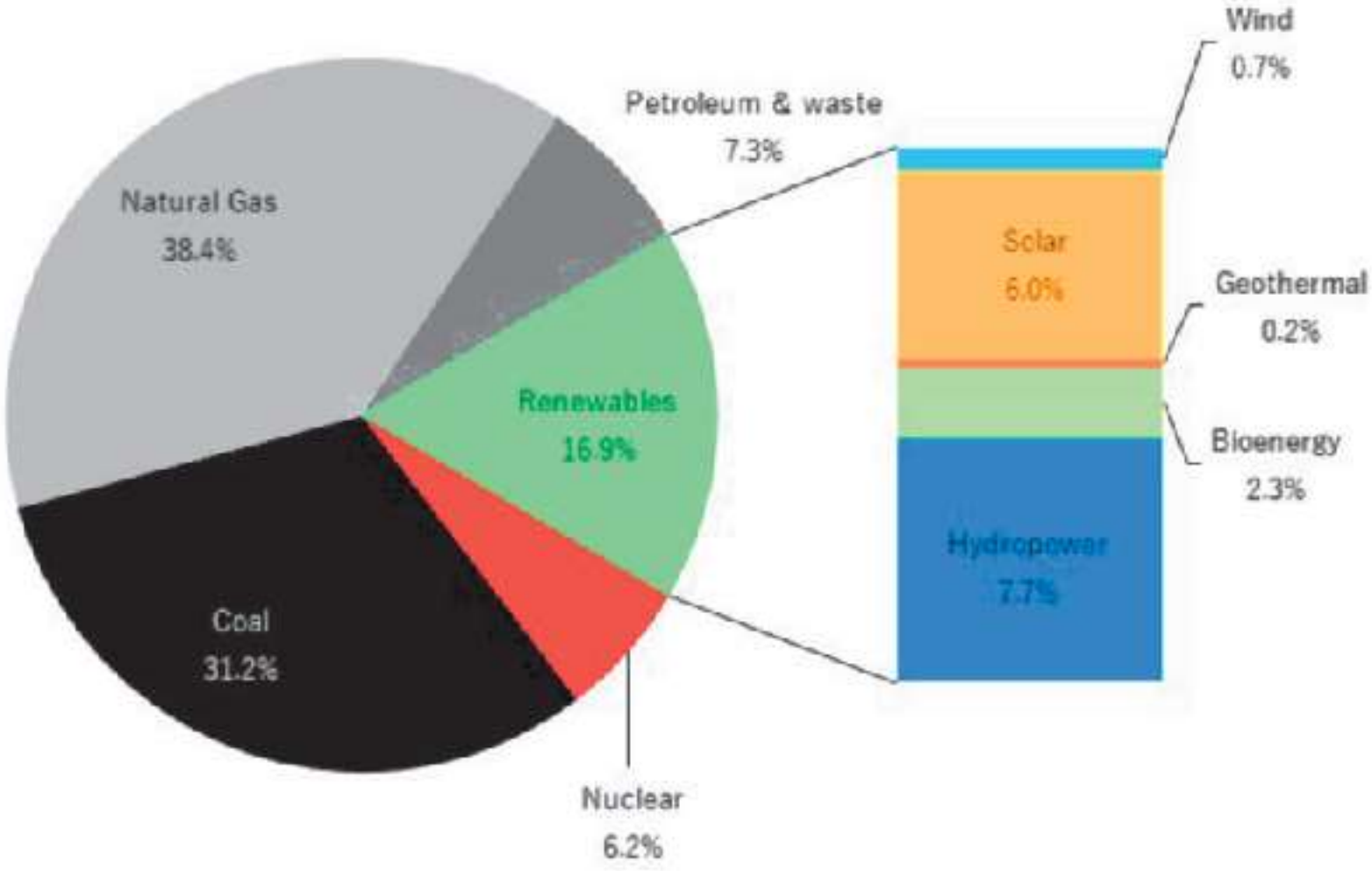


source: Ministry of Economy, Trade and Industry, 28 April 2015

Japan: energy transformation is now

Electricity Generation Mix FY 2018 (preliminary) as of 25 November 2019

RES % in electricity 16.9% (FY'18)

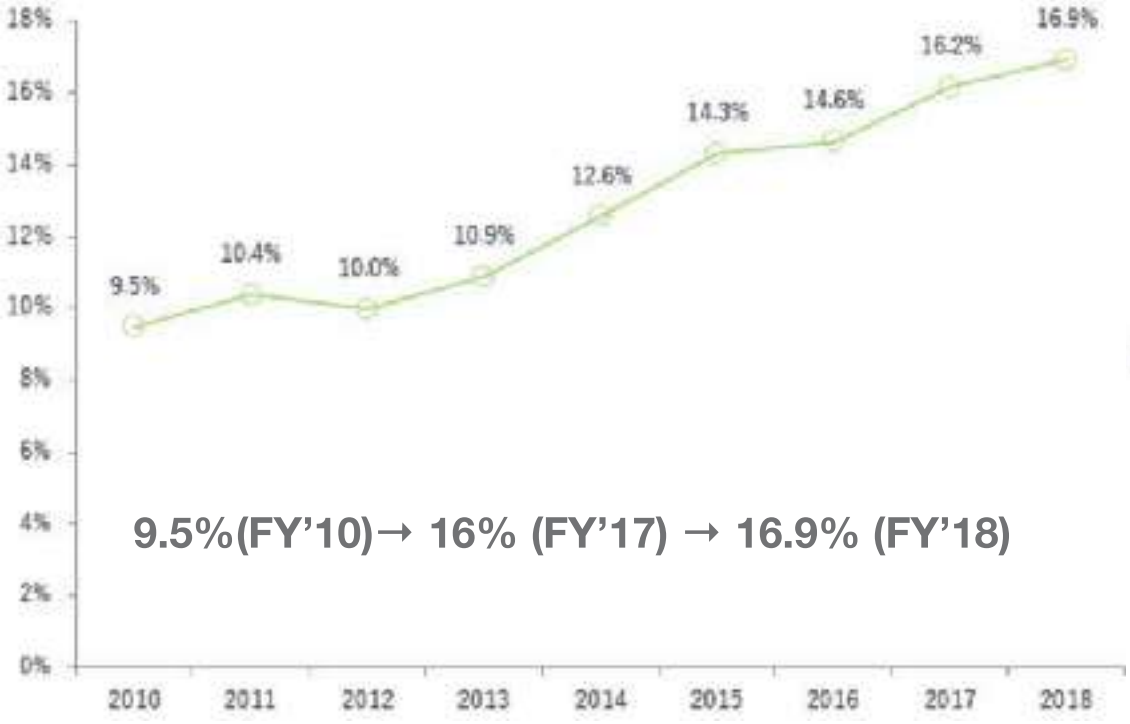


Source: REI's website - original data from METI/ANRE, Nov 2019 https://www.enecho.meti.go.jp/statistics/total_energy/

Japan: energy transformation is now

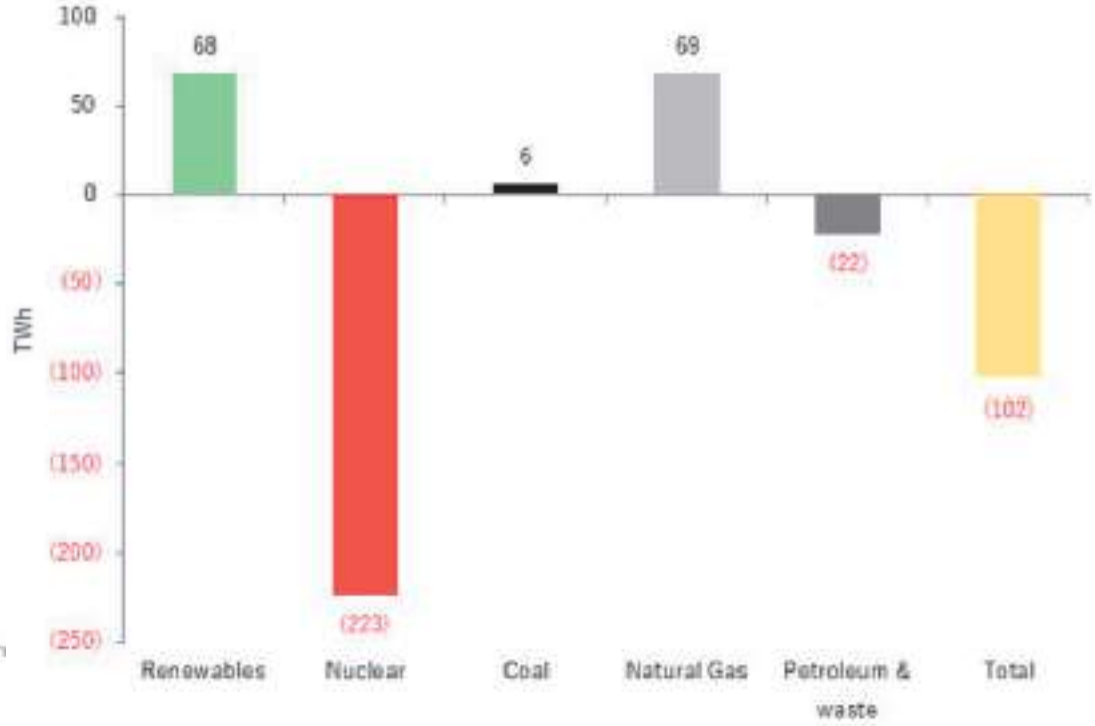
Renewables electricity grow from 9.5% to 17% in 8 years.

change in elec.generation from FY2010 to FY2018



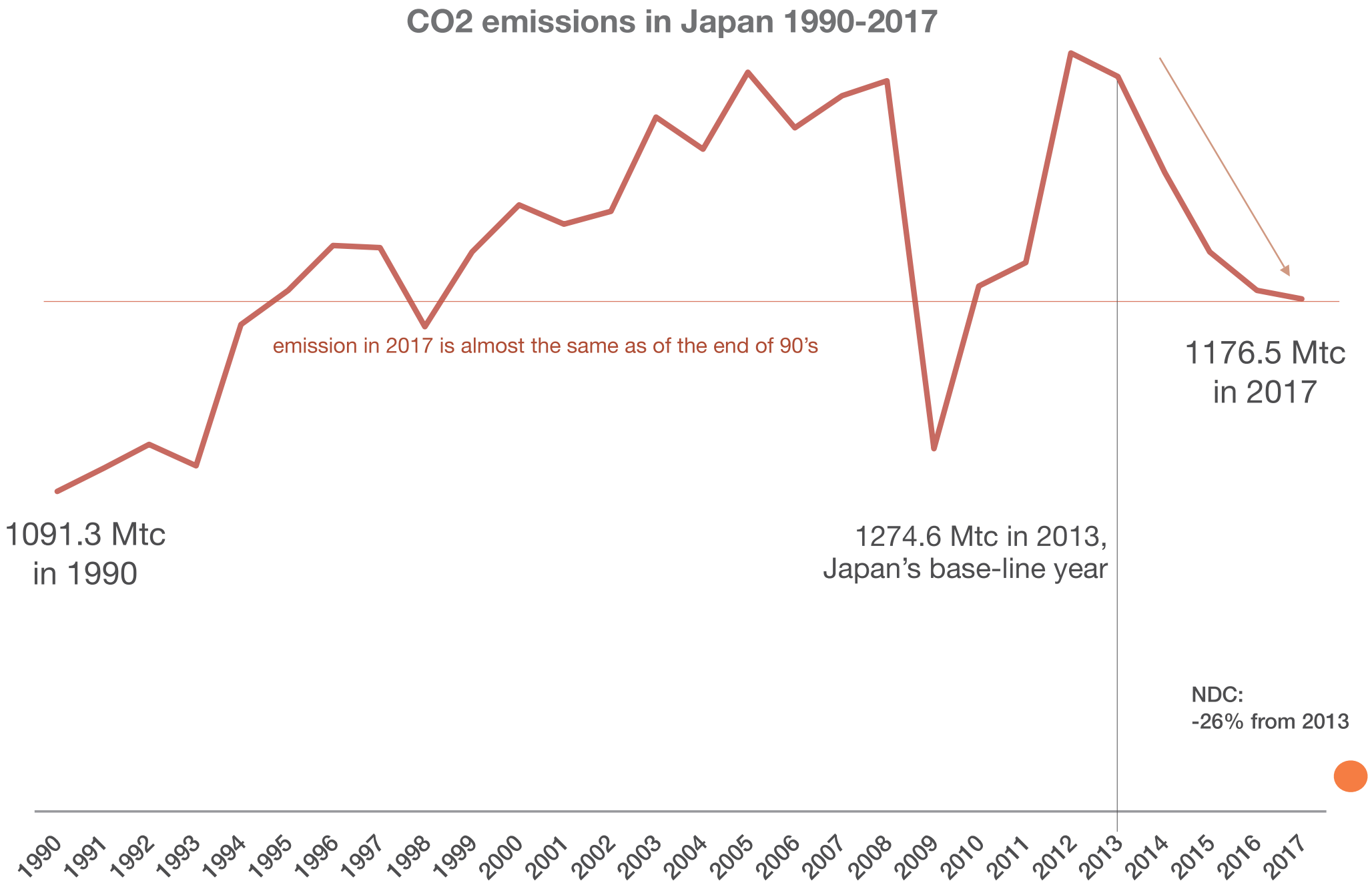
9.5%(FY'10)→ 16% (FY'17) → 16.9% (FY'18)

change in elec.generation FY2010 vs FY2018



Source: REI's website - original data from METI/ANRE, Nov 2019 https://www.enecho.meti.go.jp/statistics/total_energy/

Japan: energy transformation is now



Source: BP statistical review of world energy 2018

Japan: energy transformation is now?

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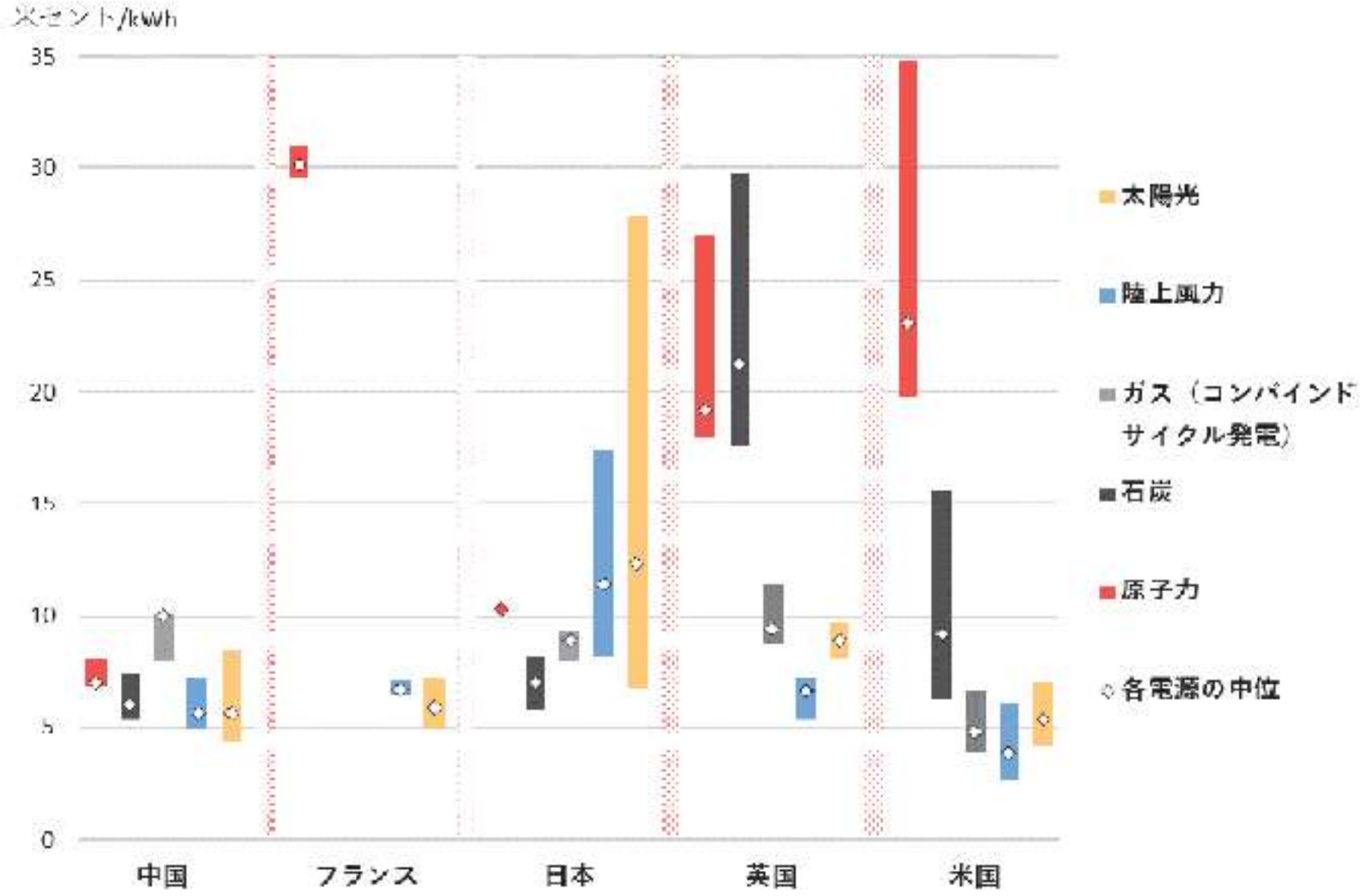
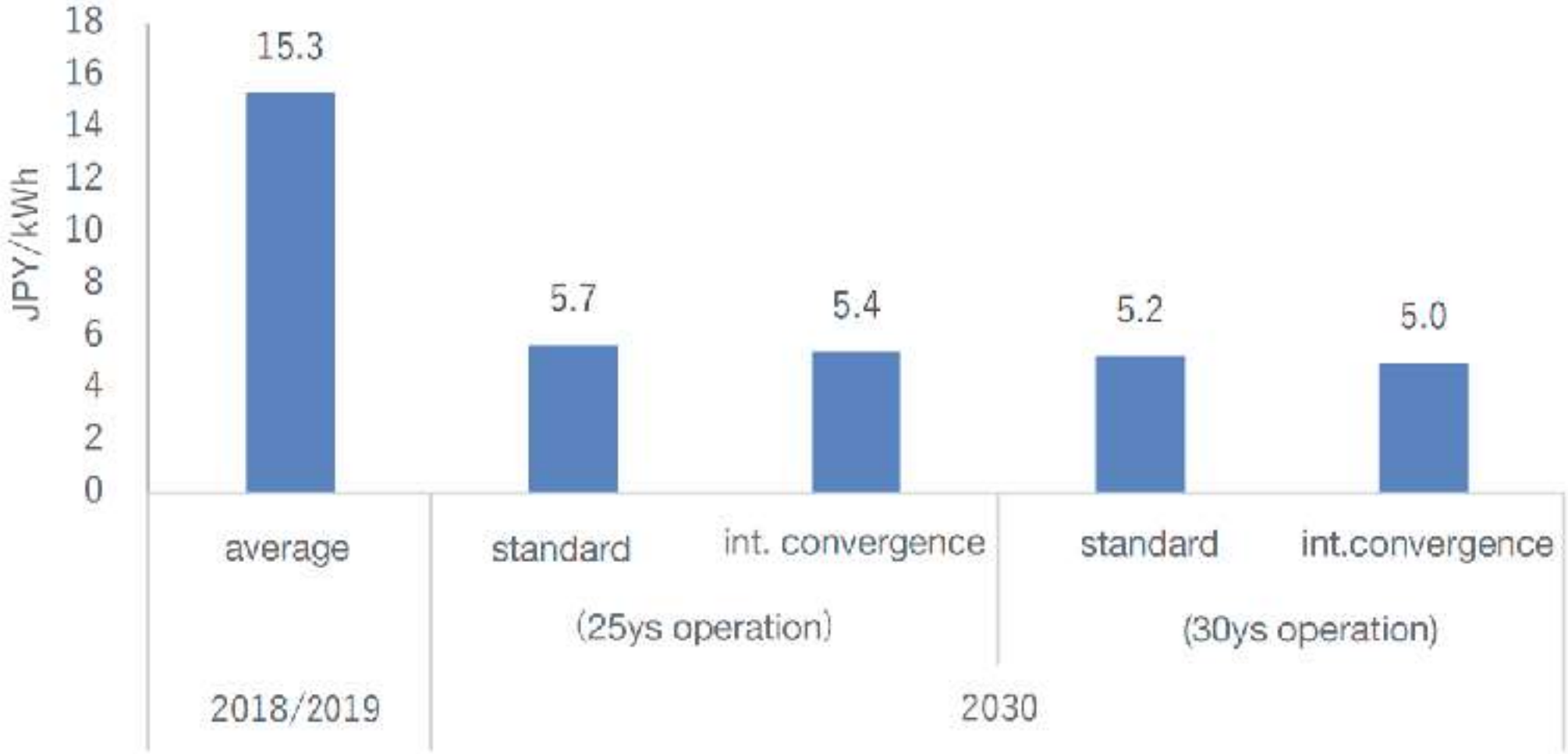
LCOE of different power sources（Q42018, new)



※廃炉と廃棄物処分のコストは含まない

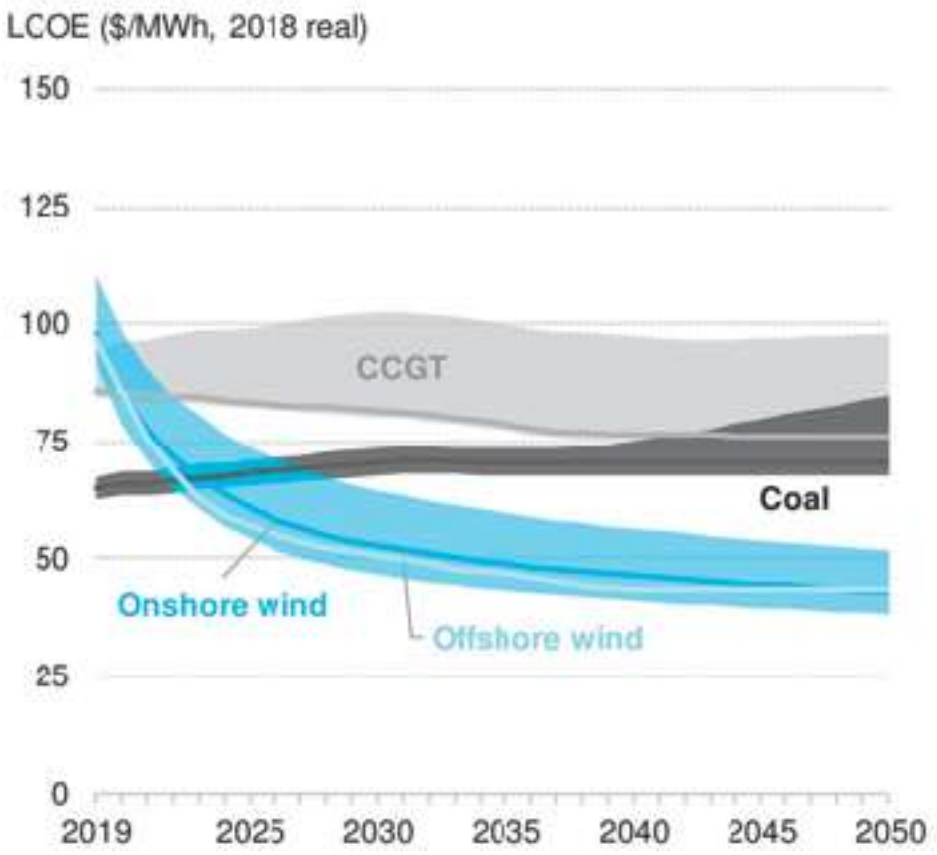
出典：BNEFの資料をもとに自然エネルギー財団作成


JPY/kWh
18
16
14
12
10
8
6
4
2
0
15.3
5.7
5.4
5.2
5.0
average
standard
int. convergence
standard
int.convergence
(25ys operation)
(30ys operation)
2018/2019
2030

Japan: energy transformation is now

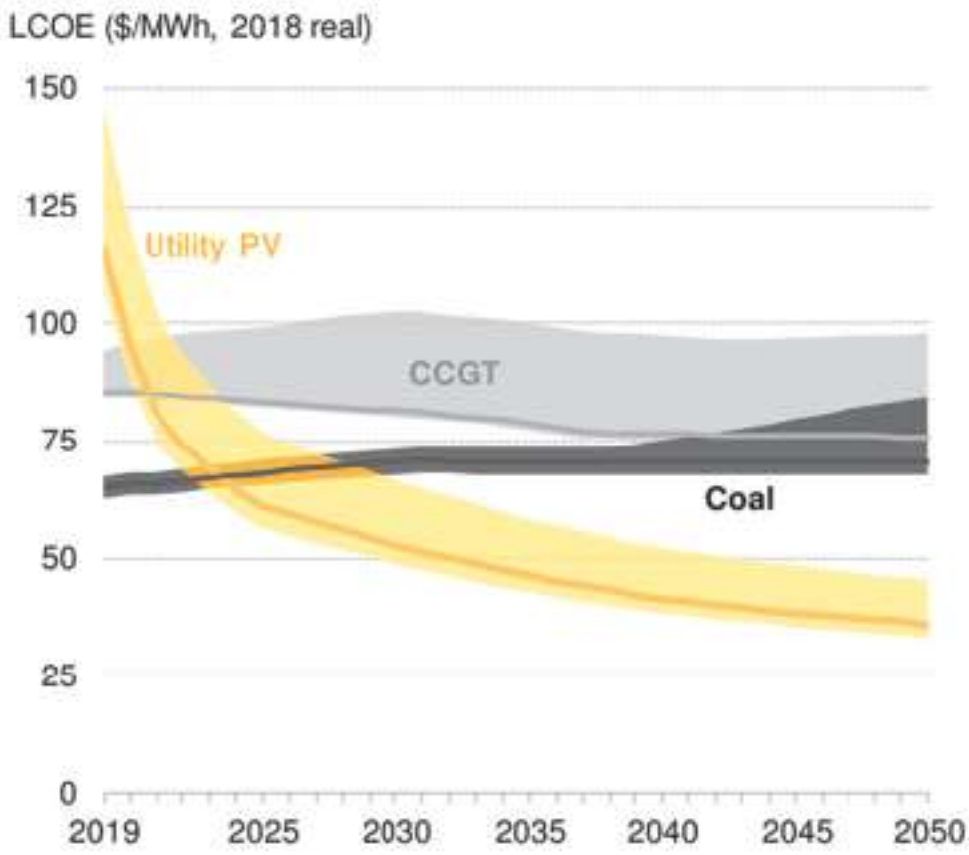
BNEF estimates VREs would be the cheapest source of new electricity in early 20's. Onshore wind would be cheaper than new fossils in early 20's.

Wind vs. coal and CCGT



Source: BloombergNEF

Utility-scale PV vs. coal and CCGT



Source: BloombergNEF

Note. All LCOE calculations are unsubsidized. The range of the LCOE represents a range of capacity factors. Our offshore wind LCOE forecast is global. For thermal plants, the upper bound reflects realized capacity factors from our NEO dispatch analysis, and the lower bound reflects a standard capacity factors assumption for a new plant in this market.

source: Bloomberg NEF, 2019

Japan: energy transformation is now

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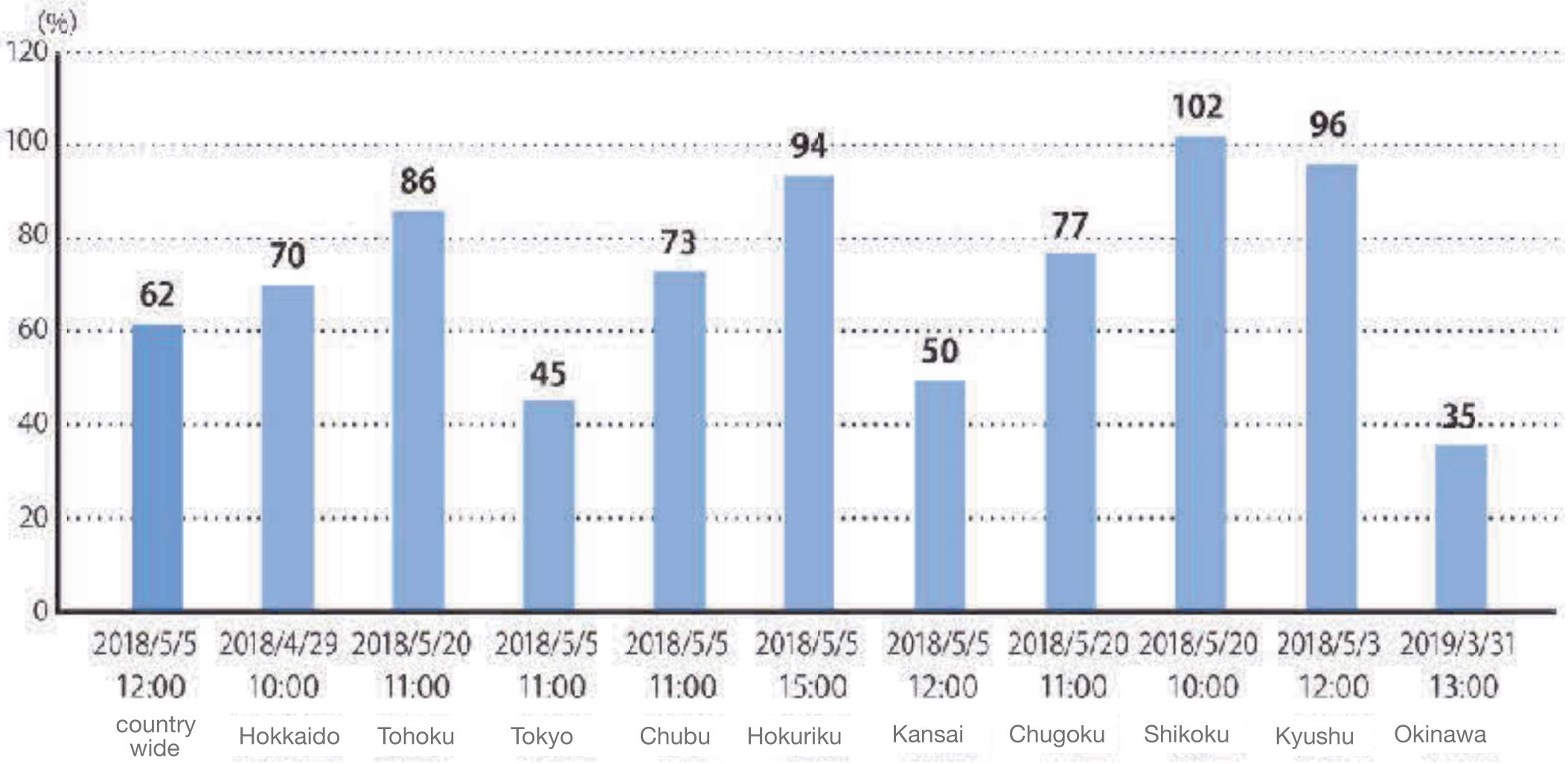
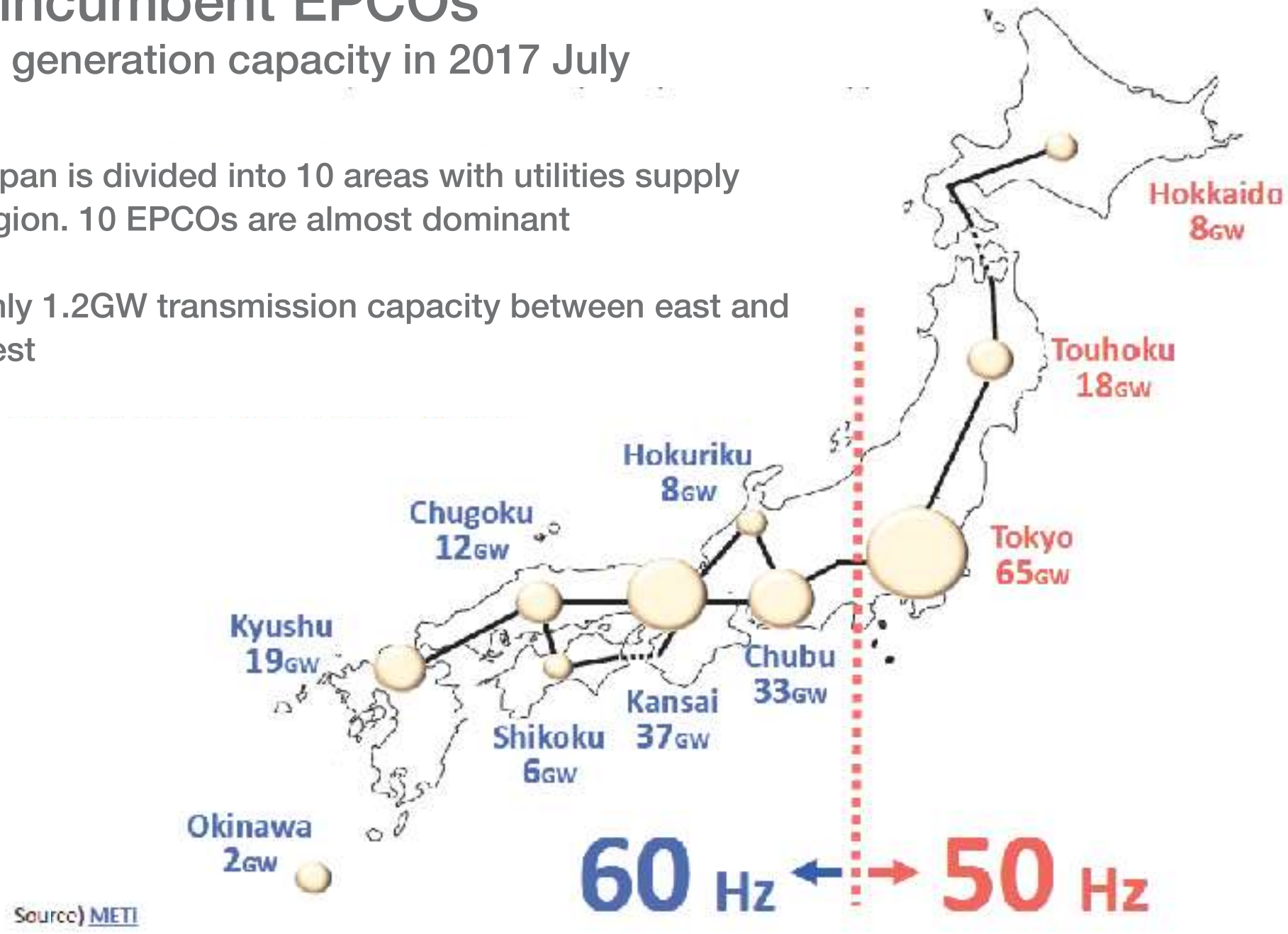
Japan's 10 electricity market areas' maximum RES integration %, day and time in FY2018



Japan: flexibility is needed

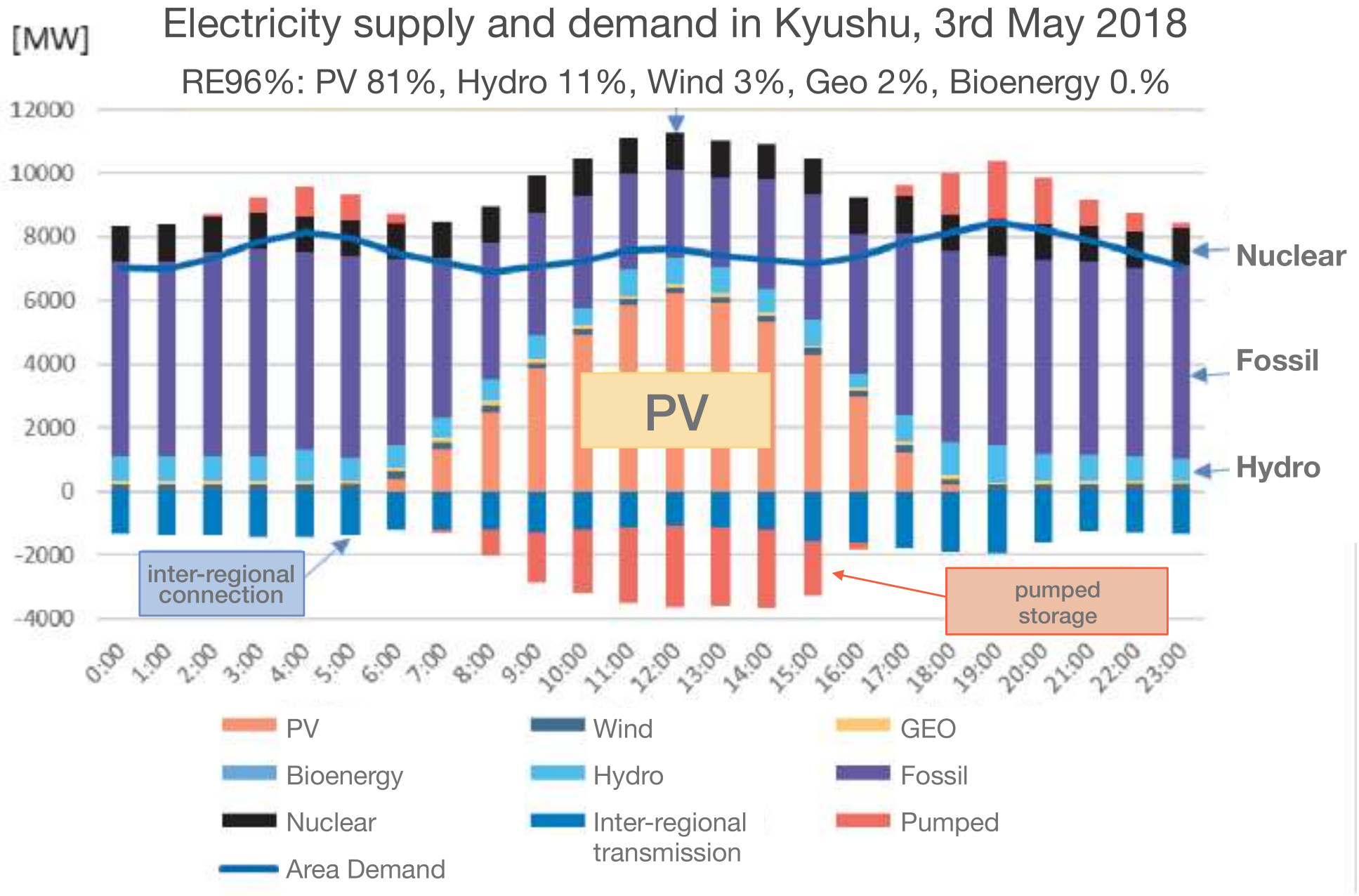
10 incumbent EPCOs
with generation capacity in 2017 July

- Japan is divided into 10 areas with utilities supply region. 10 EPCOs are almost dominant
- Only 1.2GW transmission capacity between east and west



Source) METI

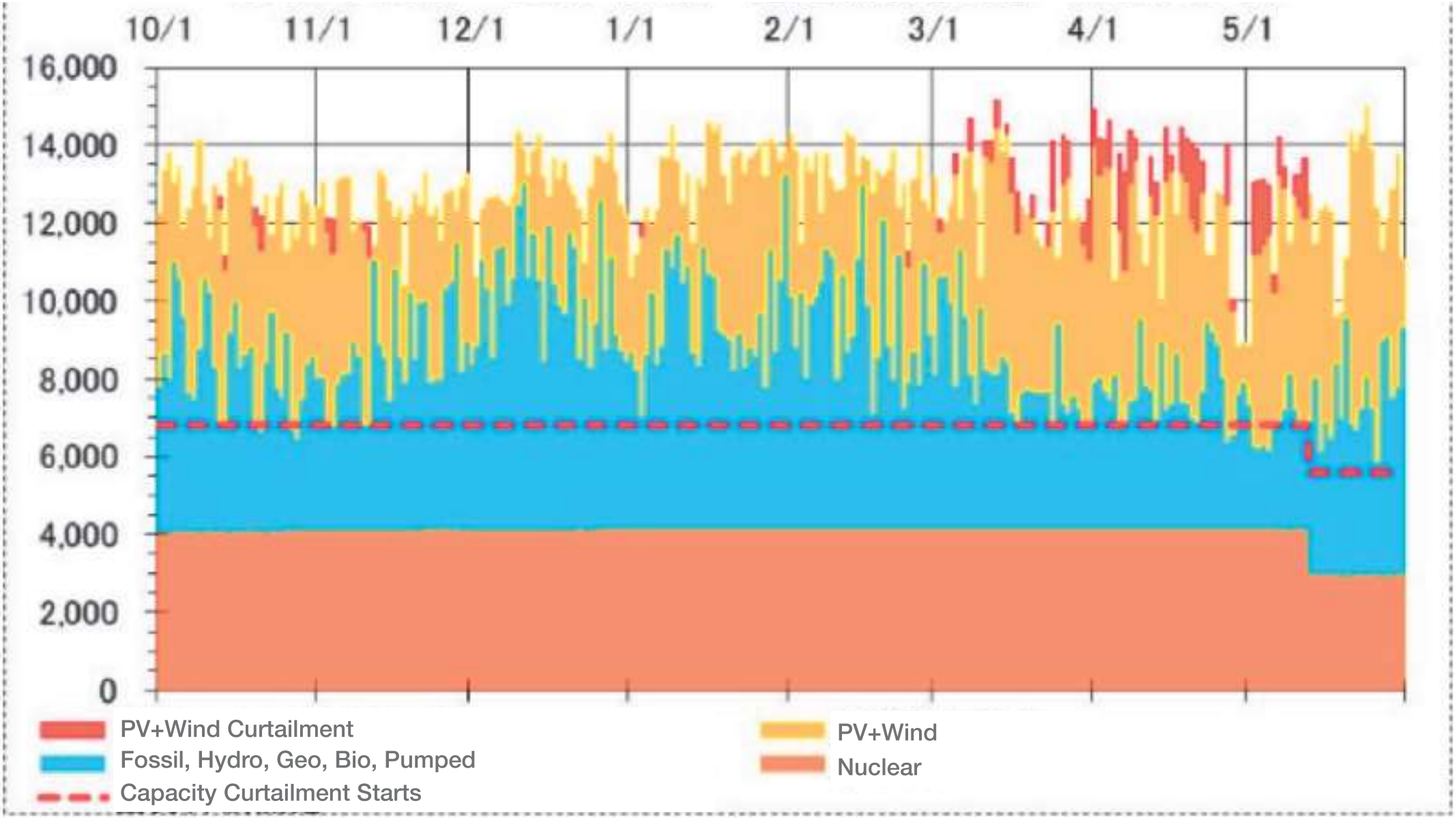
Japan: flexibility is needed



Source: Institute for Sustainable Energy Policies, 2018

Japan: flexibility is needed

Electricity supply and demand in Kyushu (MW, at noon only) from OCT 2018 to MAY 2019



Source: Renewable Energy Institute, 2019

Japan: flexibility is needed

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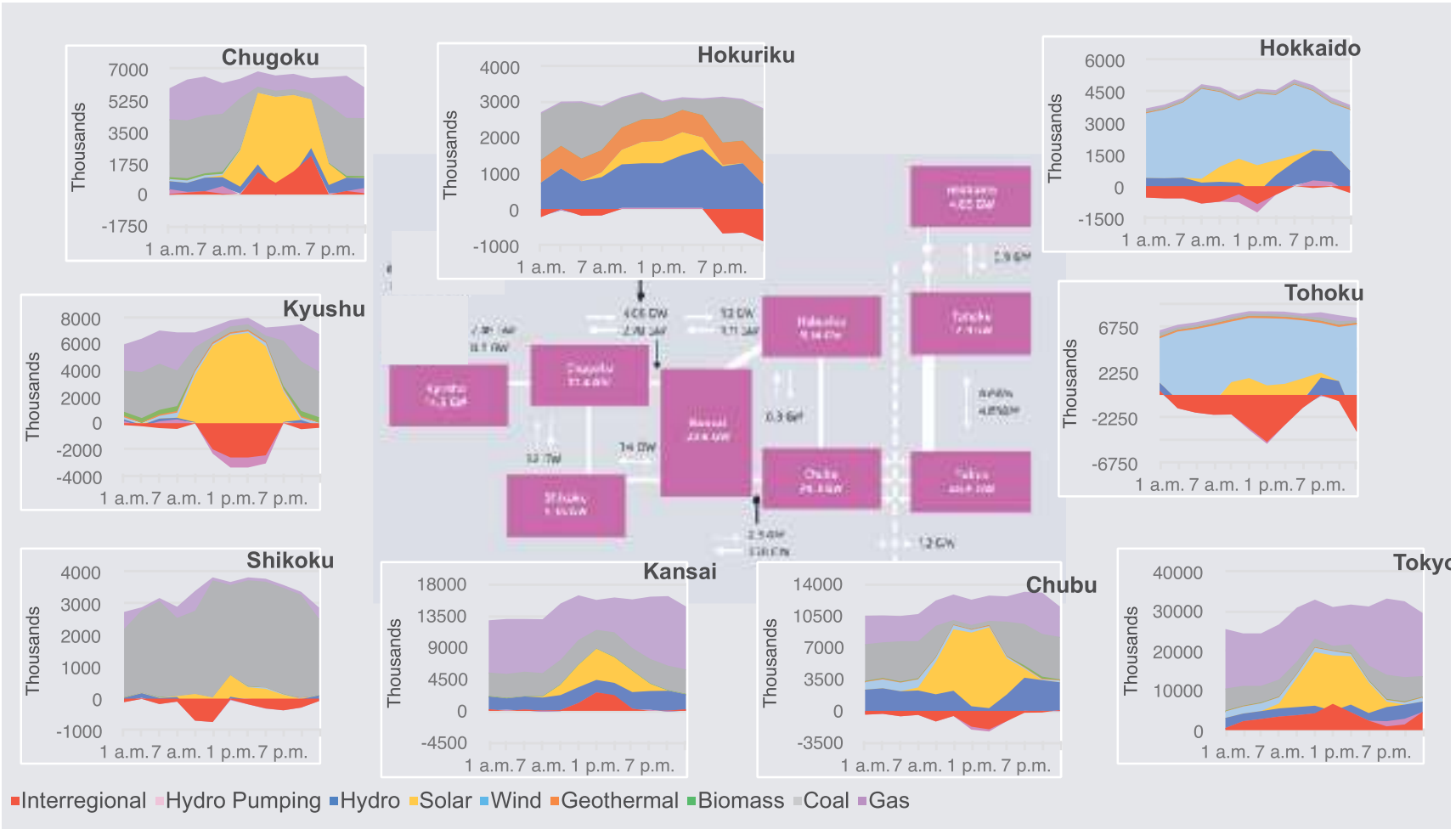
Dispatch modeling: Hourly demand-supply was simulated in minimum/maximum demand day in each month in 2030 by using the SWITCH model*



Main flexibility : pumped-hydro (16 GW), cross-region exchanges, thermal power plants (coal and gas). Nuclear cannot operate flexibly in Japan.

In +RES scenario, the max. PV in-feed for all Japan reaches 64 GWh/h and 26 GWh/h for wind**

Wind energy is produced almost exclusively in East Japan

In Kyushu, Shikoku, Hokkaido and Tohoku hourly VRES infeed can be above demand levels

*SWITCH model was developed by Dr. Fripp Mathiass (Assistant professor at Hawaii University) and maintained by Renewable & Appropriate Energy Laboratory of UC Berkeley. Hourly supply-demand of each area is simulated to minimize cost considering interregional electricity trade.

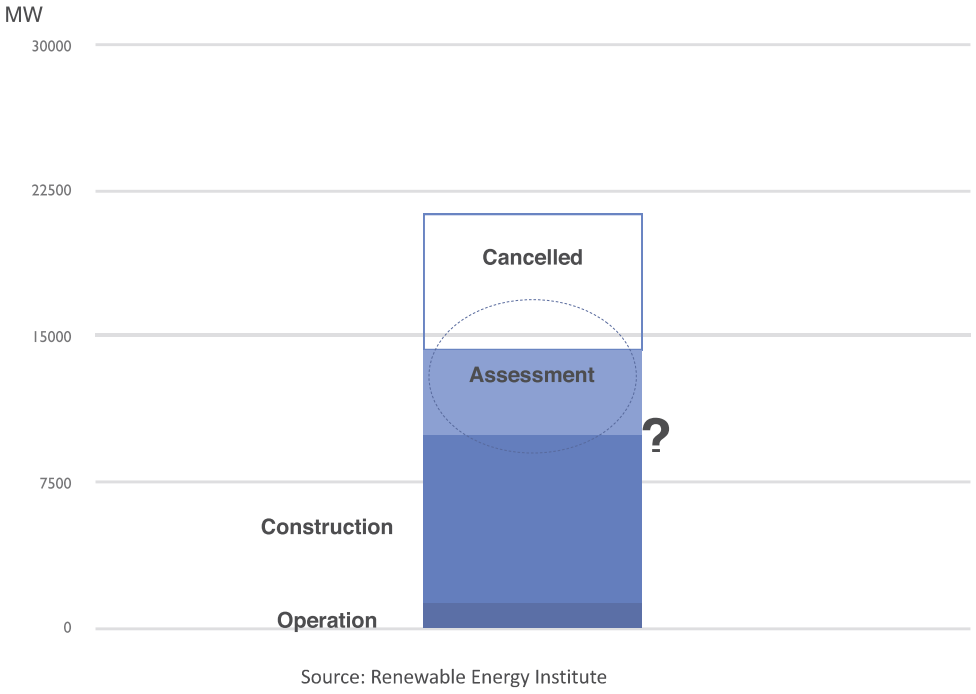
** For installed PV and wind capacities of respectively 100 GW and 36 GW.

Japan: energy transformation?

Status of new coal project developments

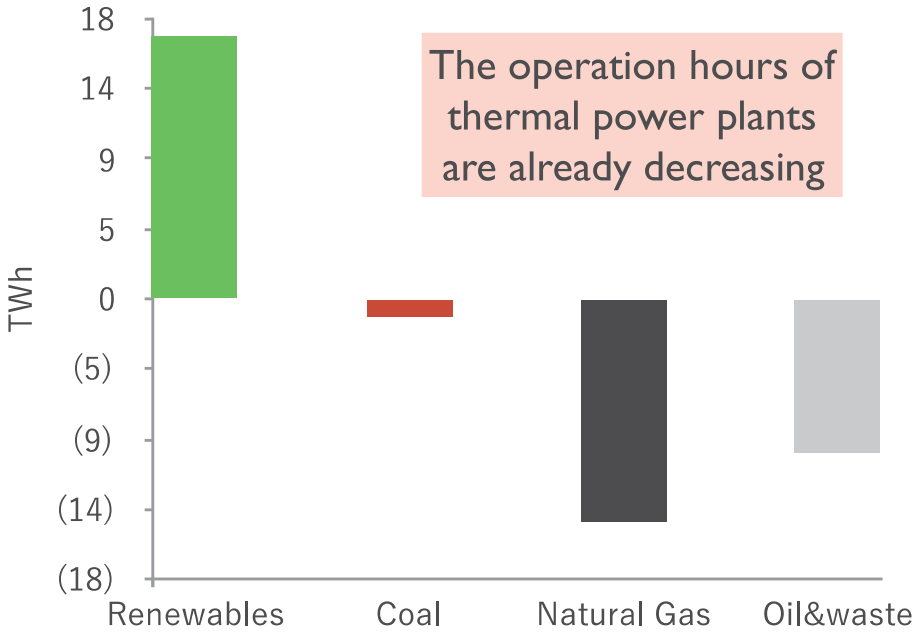
✓ After 2011, 48 (21GW) new capacity plan ⇒Now 34 units (14 GW)

✓ After 2017, cancellation announcements increased: 14 units, 7.6GW



Source: Renewable Energy Institute

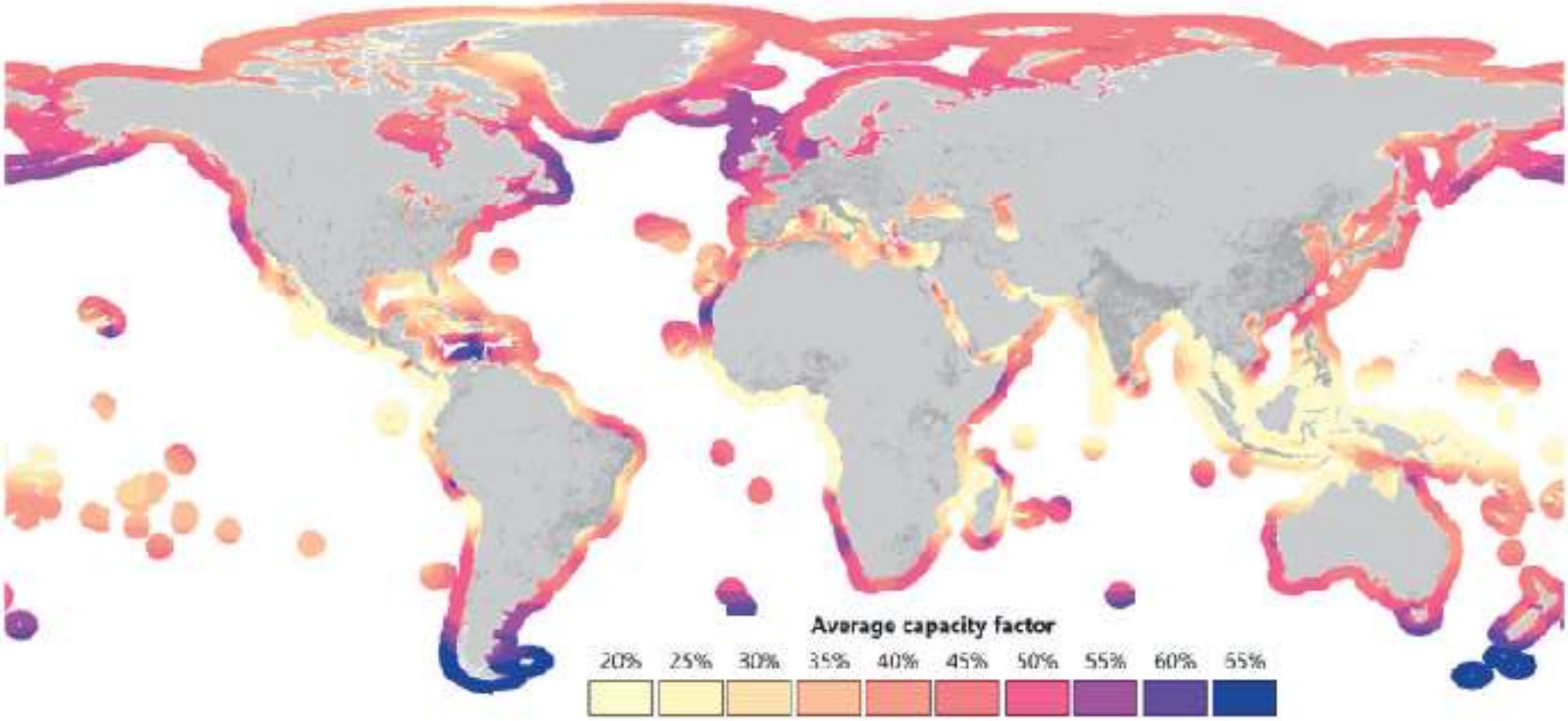
Comparison of the change in electricity generation by source FY 2017 VS. FY 2016



The operation hours of thermal power plants are already decreasing

Average simulated capacity factors for offshore wind worldwide

source: IEA 2019, Offshore Wind Outlook



Average capacity factors reflect the quality of the wind resources available offshore around the world

Notes: Inland dots depict population density of more than 500, 2 000 and 8 000 people per km^2 with darker shades of grey.

Source: IEA analysis developed in collaboration with Imperial College London based on Renewables.ninja.

Japan: energy transformation is possible

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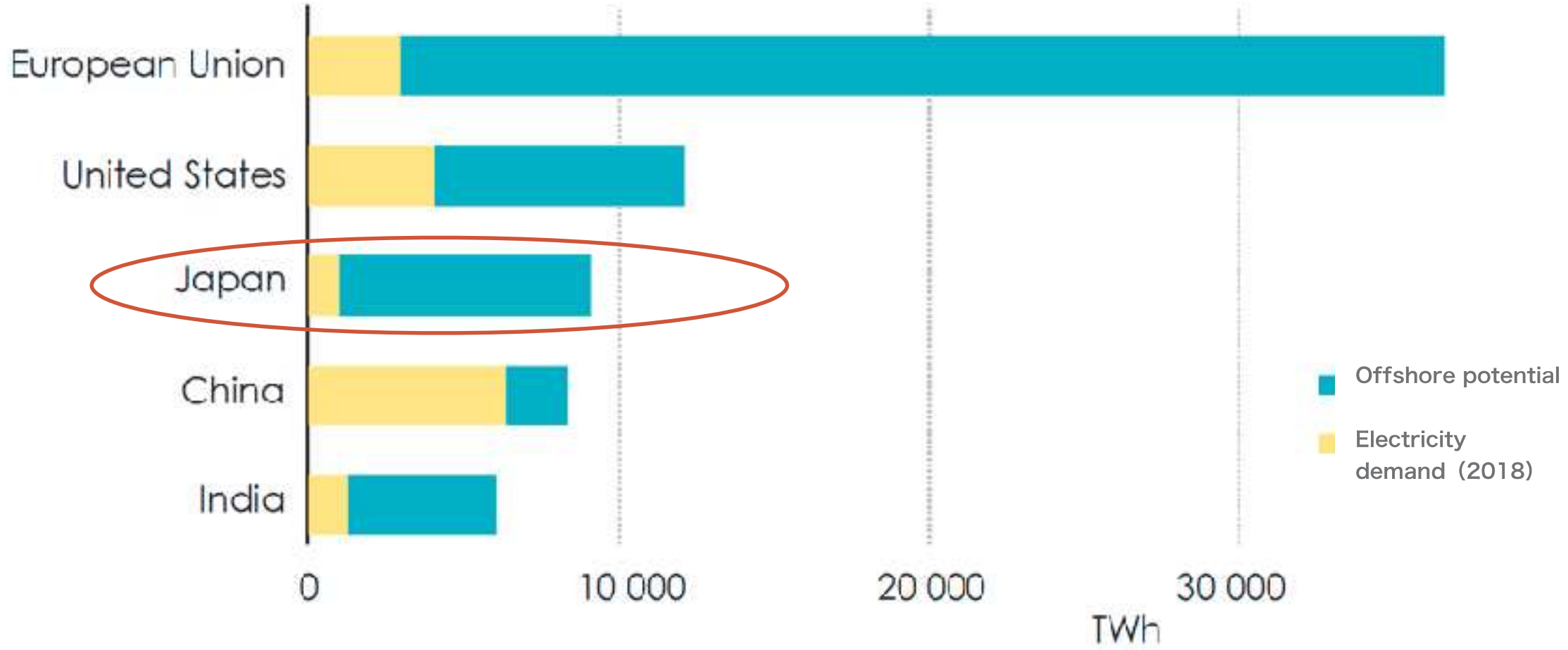
2018 domestic electricity demand by region vs technical potential of offshore wind



Based on the latest satellite data and the latest turbines.
As much as 18 times of current global electricity demand.

source: IEA 2019, Offshore Wind Outlook

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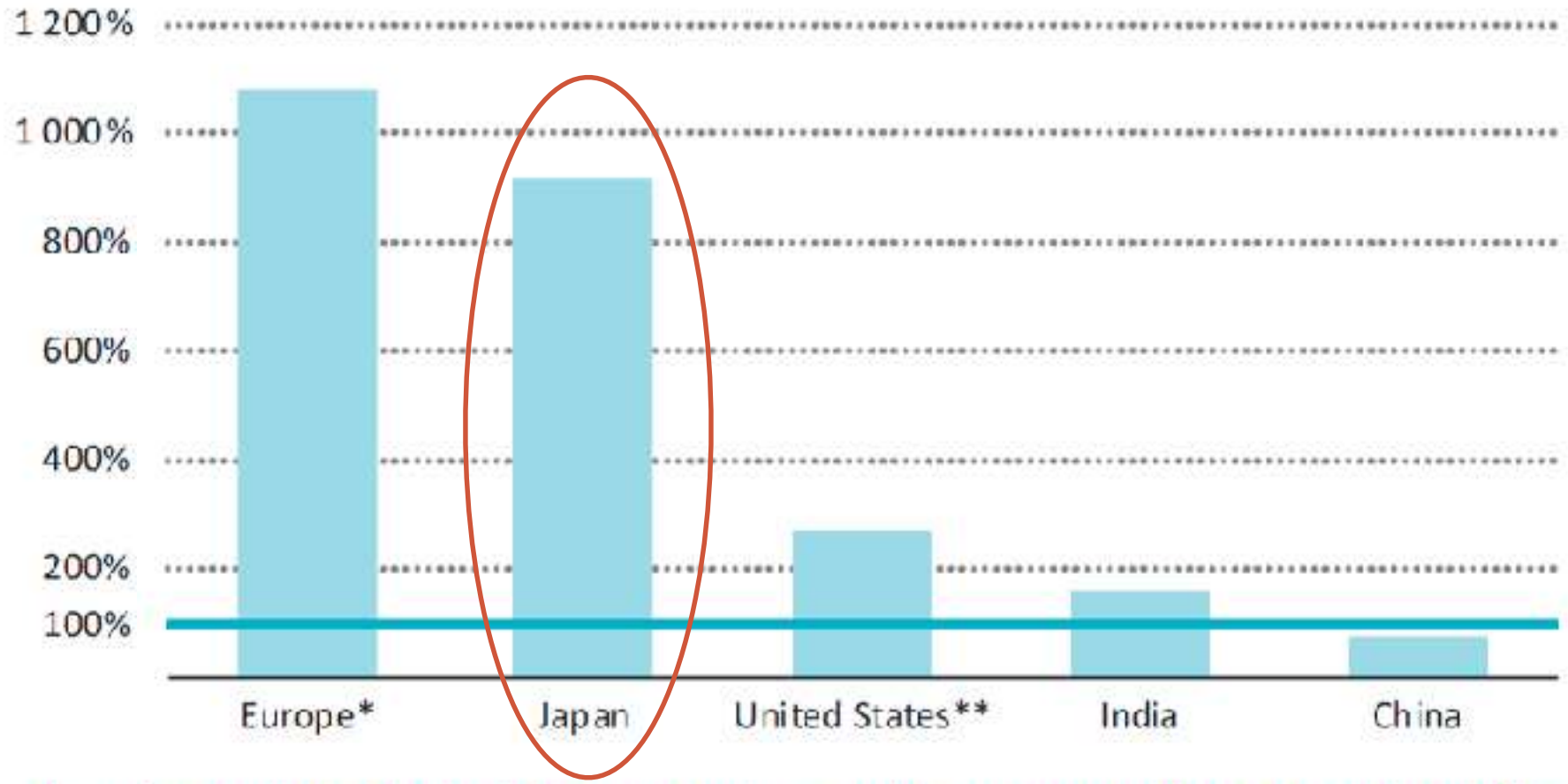
Ratio of technical potential to domestic electricity demand by region in the Stated Policies Scenario, 2040 IEA

source: IEA 2019, Offshore Wind Outlook



Based on technical potential, many regions could cover more than or nearly all of their domestic electricity demand from offshore wind alone

* Potential excluding Greenland and overseas territories. ** Potential available excluding Alaska and Hawaii.

Source: IEA analysis developed in collaboration with Imperial College London.

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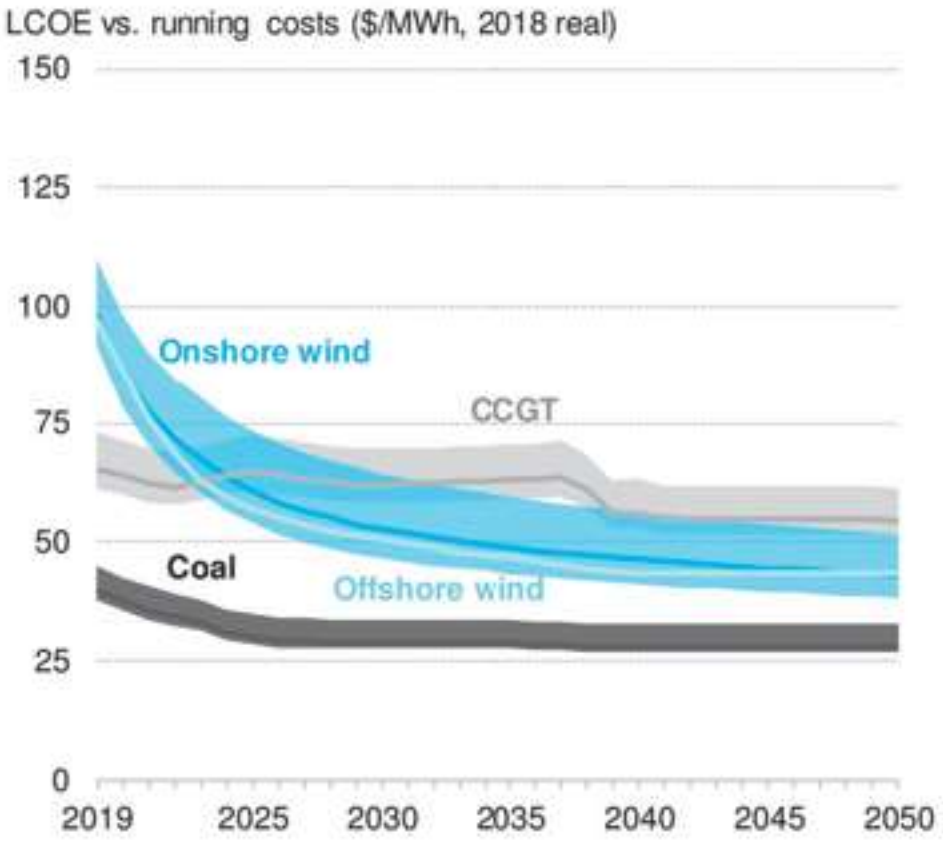
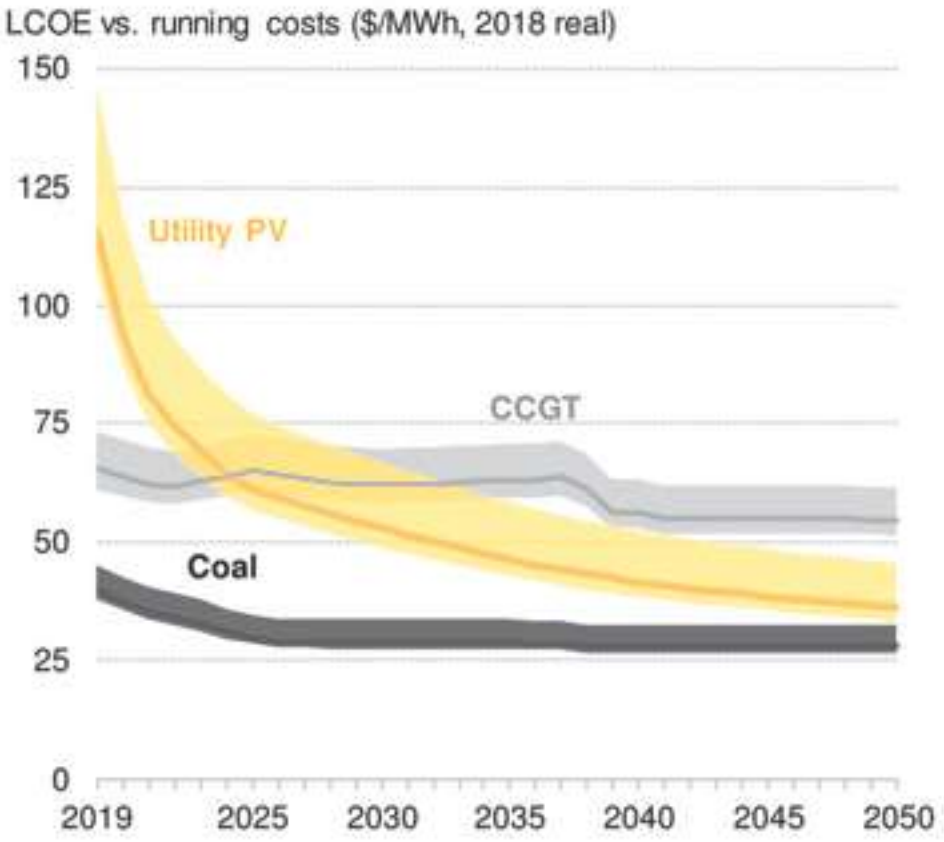
BUT without new policies, existing coal will continue to remain cheapest….

New wind vs. existing coal and CCGT



Source: BloombergNEF

New utility-scale PV vs. existing coal and CCGT



Source: BloombergNEF

Note: All LCOE calculations are unsubsidized. The range of the LCOE represents a range of capacity factors, it excludes curtailment. Our offshore wind LCOE forecast is global. For thermal plants, the short-run marginal cost range represents a diversity of plant efficiencies in the fleet.

source: Bloomberg NEF, 2019

Japan: energy transformation is possible

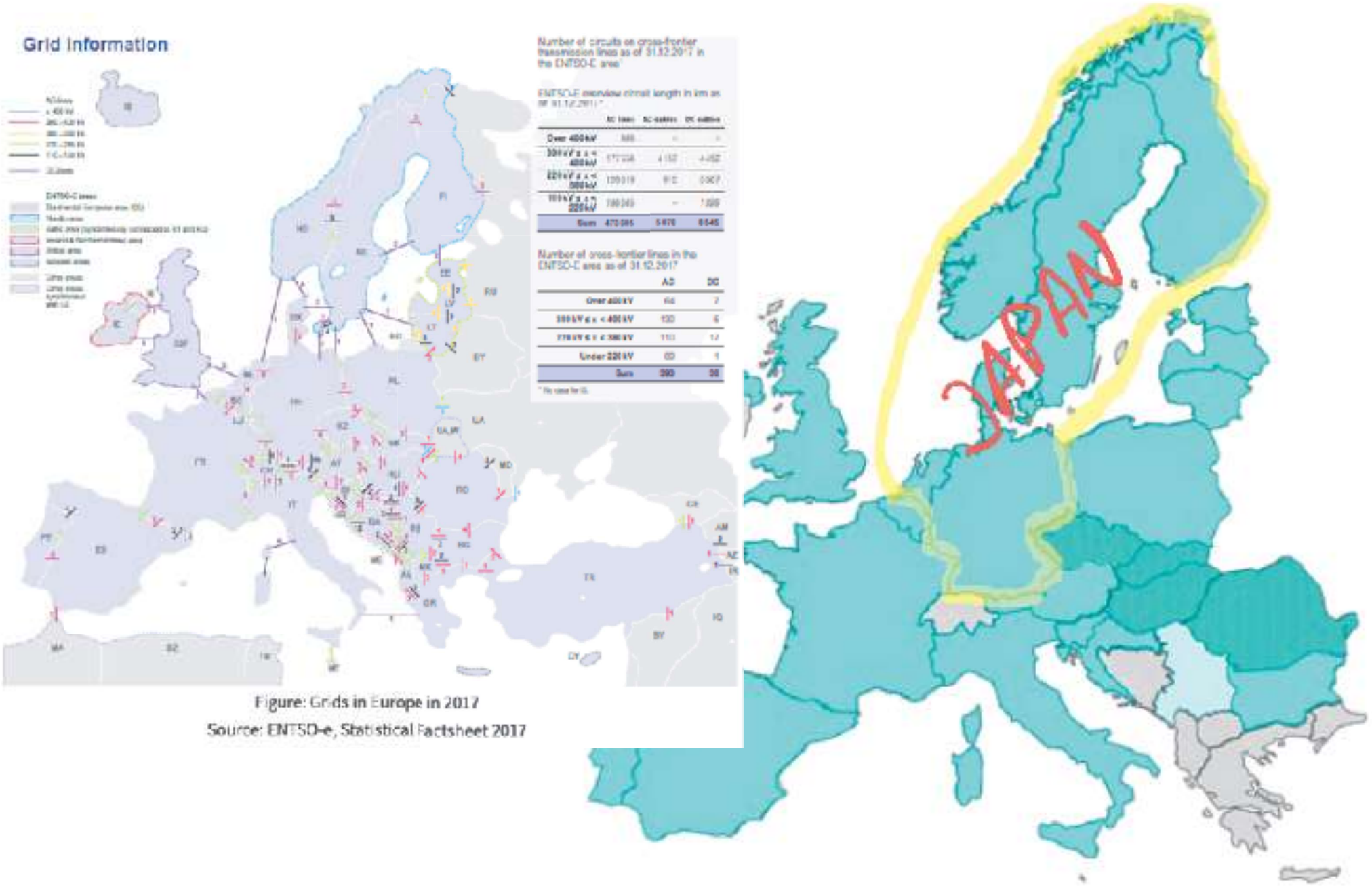
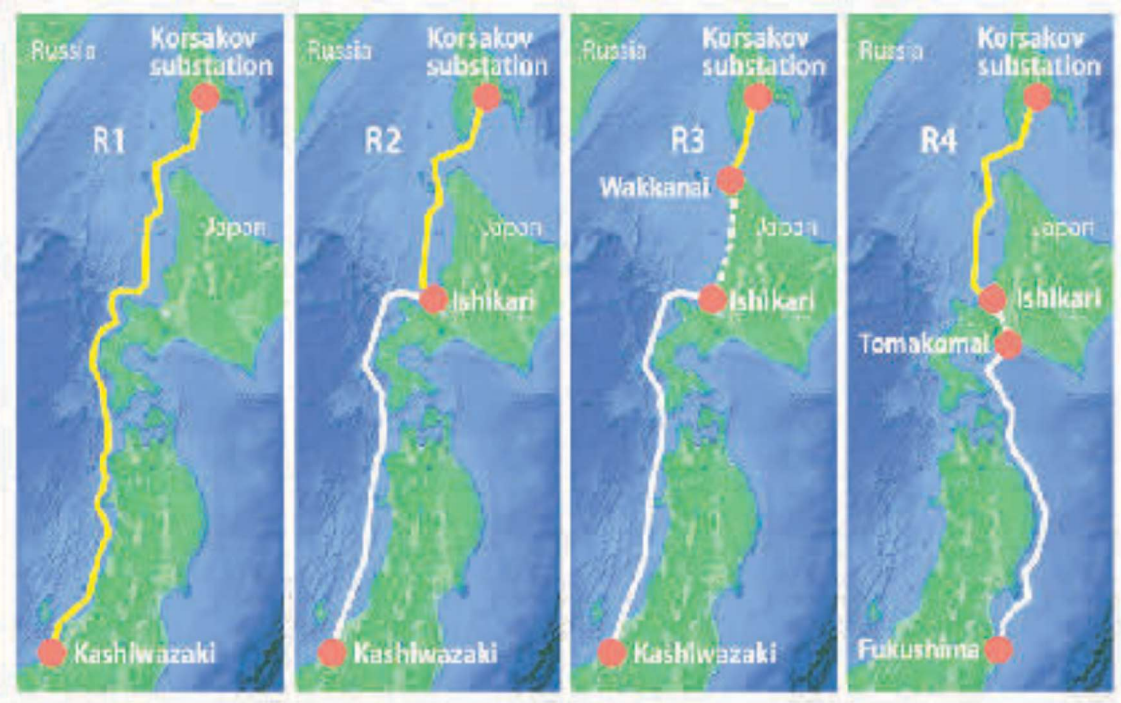


Figure: Grids in Europe in 2017

Source: ENTSO-e, Statistical Factsheet 2017

Source: ENTSO-e, Peter Jørgensen, Vice President, Energinet Denmark at REvision2019 Conference by Renewable Energy Institute

Japan: energy transformation is possible

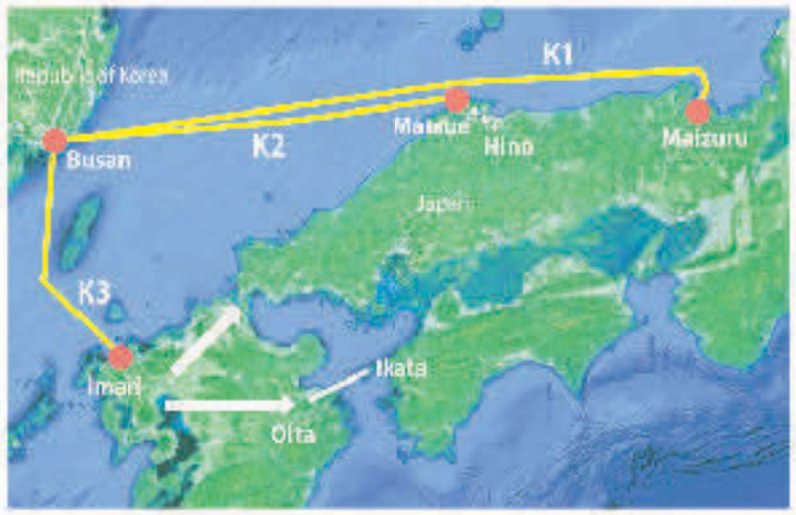


R1 Sakhalin—Kashiwazaki
Length: 1,255 km

R2 Sakhalin—Ishikari—Kashiwazaki
Length: 1,255 km

R3 Sakhalin—Wakkanai—Ishikari—Kashiwazaki
Length: 1,258 km
(161+297+800 km)

R4 Sakhalin—Ishikari—Tomakomai—Fukushima
Length: 1,246 km
(455+108+683 km)



K1 Busan—Maizuru
Length: 627km

K2 Busan—Matsue (→Kansai)
Length: 372km
+41 km grid reinforcement
(Matsue-Hino)

K3 Busan—Imari (→Kansai)
(via Chugoku & Shikoku region)
Length: 226km
+70 km grid extension (Oita-Ikata)

Japan-Russia			Japan-South Korea		
Route	Length	Max. Depth	Route	Length	Max. Depth
Sakhalin-Kashiwazaki	1,255 km	300 m	Busan-Maizuru	627 km	200 m
Sakhalin-Ishikari	455 km	300 m	Busan-Matsue	372 km	150 m
Sakhalin-Wakkanai	161 km	≤ 100 m	Busan-Imari	226 km	120 m

Source: Renewable Energy Institute, 2018

Paradigm Shift in Energy
Peace in Asia

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