

GLOBAL WIND MARKET OUTLOOK (2019-2025)

March 17, 2019 (revised April 1, 2019)

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Global wind outlook summary

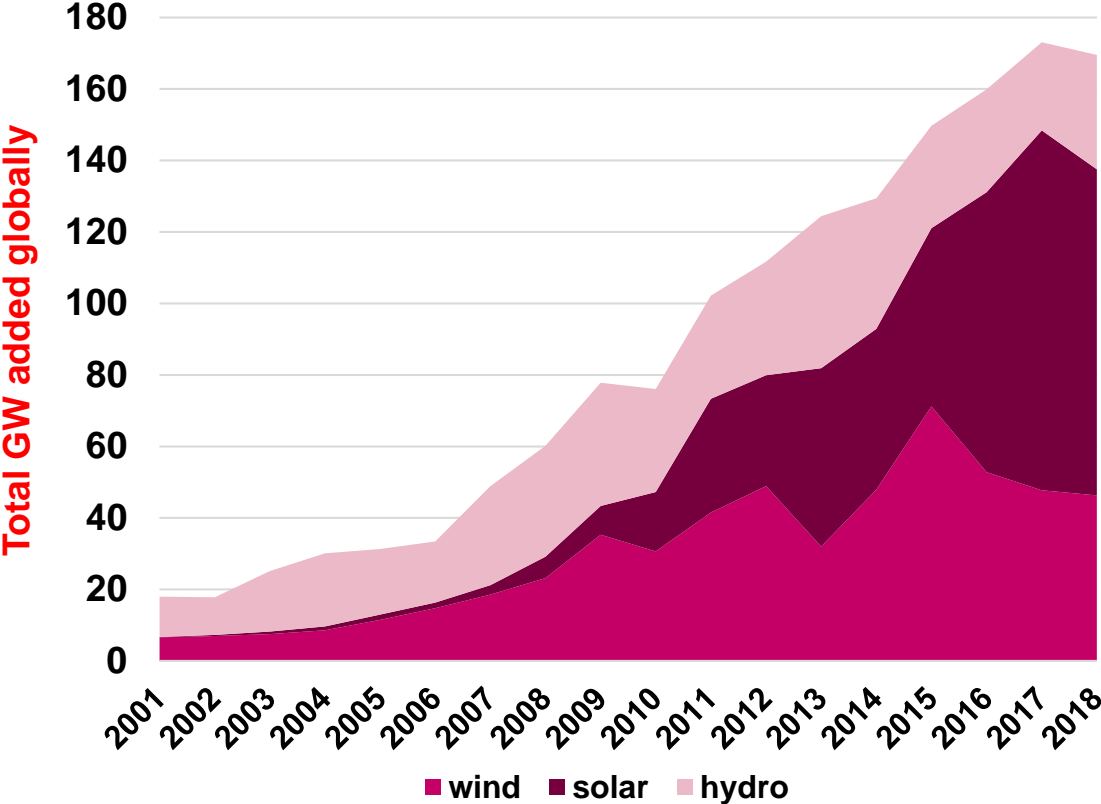
- Wind capacity additions shifted lower over the past year, with about 46 GW added globally, or a 3% Y/Y decline in growth.
- Platts Analytics global power outlook assumes **annual wind additions of 45-50 GW/year will take place for the period 2019-2025**. While overall additions are not as large as solar (~100 GW/year), wind generation will still grow faster than solar, thanks to already stronger load factors, which are likely to increase further.
- **China** maintains the lead globally, with 2018 additions increasing by over 30% Y/Y, equivalent to 20 GW. **We assume wind capacity growth in China will flatten with additions remaining at 2018 levels through 2025**. However, an imminent shift to auctions and limitations in provinces, where curtailments are the highest, pose some risks to growth in the medium term. The **U.S.** will continue to see upward momentum in the near term (10+ GW in 2019) due to the phase out of the federal tax credit. India remains a very promising market thanks to significant tender activity and political will to diversify the mix, in spite of slowing additions in 2018 and so far in 2019.
- **Limitations are emerging for onshore wind**. Our data shows that commissioning times for onshore projects are lengthening in general, with the exception of China. In Europe, especially Germany, the expansion of onshore wind is now facing considerable attrition due to the introduction of distance rules from dwellings, which make suitable sites scarcer, and changing supporting mechanisms.
- In key auctions around the world, bids for onshore wind also appear to be stabilizing. This easing is partly due to an upward trend in steel prices (a key material used in wind turbine towers) and scarcer sites in other cases.
- **The future of wind is offshore**. Interest in offshore wind continues to gain momentum, with about 100 GW currently in the pipeline versus 240 GW for onshore wind. With costs declining, offshore wind is now starting to look attractive in Europe, even on a merchant basis, as shown by the zero bids projects in Europe. In some regions, a driver of offshore wind development will be greater proximity to large load centers, while players are becoming more comfortable with the technology.

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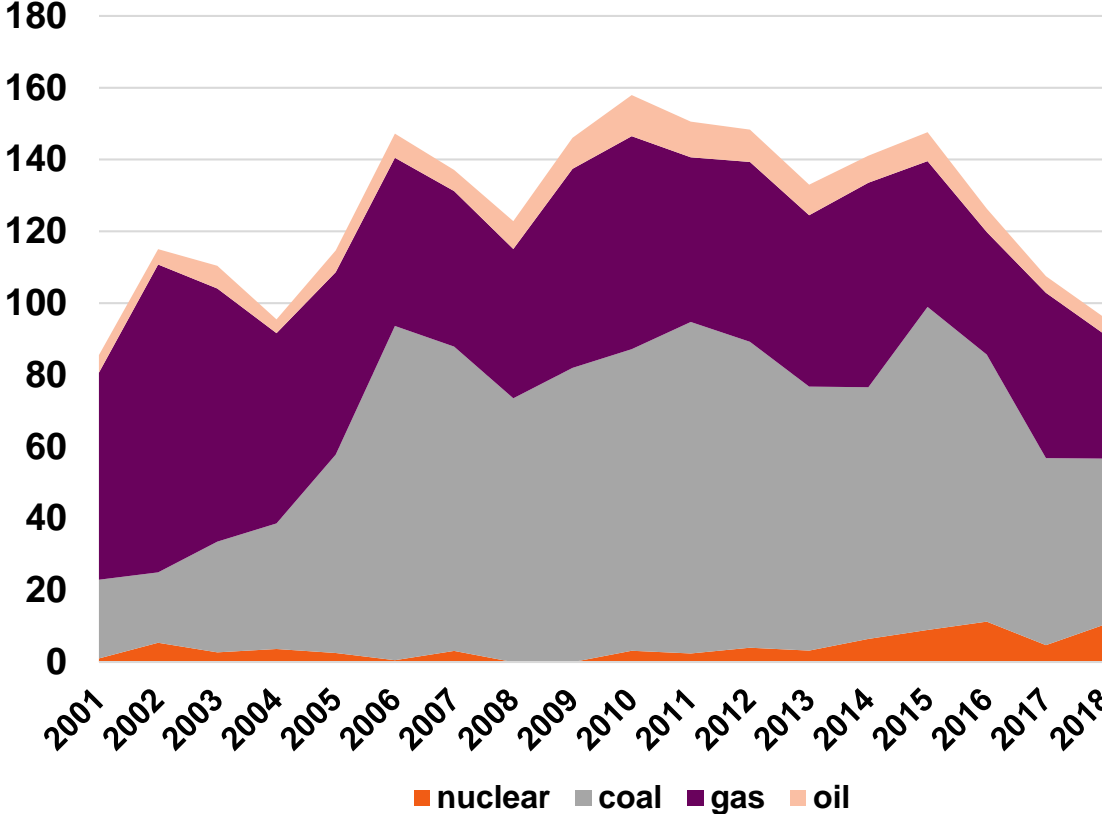
- Overview of recent wind capacity trends
- Overview of trends in costs and wind capacity auctions globally
- Overview of the wind outlook by major market
- Country details: wind capacity additions and generation mix going forward

Wind additions in the broader global capacity trends

Renewables

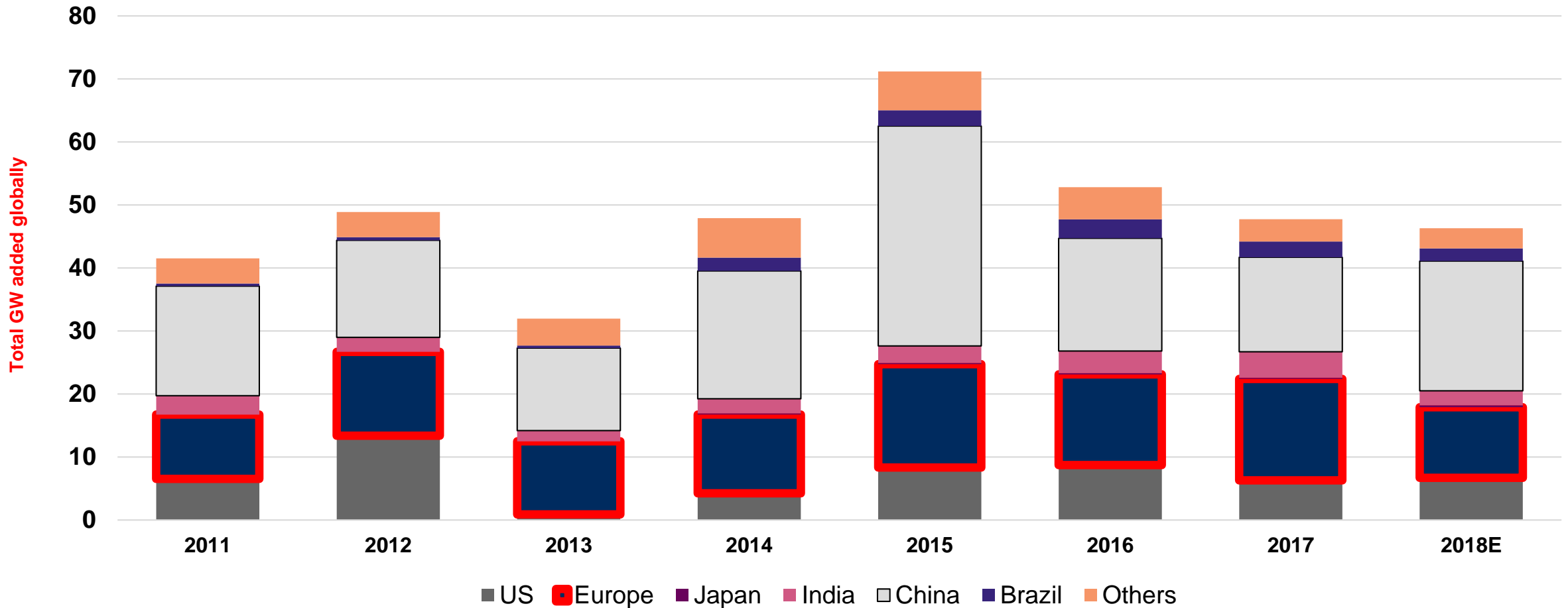


Fossil fuel and nuclear



Source: IRENA, Platts Analytics, Market Intelligence World Electric Power Plant database. 2018 is a preliminary estimate.

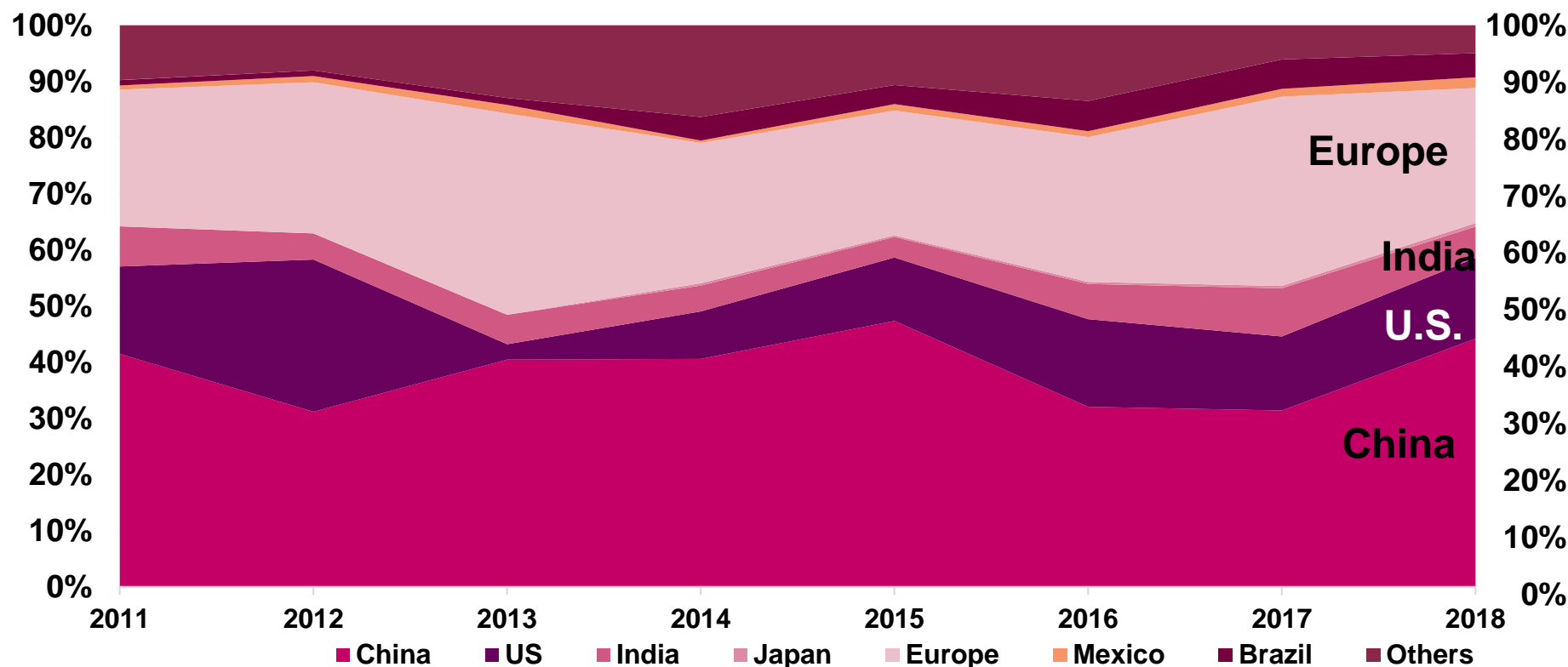
Wind additions softer in 2018: Europe a drag on global growth in spite of stronger China



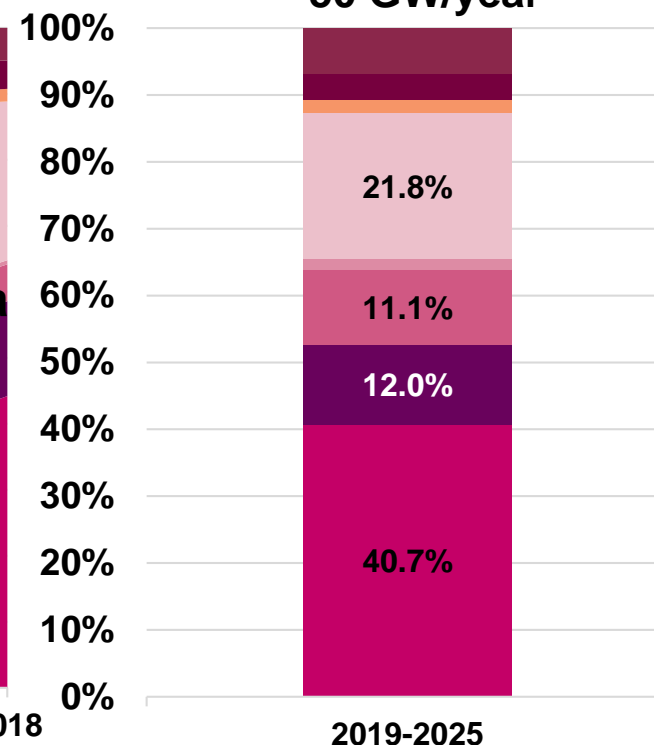
Source: IRENA, Platts Analytics. Note, 2018 is a preliminary estimate

Wind additions by region: China and U.S. lead in the near term, Europe faces challenges, India and LATAM emerging

Wind additions share by major market



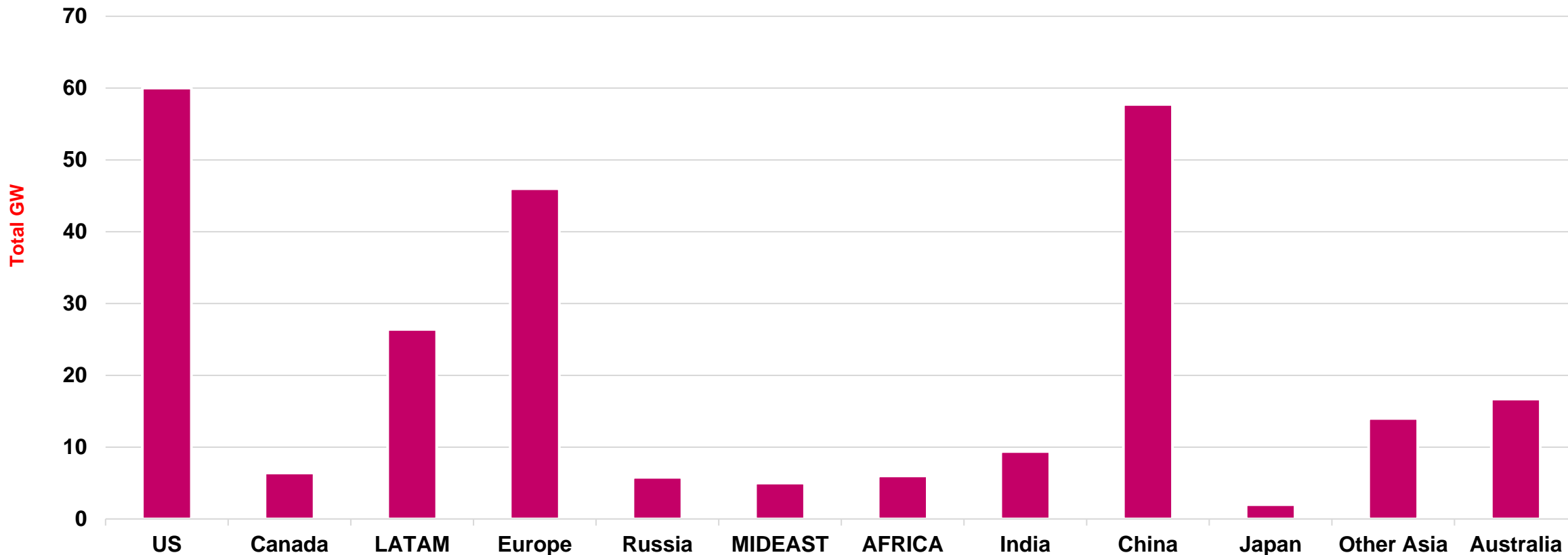
2019-2025:
~ 50 GW/year



Source: IRENA, Platts Analytics, Market Intelligence World Electric Power Plant database

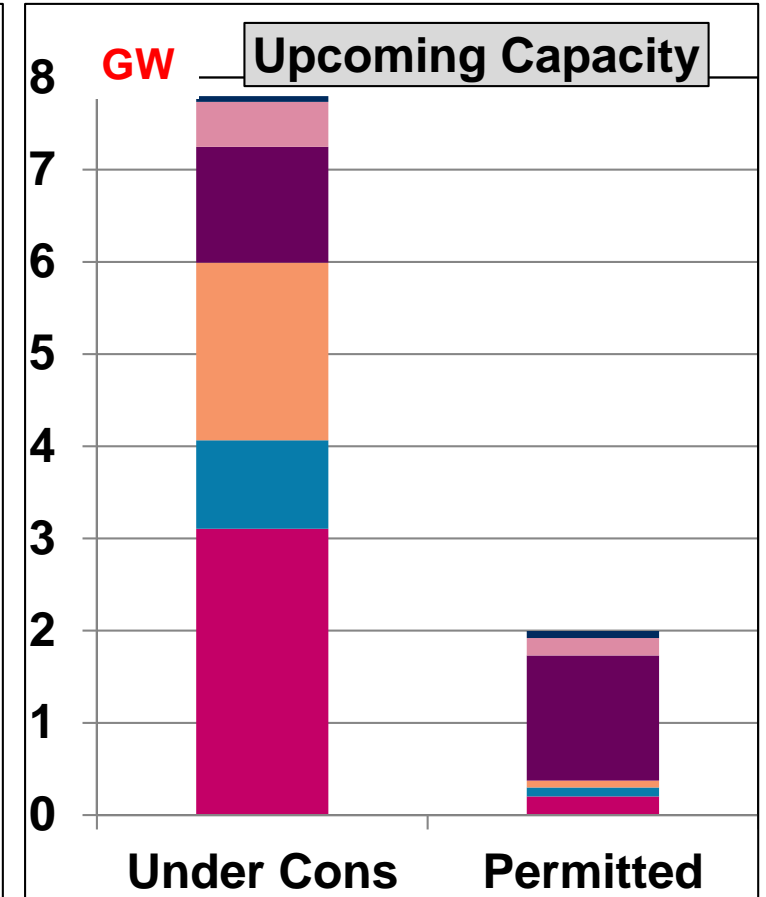
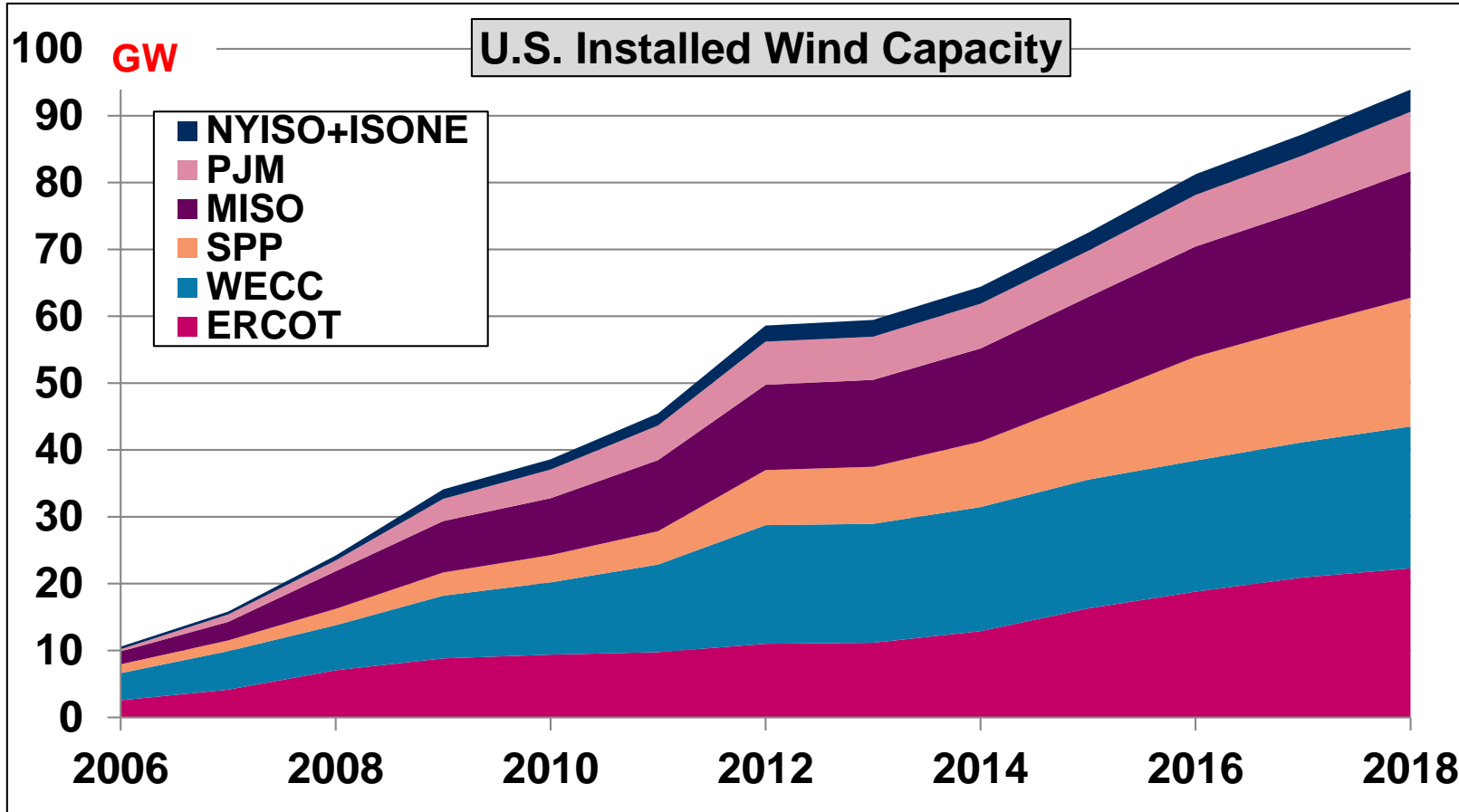
Details of onshore wind project pipeline: U.S. and China lead, followed by Europe

Projects in construction/development, planned and/or tendered



Source: Platts Analytics, Market Intelligence World Electric Power Plant database. Note: U.S. does not include recently announced projects, only construction, early and advanced development. Data is as of Jan. 2019, except China (Oct. 2018).

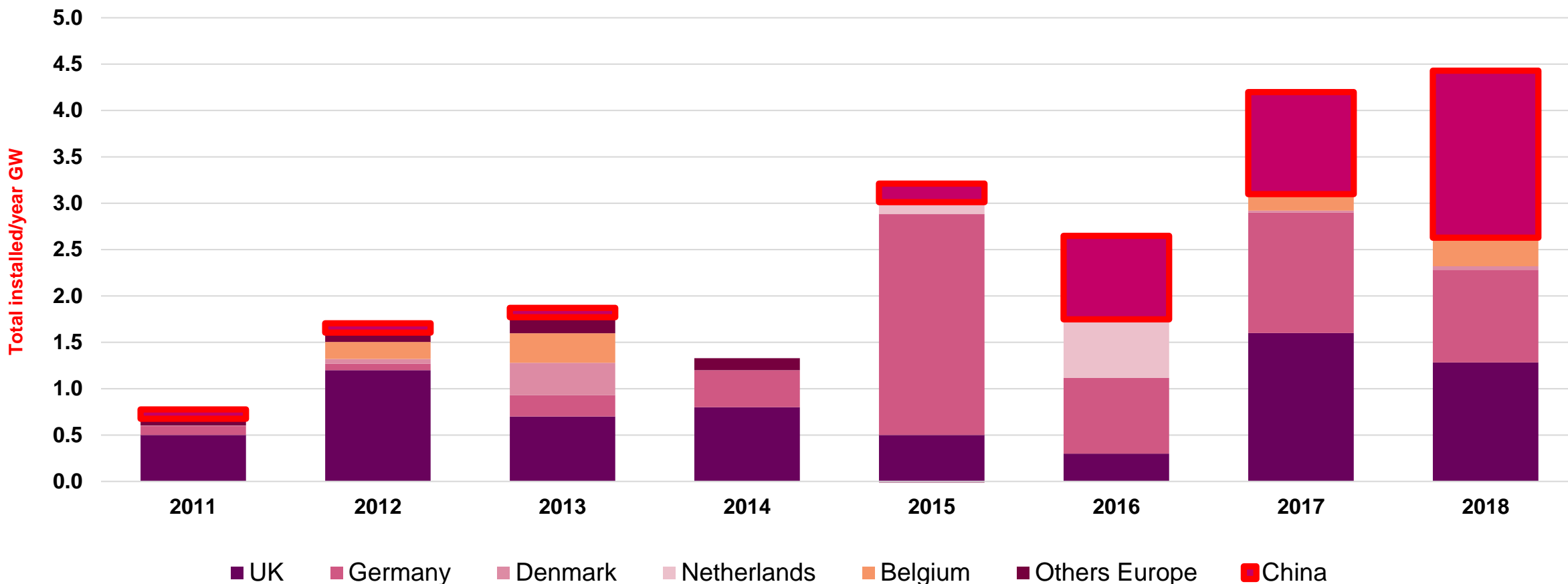
U.S. wind capacity now exceeds 90 GW, focused in Texas, Plains states, and Western U.S.



Source: Platts Analytics, EIA, NREL.

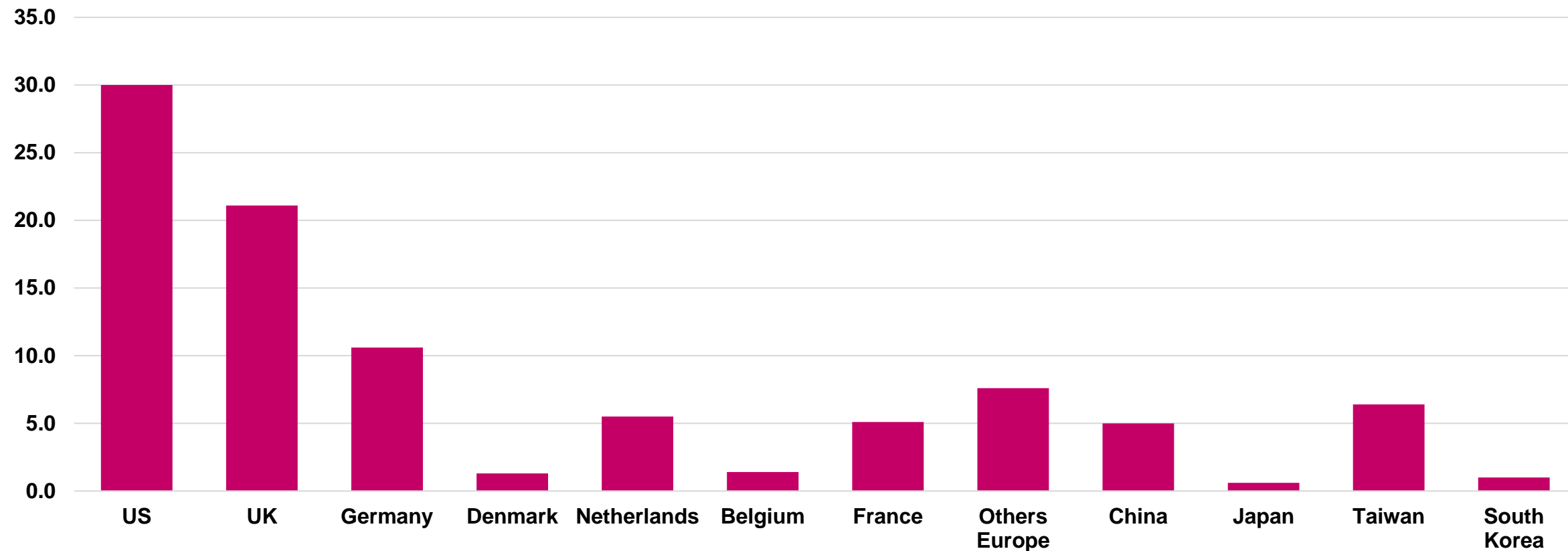
Note: Chart does not include capacity in SERC (0.5 GW) or AK/HI (0.5 GW)

Offshore wind installed capacity: Europe still leads, but China emerging



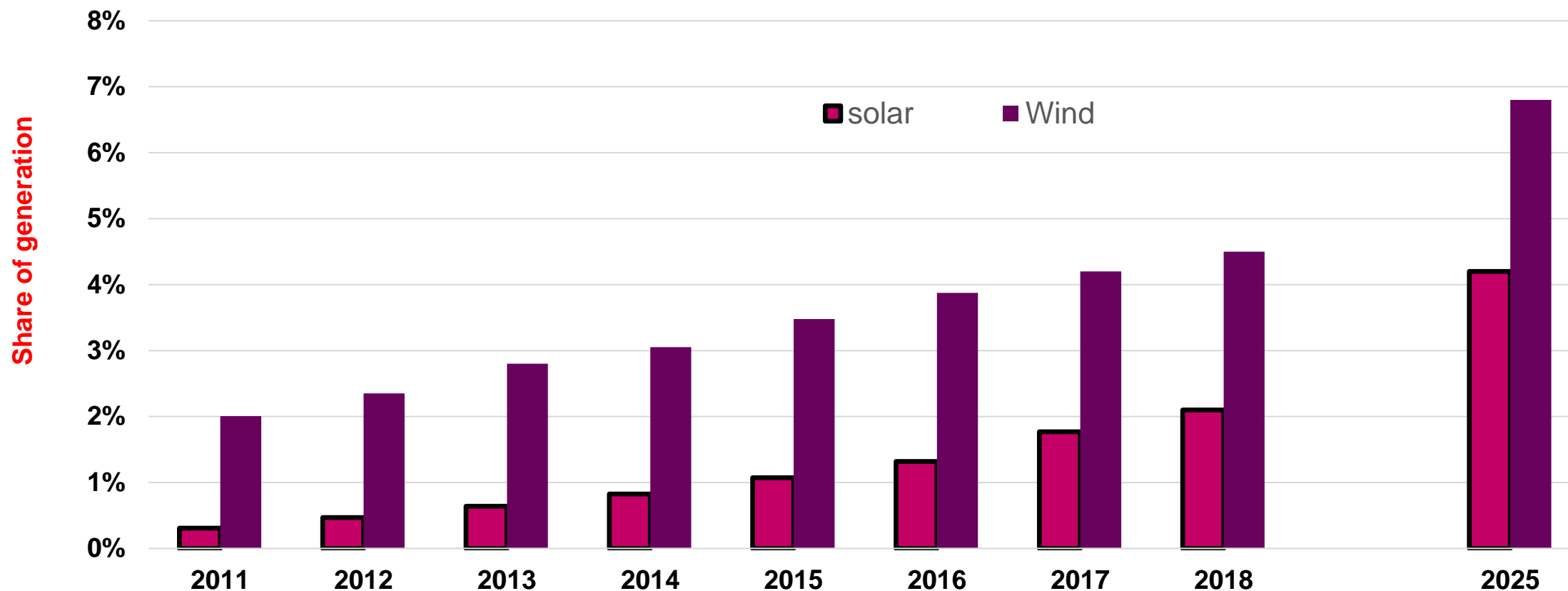
Source: Platts Analytics, Market Intelligence World Electric Power Plant database

Europe leads in pipeline of offshore wind projects: increasing interest in U.S., potential emerges in Asia



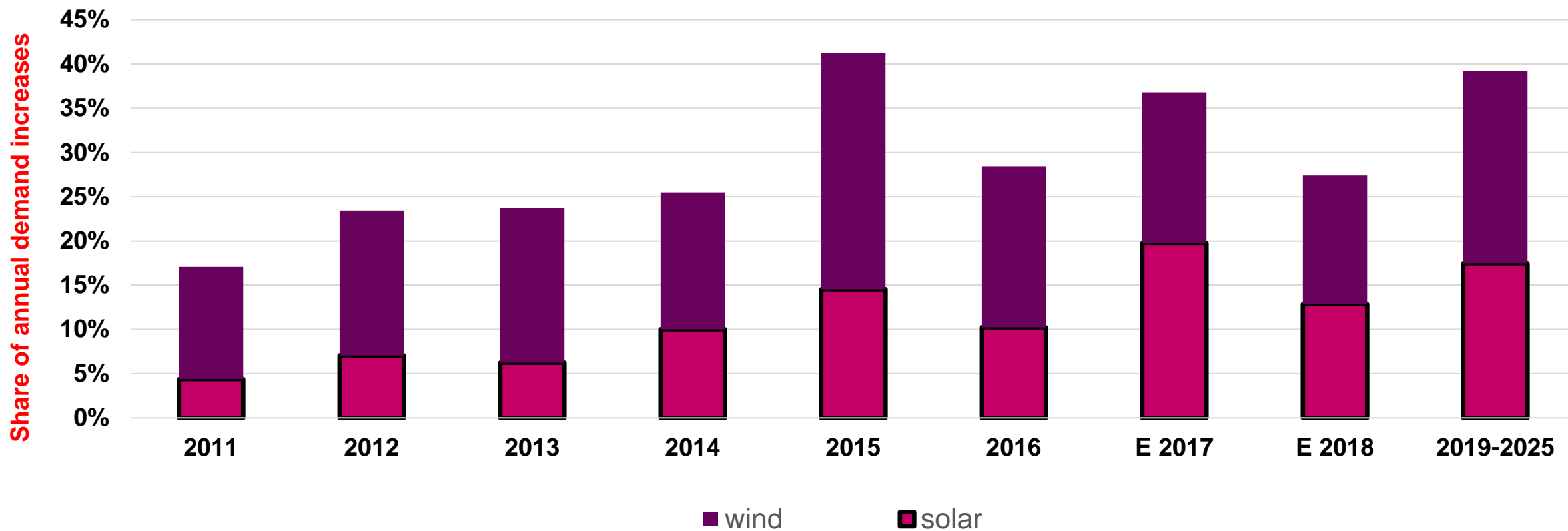
Source: Platts Analytics, Market Intelligence World Electric Power Plant database. Note: Chinese pipeline is not complete. Data is as of Jan. 2019.

Solar and wind in perspective: although solar represents the largest technology for annual installations, wind generation holds onto larger portion of the global power mix



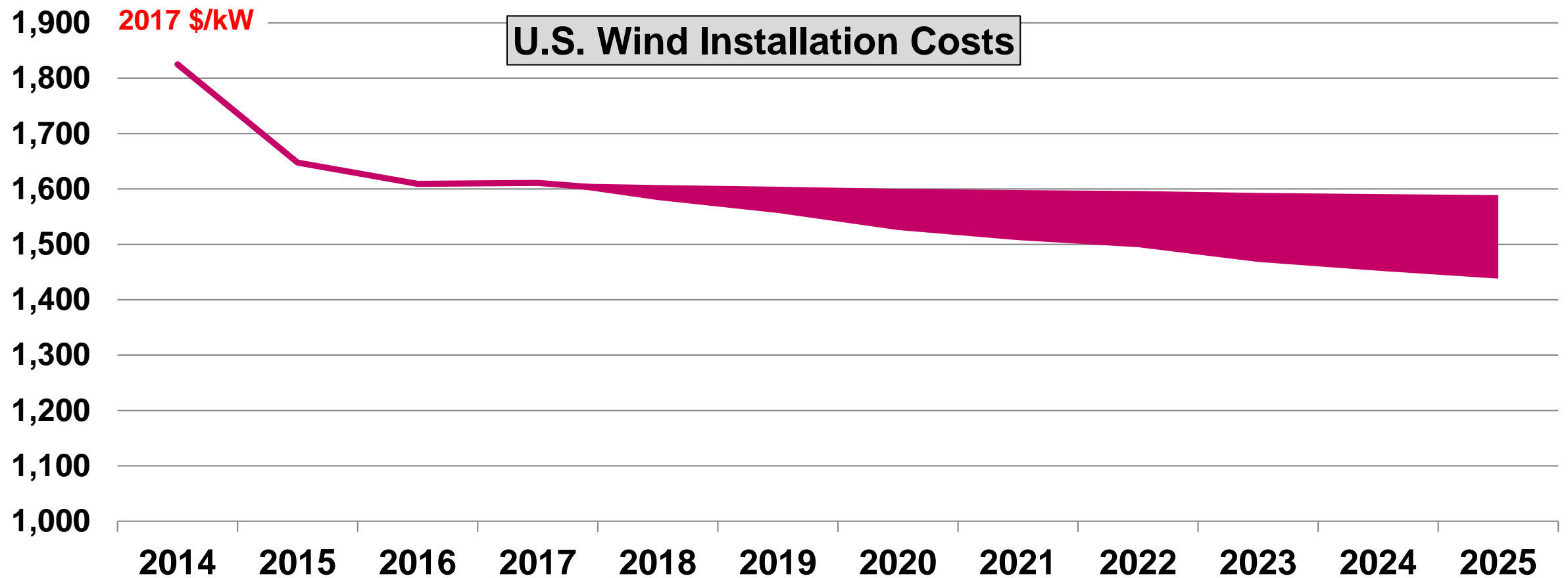
Source: Platts Analytics World Energy Demand Model

Solar and wind additions will meet about 1/3 of global electricity demand increases



Source: IEA, Platts Analytics World Energy Demand Model

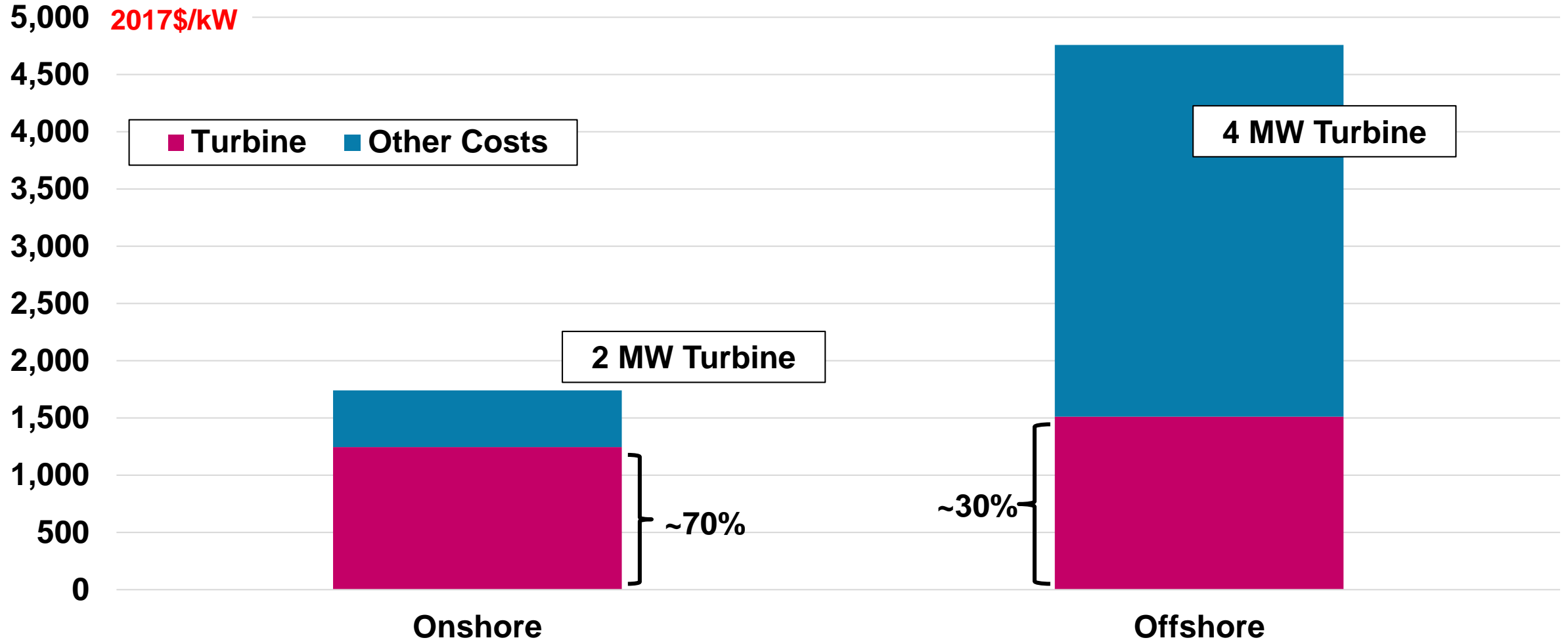
U.S. wind installation costs assumptions



Source: Platts Analytics

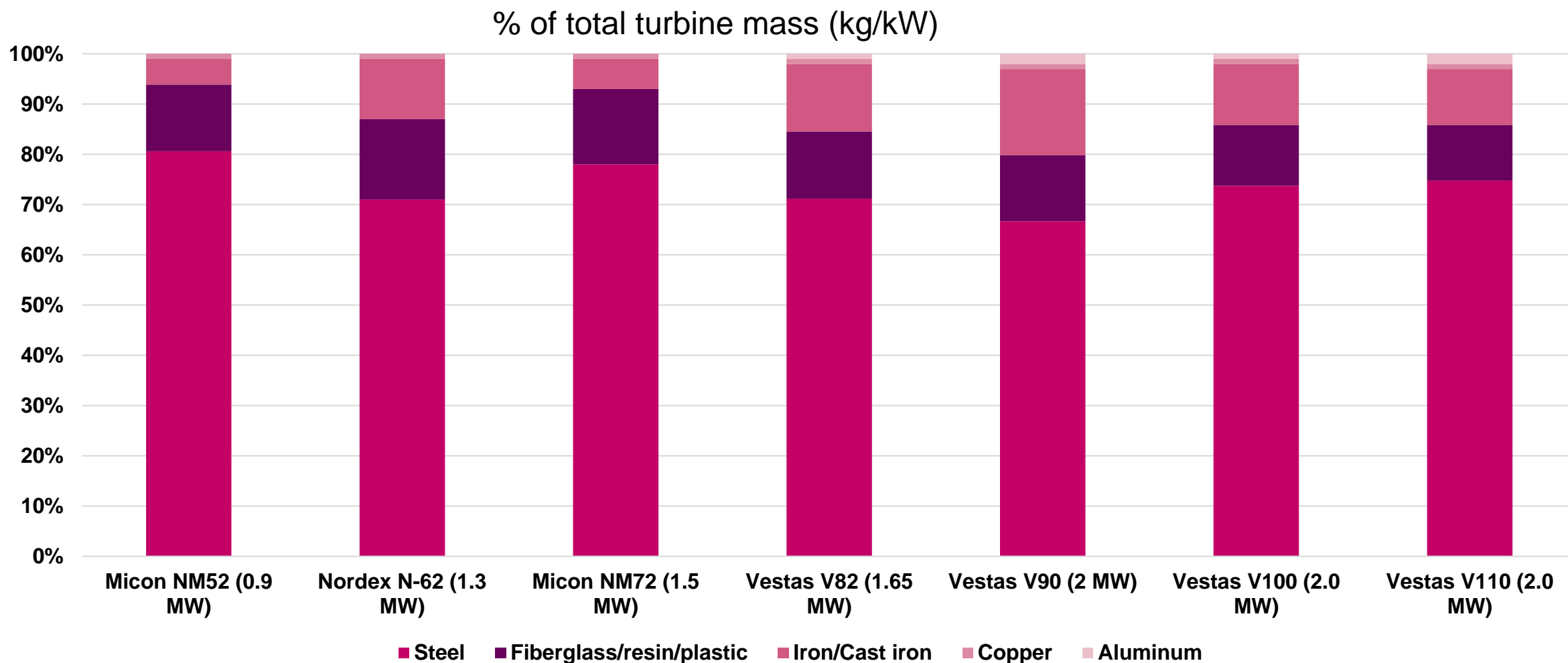
Note: Chart does not include impact of the Production Tax Credit.

Onshore wind costs are driven by the turbine, in contrast to offshore wind



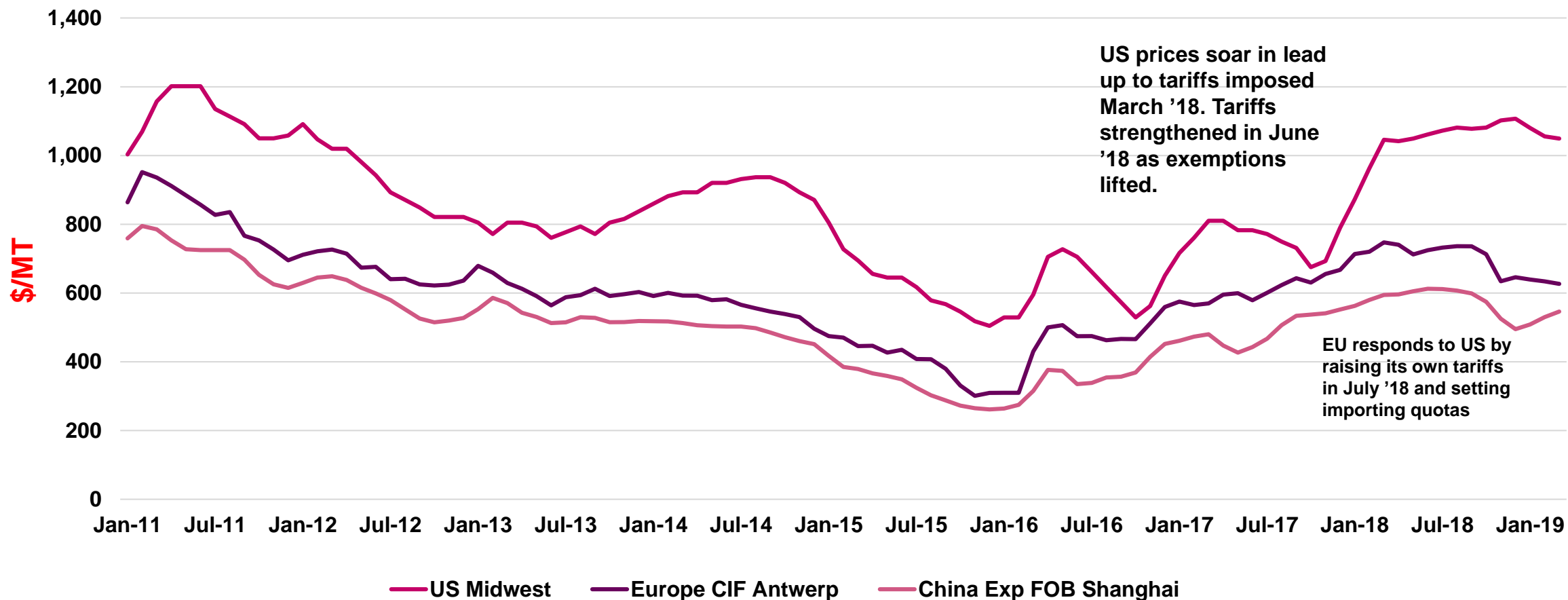
Source: Platts Analytics, NREL. Onshore wind is for U.S., offshore is for international projects.

Steel is a key raw material used in wind turbine manufacturing



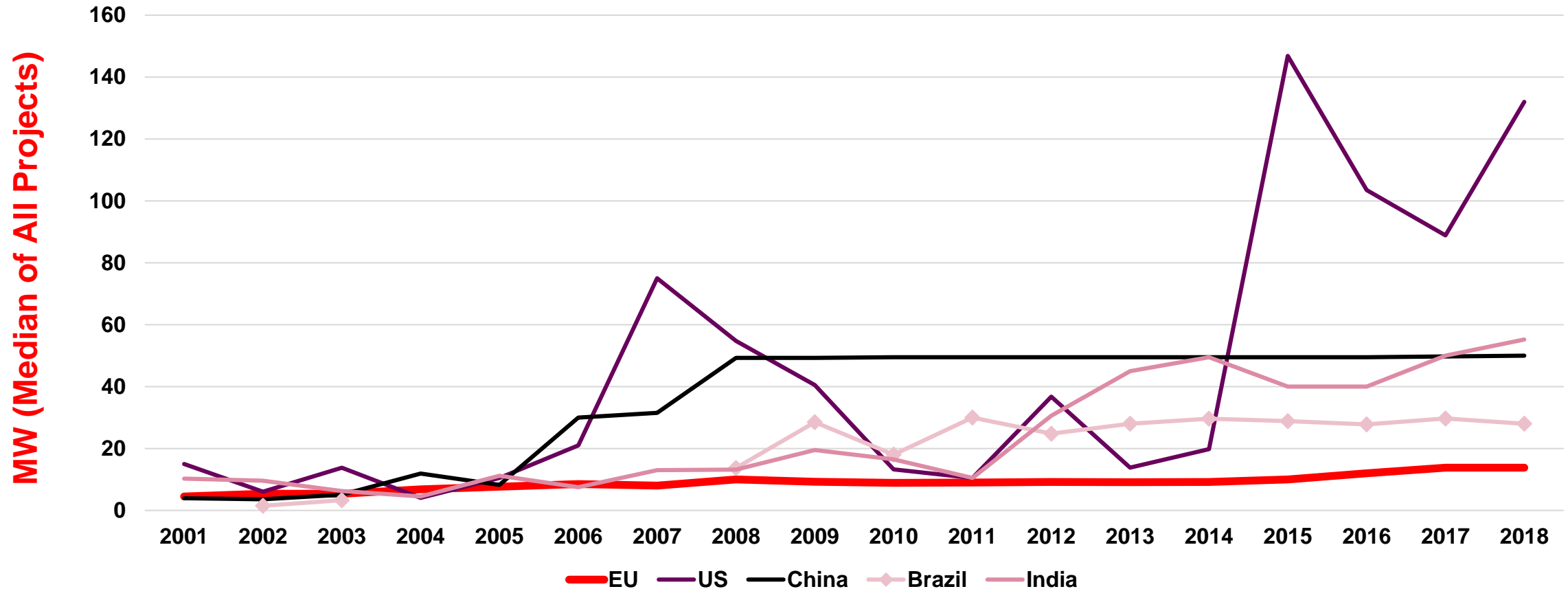
Source: NREL

Steel prices have been trending higher, underpinning wind turbine costs



Platts Steel Plate Price assessments

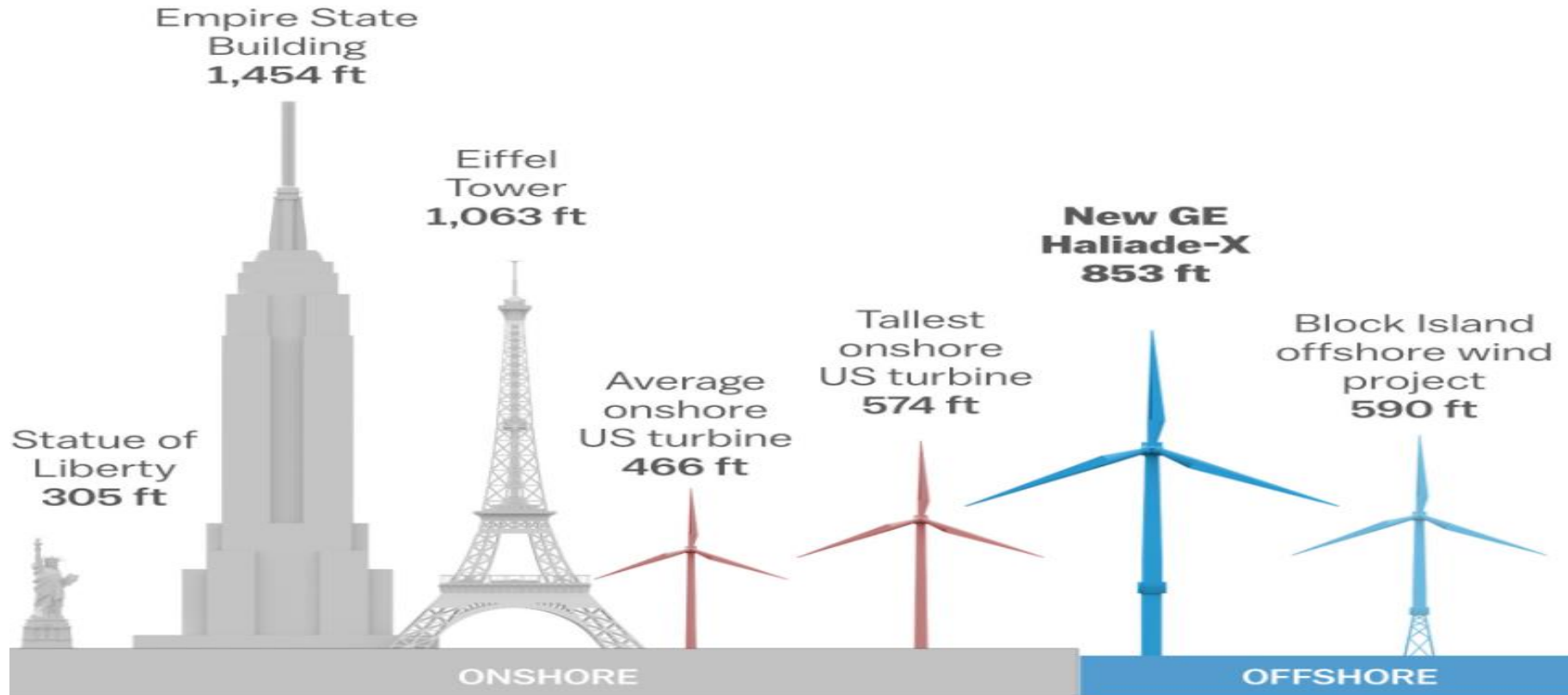
Median size of onshore wind projects increase over the years; US projects the largest in the world, smallest are in Europe



Source: Platts Analytics, Market Intelligence World Electric Power Plant database

Wind turbines: as heights and sizes increase, so does the logistical complexity of building and executing a project

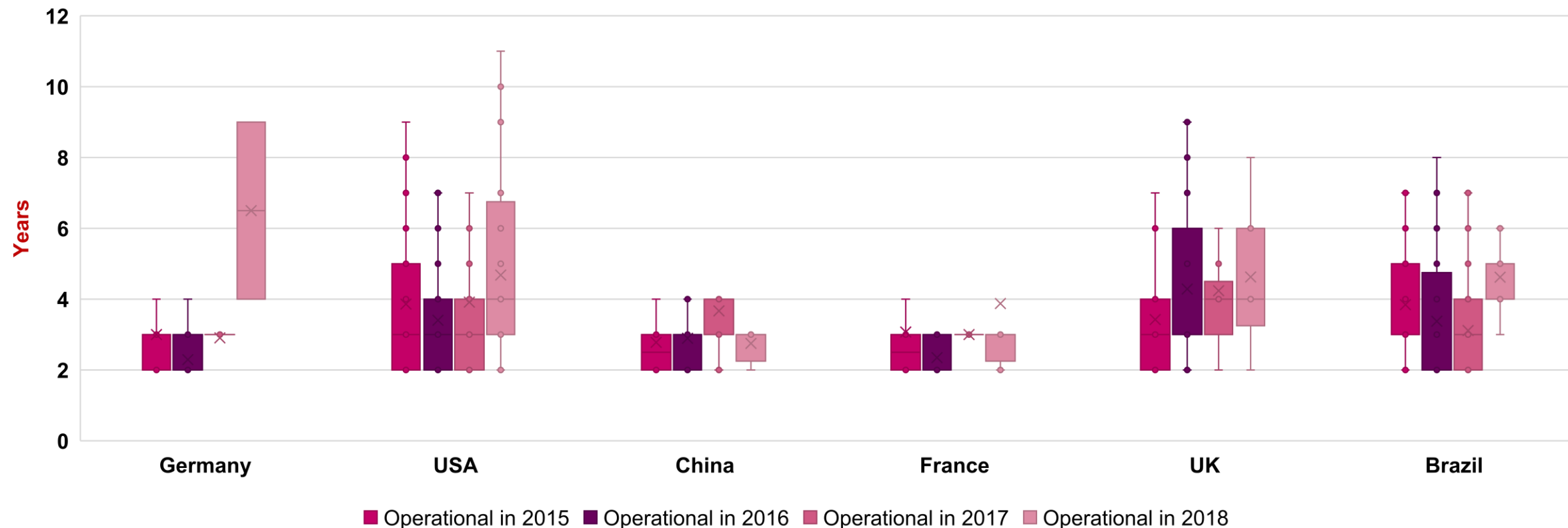
Suitable sites for onshore wind more difficult in highly populated regions



Source: GE, Vox research

As projects grow larger and more complex, commissioning takes longer, with the exception of China

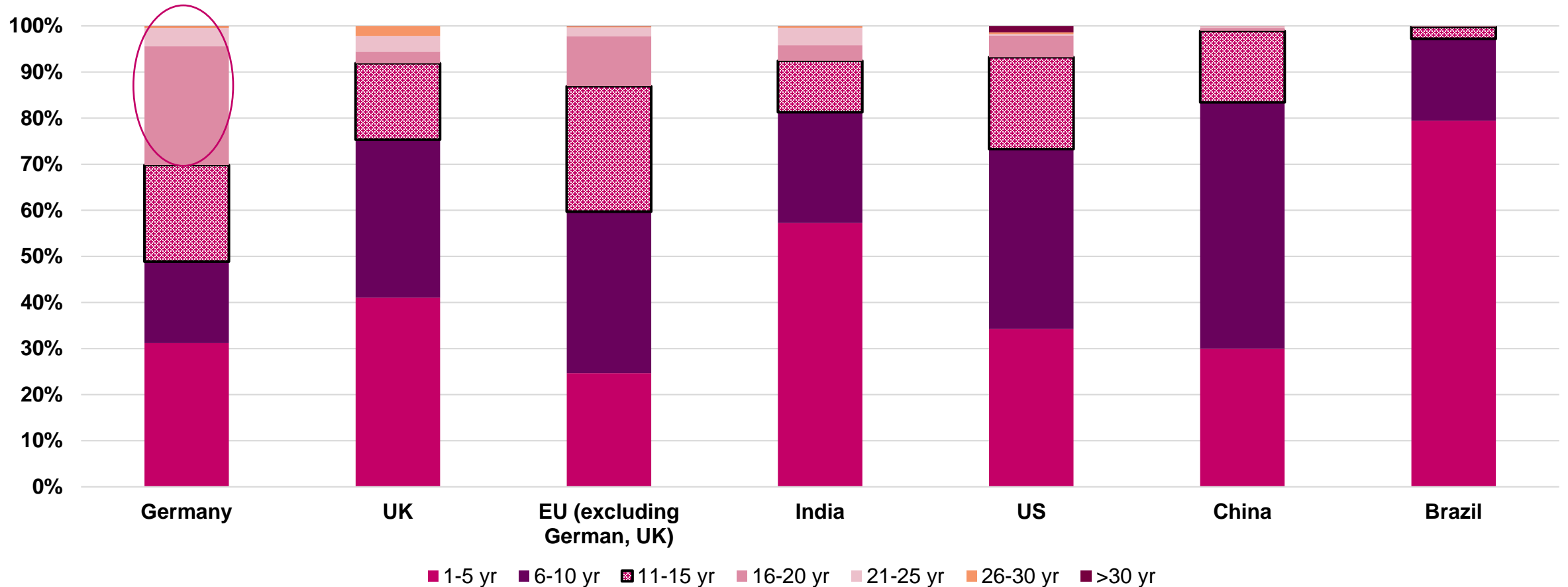
Number of years to bring a project online – onshore only



Source: Market Intelligence World Electric Power Plant database

The box and whisker chart shows all the sampled projects as dots. The upper and lower end of the line marks the min and max, the upper and lower line of the box mark the upper and lower quartile, and the marker shows the mean of a project's lifetime. Outliers were removed.

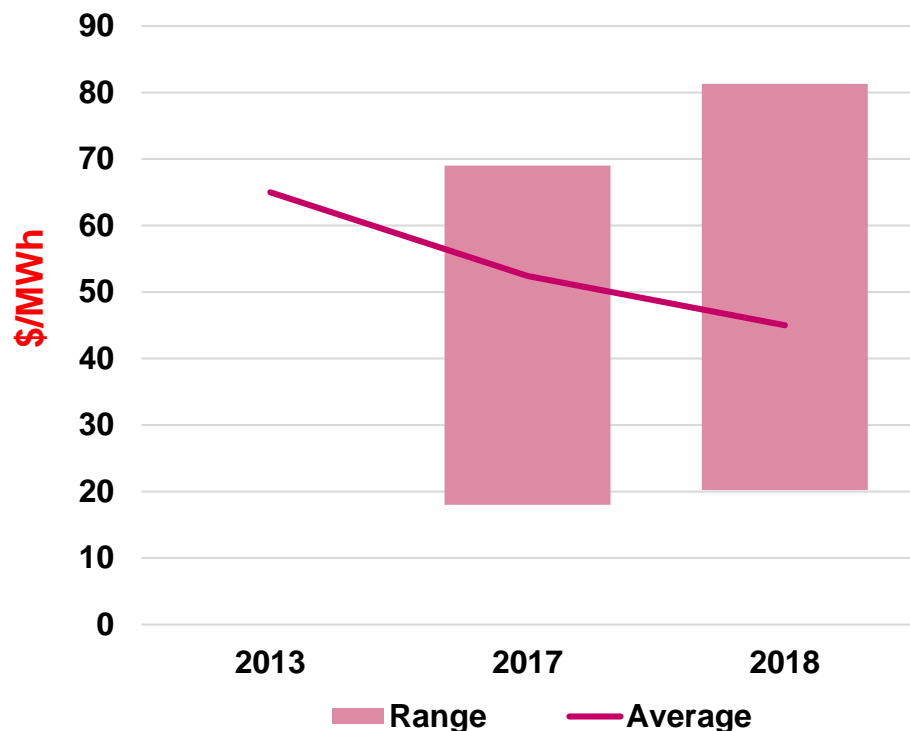
Germany operates about 30% of total wind capacity over 15 years old, featuring the greatest potential for repowering



Source: World Electric Power Plant Database

Onshore wind auction prices appear to be stabilizing, with higher bids emerging

Global weighted-average onshore wind auctions results



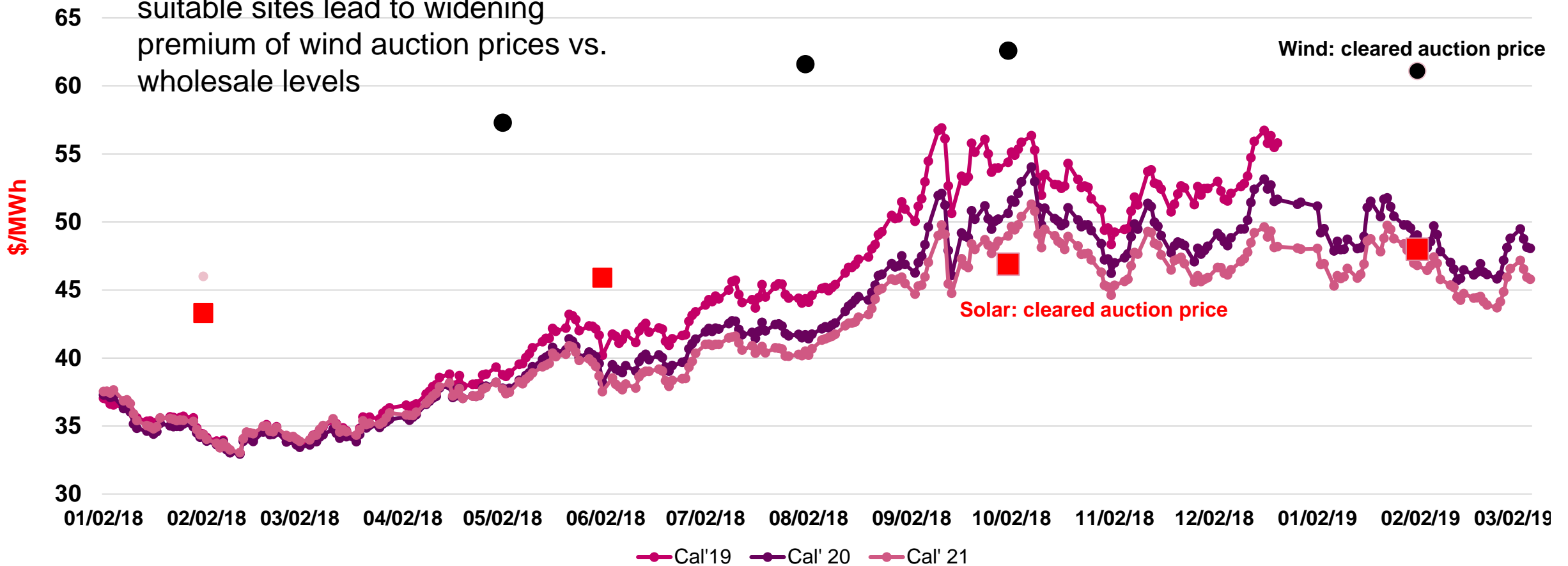
Key auctions results in 2018

Country	Bid (\$/MWh)	MW	Plant	Date
Saudi Arabia	\$21.3	400	Dumat Al Jandal	July 2018
Germany	€46/MWh	709	Various	Feb 2018
Germany	€57.3/MWh	604	Various	May 2018
Germany	€61.6/MWh	670	Various	Aug 2018
Germany	€62.6/MWh	363	Various	Oct 2018
France	€65.4/MWh	508.4	Various	Feb. 2018
France	Not disclosed	118	Various	Sep. 2018
Canada	\$29-30/MWh	764	Various	Dec. 2018
Brazil	\$20/MWh	133.6	Various	Apr. 2018
Brazil	\$22/MWh	1230	Various	Aug. 2018
India	USD 38-40/MWh	5,200	Various	Feb/Apr/Aug

Source: IRENA and trade press. Data represent awarded capacity by year of auction award, for projects to be built in the future, and do not represent investment. It includes, when available, Argentina, Brazil, Chile, Denmark, France, Germany, India, Italy, Malaysia, Mexico, Morocco, Netherlands, Russia, Saudi Arabia, South Africa, Spain, Turkey, United Arab Emirates, United Kingdom. China is excluded from the analysis. 2018 is a provisional estimate from the table above.

German onshore wind auction prices move higher, suggesting higher costs to bring wind online

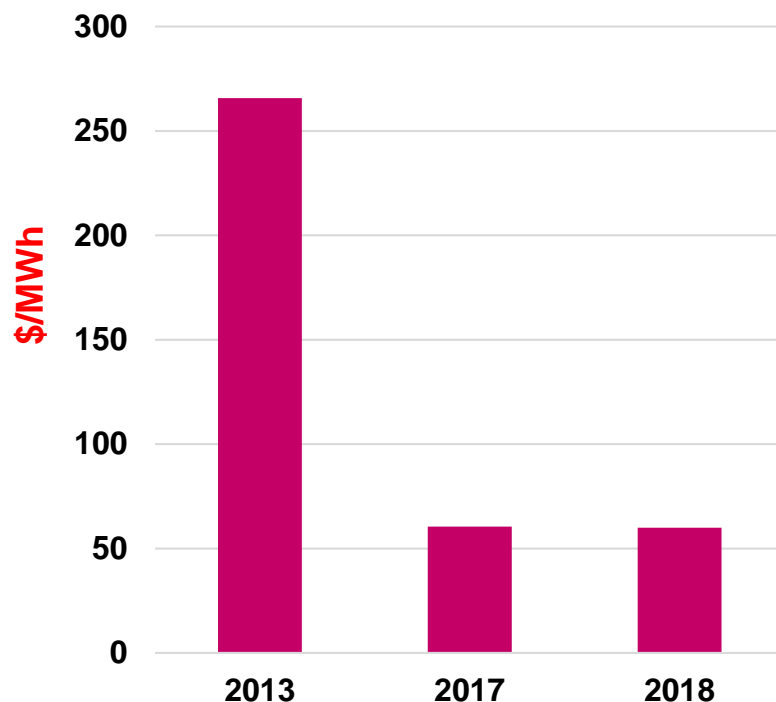
Permits backlog and difficult to find suitable sites lead to widening premium of wind auction prices vs. wholesale levels



Note: Auction results shown at bidding dates. Source: Platts Analytics, BNetzA, EEX

Offshore wind auction prices: costs further decline, with zero bids emerging in Europe

Weighted-average auctions prices



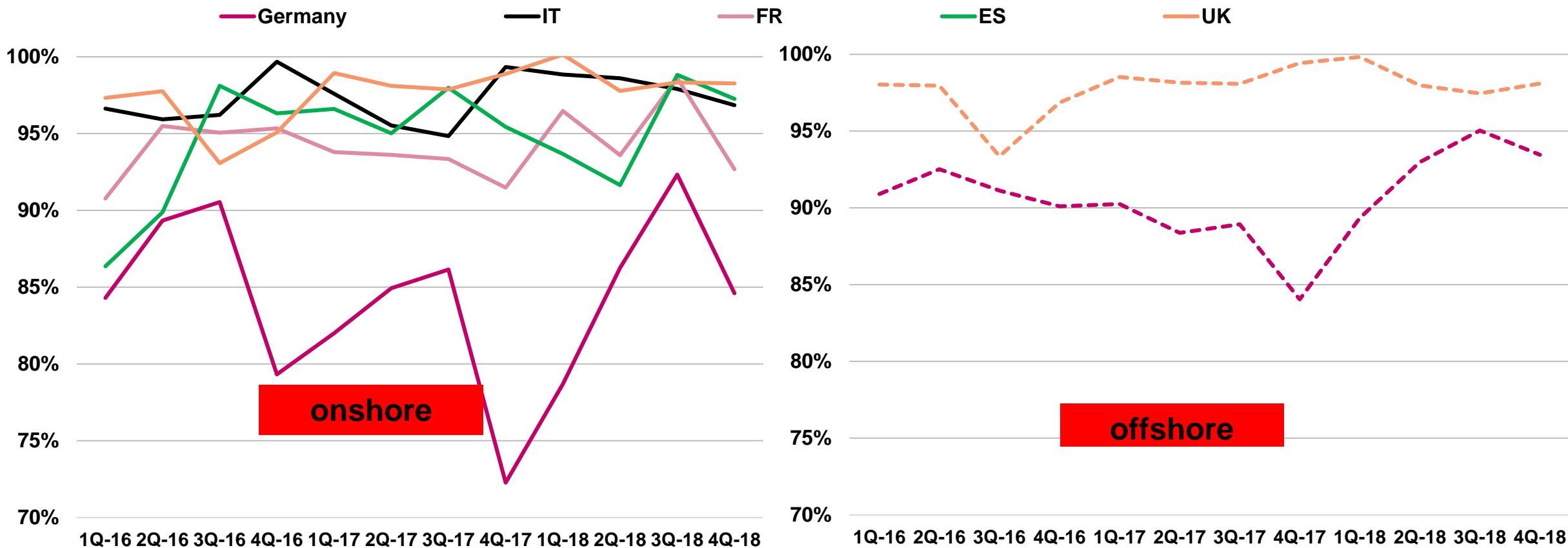
Key auctions results in 2018

Country	Bid (\$/MWh)	MW	Plant	Date
Germany	€0 (no price guarantee) to €98.3/MWh, €46.6/MWh weighted average	1610	Various	April 2018
Netherlands	€0 (no price guarantee)	700	Hollandse Kust Zuid	April 2018
U.S.	starting \$74/MWh, average \$84/MWh	800	Vineyard Wind	Summer 2018
Taiwan	72 to 82.61\$/MWh	3836	Orsted and others	April, June 2018

Key auctions in 2019: NY (0.8 GW), UK (up to 6 GW), Denmark (0.8 MW)

Data represent awarded capacity by year of auction award, for projects to be built in the future, and do not represent investment. Projects with multiple phases are treated as single projects when awarded in the same year and share a common developer. Includes Germany, UK, France, Netherlands, U.S., Taiwan
 Source: Platts Analytics

Wind capture price* as proportion of market price across selected markets: offshore higher than onshore. Generally flat trend in spite of higher wind penetration



Note: * Capture price refers to the price a typical wind plant achieves in the market. Source: TSOs, GME, EPEX, OMIP, NordPool

Overview of the wind outlook by major market (I)

Bearish
 Neutral
 Bullish

WIND CAPACITY
ADDITIONS VS.
2018

OUTLOOK

COMMENTS

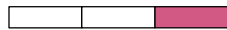
China



We assume wind capacity additions in China will be on the order of 20 GW/year in the near term, in line with the 2018 additions. However, early data for 2019 is showing some downside risks to this view. **Although a shift to auctions is in sight, the pipeline of projects that is entitled to the old FiT regime is still large (50+ GW).**

Grid curtailments appear to have been improving, although this may be the result of particularly high power demand in 2018. Limitations to bring online new wind projects are in place in the northern provinces (notably XinJiang, Gansu and IM). About 40% of the 50+ GW pipeline could face permitting delays.

India



India's wind deployment has significantly decelerated in 2018 and so far in 2019, as a result of a number of execution hurdles in conjunction with a recent shift to auctions. About **5.2 GW of wind have been awarded in auctions held in Apr-Dec 2018. Auctioned volumes could ramp up to ~10 GW/year. However, infrastructure constraints, land availability and broader power sector uncertainties may delay additions in the near term.**

Middle East



Saudi Arabia's 400 MW Dumat Al Jandal project was awarded at \$21.30/MWh – among the lowest bids globally. This bid has surprised for its low level, especially for a country just starting the development of wind. **The Saudi Renewable Energy Project Development Office (REPDO) will tender 850 MW of wind in 2019, as part of the revised targets: 7 GW by 2023 and 16 GW by 2030, with the Saudi Renewable Energy Project Development Office (REPDO).**

Turkey has also a sizeable pipeline of projects (3+ GW), with a 1 GW tender set for this March, which follows another 1 GW tender held in Aug. 2017 and cleared at \$34.8/MWh. It's unclear the status of the 1.2 GW off-shore tender held in October 2018.

Overview of the wind outlook by major market (II)

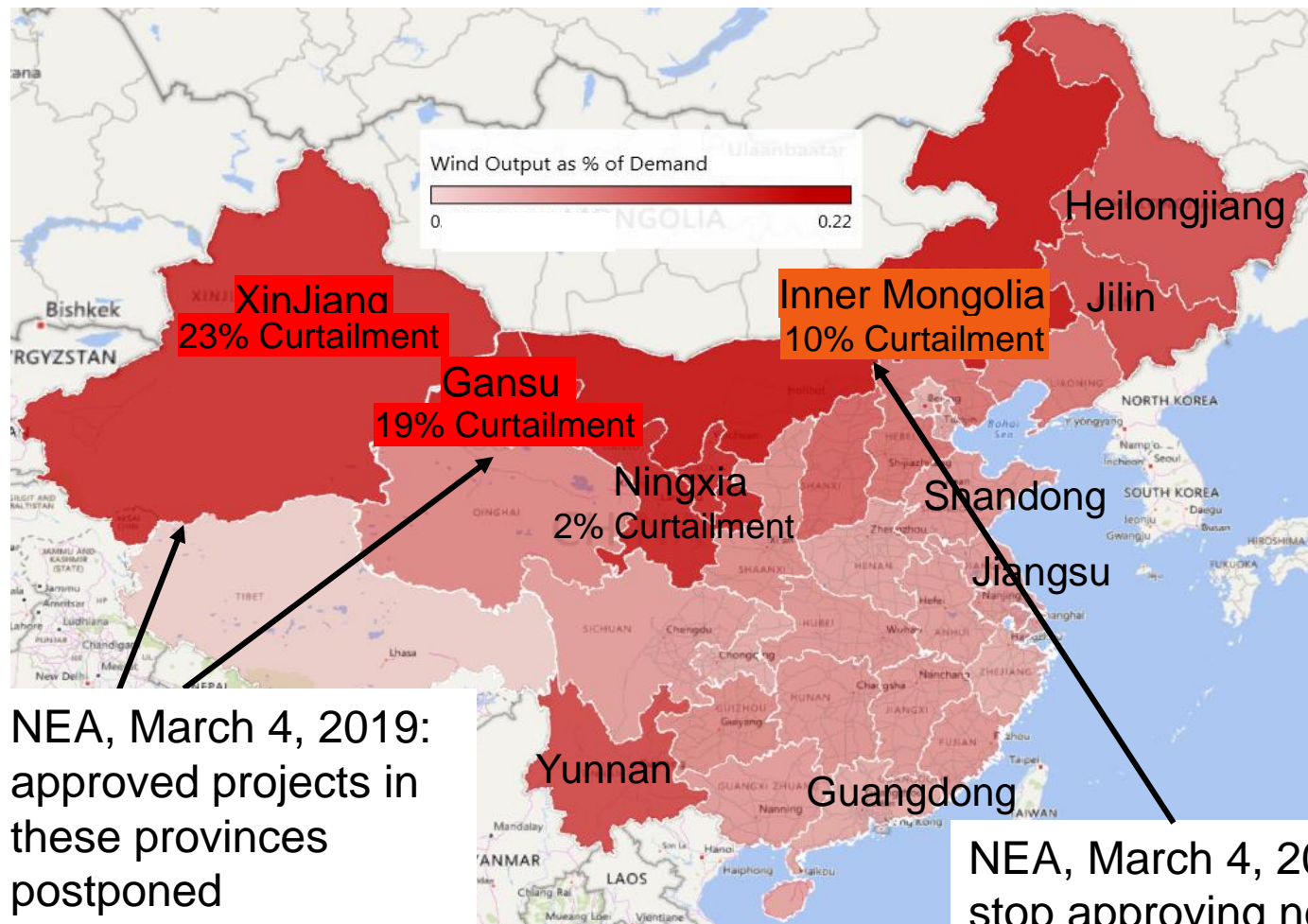
Bearish
 Neutral
 Bullish

CAPACITY ADDITIONS	OUTLOOK	COMMENTS
<u>Europe</u>		<p>Europe maintains a large pipeline of projects, both for on-shore (~45 GW) and off-shore (>50 GW), but this potential is facing a number of challenges in the medium-term, due to lengthening permitting times and a recent change in supporting mechanisms. However, in spite of this attrition, there is potential in Northern Europe, especially offshore, which could sustain additions in the 2020s. In addition, Germany has a large potential for repowering (some 10 GW).</p> <p>Spain offers some upsides in the shorter term, while France has also seen a recent acceleration in capacity connected to the grid in 4Q 2018, although there are risks that this recent trend may not be sustained and France may fall well below its set 2023 targets.</p>
<u>U.S.</u>		<p>Strong near-term momentum remain for wind, as projects are still eligible for the full PTC. Risks exist to on-shore wind deployment post 2021, but there is also growing interest in offshore along the East Coast, with the first large-scale plants set to be commissioned in the early 2020s. The pipeline of projects is large enough to sustain additions well in excess of 40 GW for the period 2019-2025.</p> <p><u>For a more detailed view of the U.S. trends and drivers, see our NY Seminar renewables outlook presentations.</u> More details on U.S. power could be found in the <u>North American electricity analytics reports.</u></p>
<u>LATAM</u>		<p>Brazil: 4.3 GW of on-shore wind has been contracted through long-term auctions, while additions have been in the 2-2.5 GW/year range in 2017 and 2018. New auctions (A-4 and A-6) will be held in 2019, 2020 and 2021 and could boost additions for the 2024-2025 period and beyond.</p> <p>In Mexico, 2.4 GW of capacity has been contracted in the 3 long-term auctions held in 2016 and 2017, with a number of bids sub \$20/MWh - among the lowest in the world. Chile is also the other bright spot in South America, with its 1.5 GW of operational wind capacity and about 742 MW in construction as of Jan 2019, but with a more substantial number of projects in the pipeline (over 9 GW). However, the pipeline of projects in Argentina has also been growing to 4 GW, which could turn Argentina into a new hot spot for wind in South America. A 350 MW wind/solar auction will be held in March 2019 in Argentina, while a much awaited 1 GW auction in Colombia was postponed again.</p>

China: strong additions in 2018. In spite of large pipeline of projects, shift to auctions and curtailments key risks ahead

- Capacity additions in 2018 totaled over 20 GW or about 5 GW above 2017 levels, up by 35% Y/Y, according to NEA. We assume an average of 20 GW/year for the period 2019-2025, with early data for 2019 pointing to downside risks to this view.
- While FiTs for onshore wind have been progressively lowered, China also took the decision to switch soon to an auction mechanism, with gradual elimination of government subsidies.
- Grid curtailment has been a major challenge, but the situation has also improved. The national average curtailment rate decreased from 17% in 2016 to the 5-7% range currently. The development of wind in Central and Southern regions is being prioritized over the three-northern regions where the curtailments are the highest (XinJiang, Gansu and Inner Mongolia). In the “Circular on wind power investment monitoring and early warning results” of March 2019, a warning to postpone construction of new projects is now in effect only for Xinjiang and Gansu provinces, while approval of new projects is paused in IM.
- China has a strong pipeline of projects that will still be able to benefit from the prior or current support mechanism and will still be largely unaffected by the switch to auctions. This pipeline consists of 57 GW, of which 8 GW will be at a distributed level, according to wind turbine supplier Goldwind. However, about 40% of this pipeline is located in provinces where there are some sort of limitations to wind development, so they could face delays.

Chinese wind penetration higher in the Northern provinces. Larger potential for wind growth in the southern/coastal provinces



NEA, March 4, 2019:
approved projects in
these provinces
postponed

NEA, March 4, 2019:
stop approving new
projects

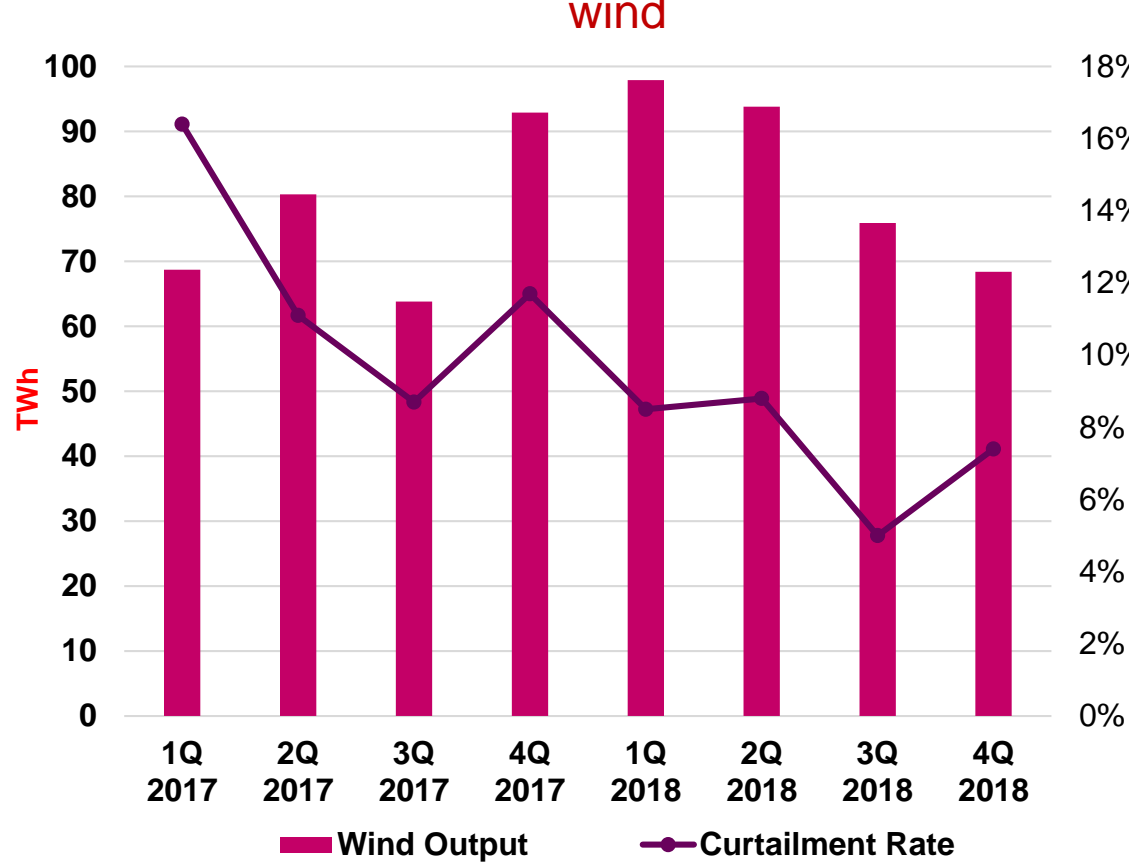
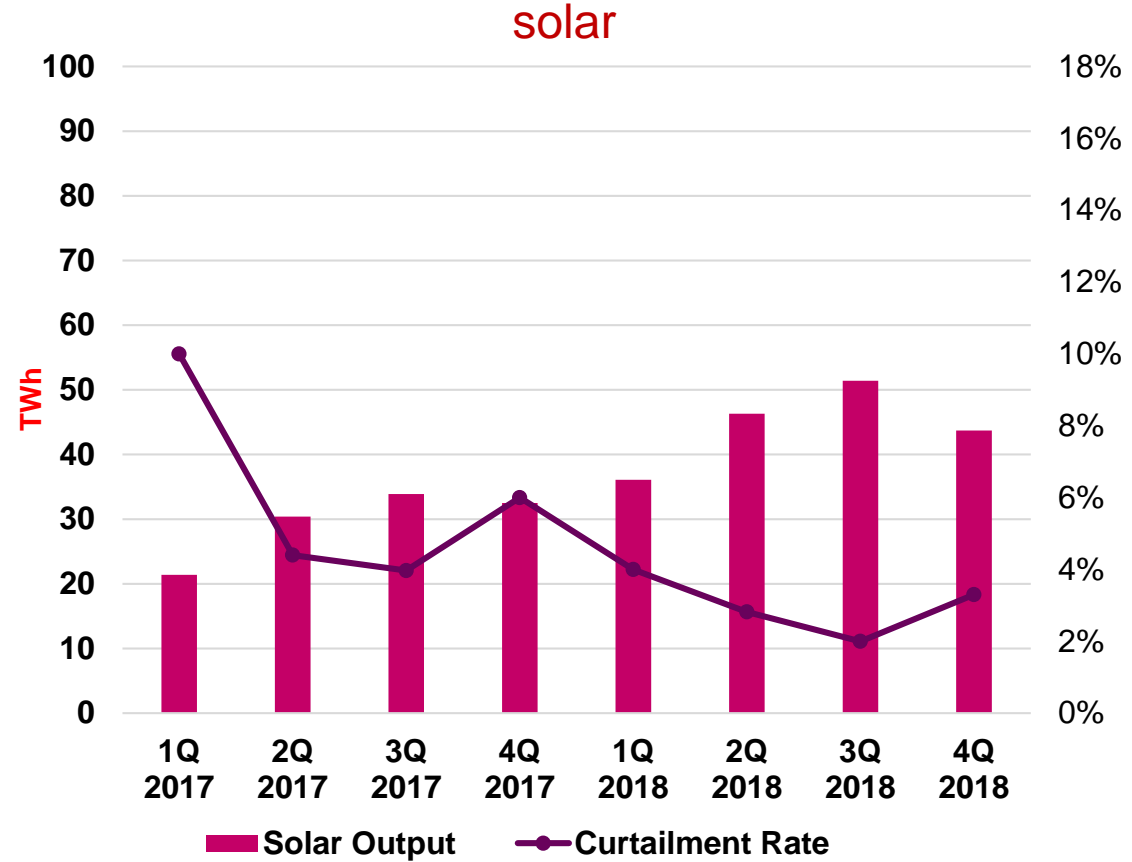
In the Northern provinces of Xinjiang, Gansu, IM and Ningxia wind serves around 20% of total demand.

Xinjiang, Gansu and IM are top 3 provinces in terms of curtailment rate – at 19%, 23% and 10% respectively in 2018.

However in the more populated provinces, e.g., Guangdong, Jiangsu and Shandong provinces, wind output accounts for less than 3% of total demand.

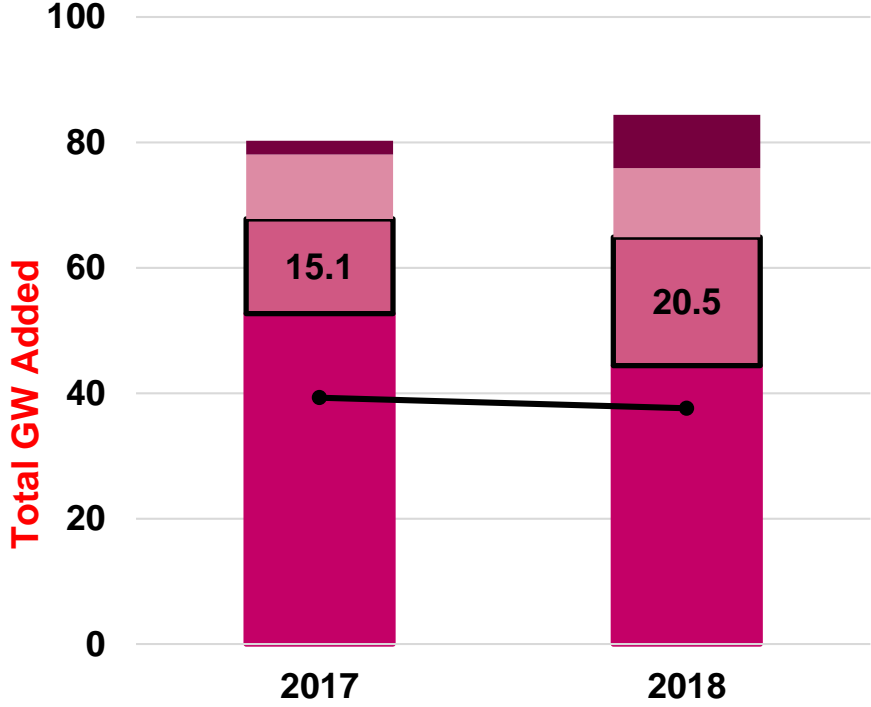
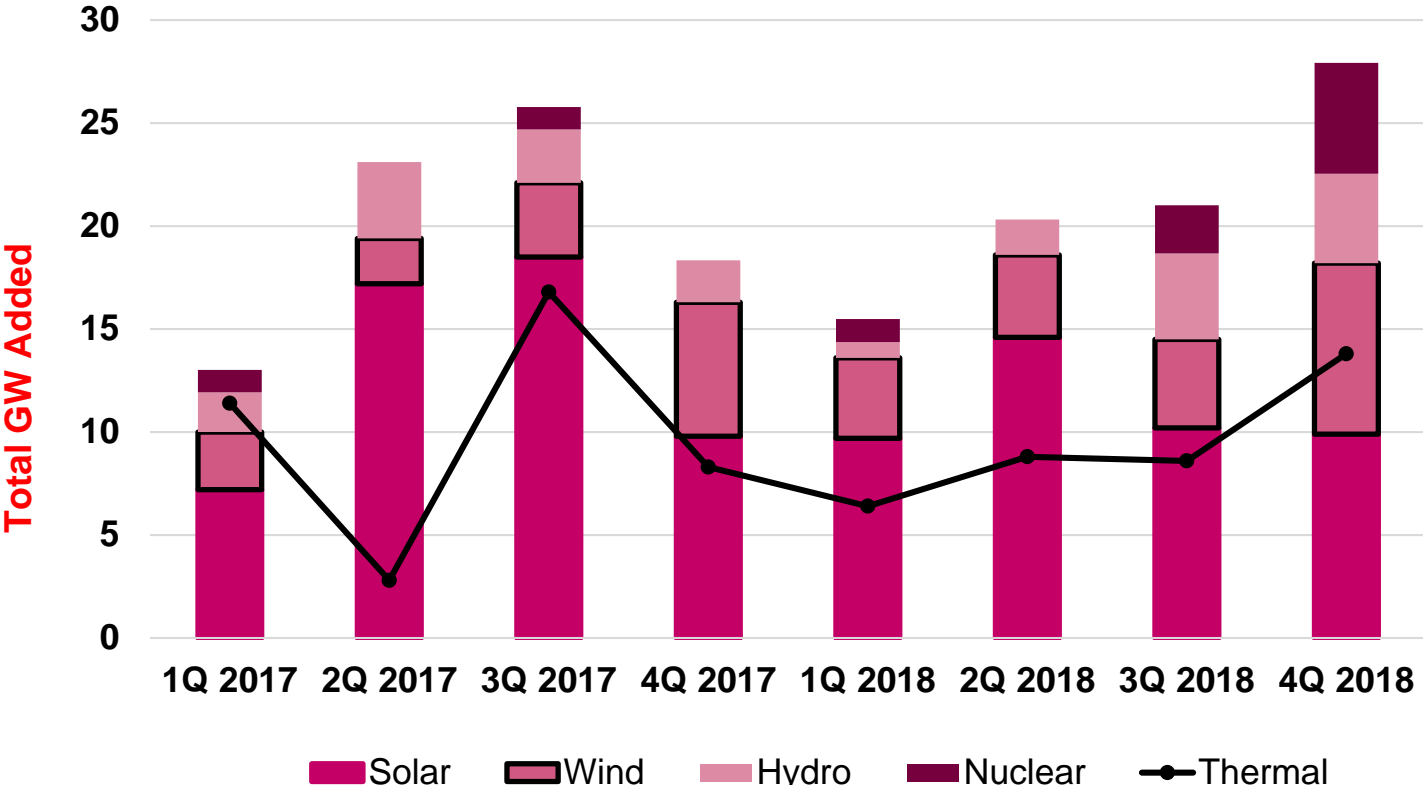
Reference: NEA, National Statistics, Platts Analytics

Chinese solar and wind curtailment rates drop significantly. Wind curtailments higher than solar



Source: NEA, Platts Analytics

Chinese capacity changes by source: large growth for wind in 2018, but additions appear slower at the start of the year

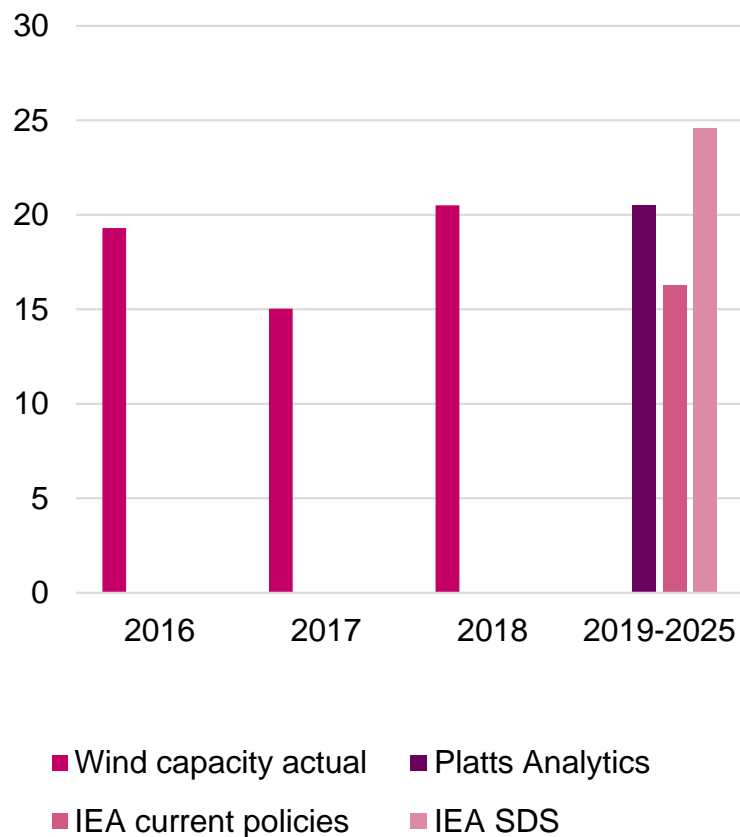


Provisional figures for Jan. and Feb. 2019: 1.3 GW of wind added, which could translate into 2.5 GW for 1Q, down from 3.9 GW added in 1Q 2018

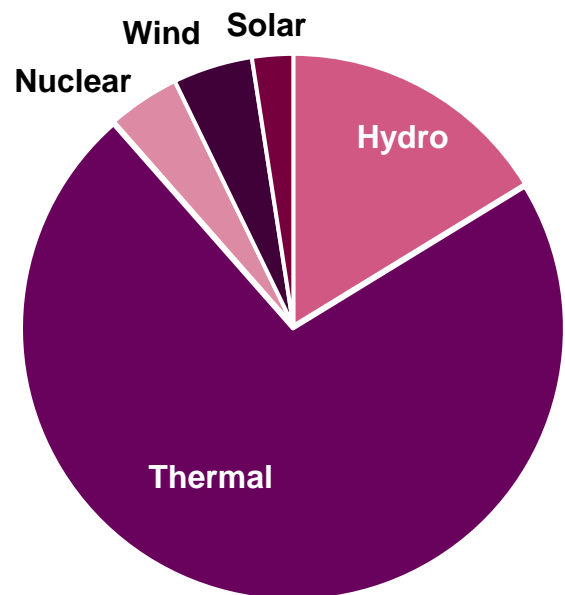
Source: National Energy Administration Statistics, China Electricity Council Monthly Statistics

China: flattening wind growth, with narrow upsides potential in the near term.

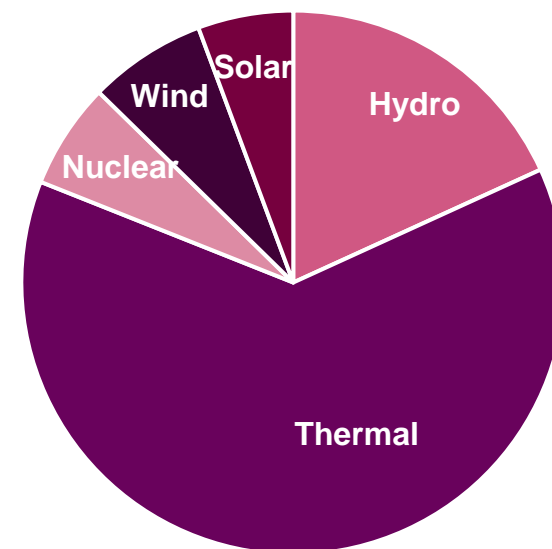
China annual additions GW



Generation Mix 2018



Generation Mix 2025



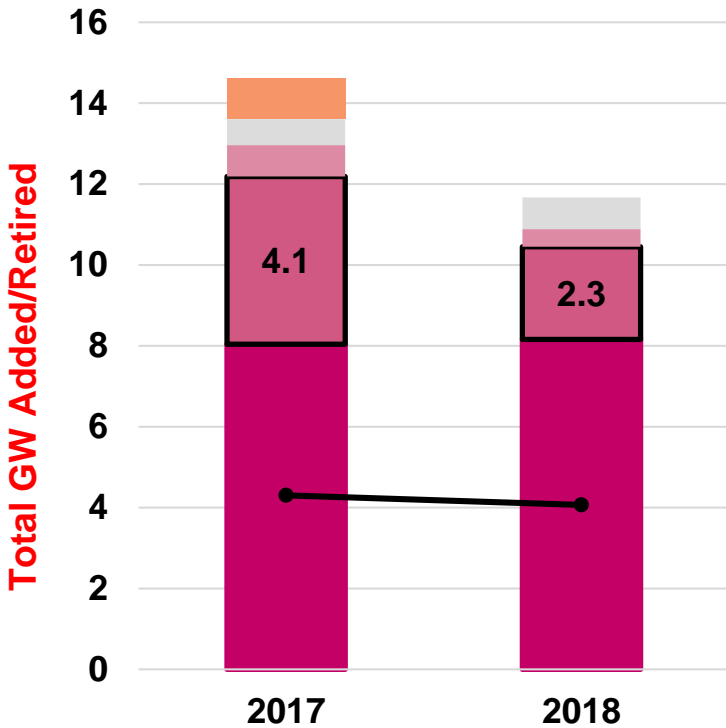
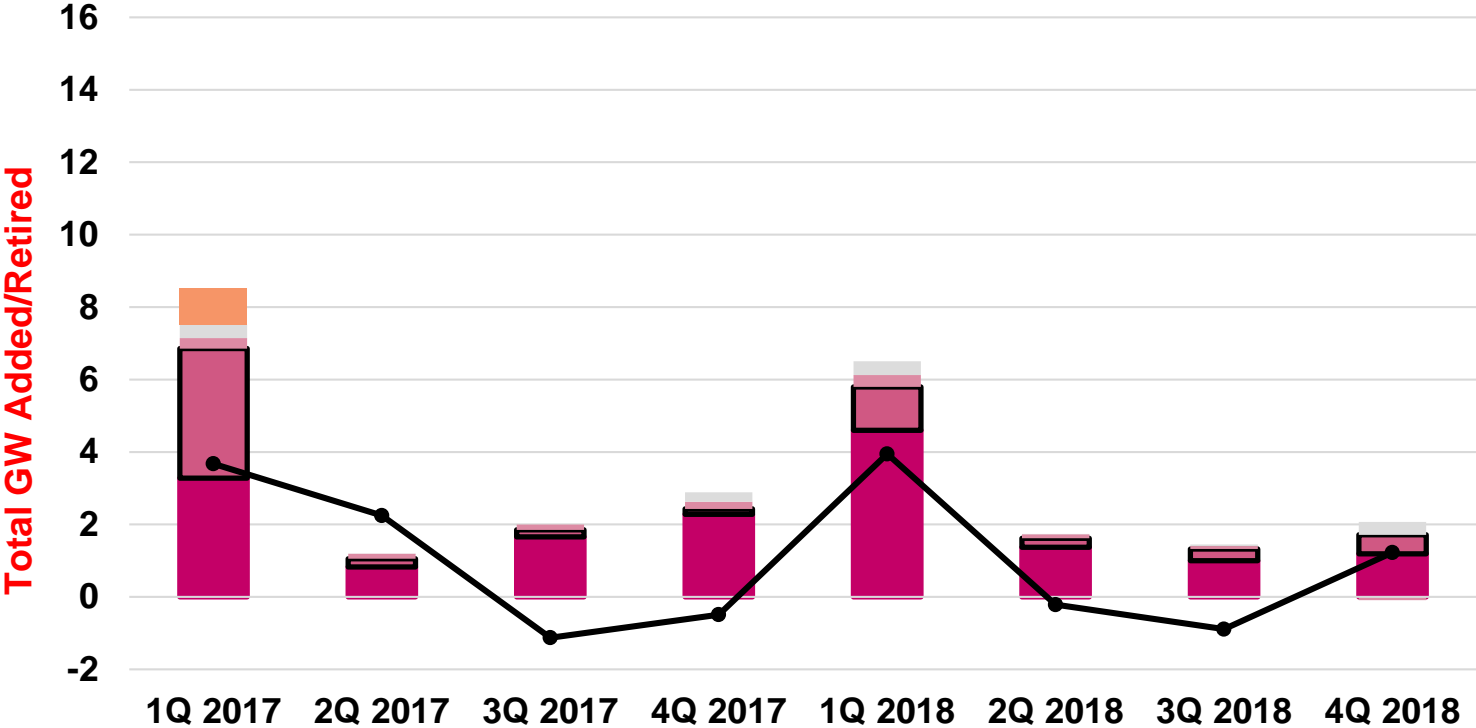
Generation mix outlook: Share of thermal remains largely intact, due to growing topline electricity demand. Risk for fossil fuel displacement (essentially coal) could emerge mostly under a more optimistic solar deployment, whereas our assumptions for wind are already quite generous. Under the IEA SDS scenario, the delta of displacement for coal from higher wind growth would be less than 1 GW, against a risk of 2+ GW/year from solar.

Source: Platts Analytics, World Energy Demand Model, Platts Scenario Planning Service, IEA 2018 World Energy Outlook

India: large pipeline of projects, but current slowdown reflects move to auctions and broader power sector uncertainties

- India has already installed some 35 GW of wind as of Jan 2019, with the government committed to diversify its power mix with a 60 GW target set for 2022.
- Only 2 GW were connected to the grid in 2018, a sharp decrease versus earlier years additions. The shift from FiT to a competitive bidding mechanism has caused uncertainties, but the first projects awarded under the new regime are now entering the commissioning phase.
- At least 7 GW of wind is under construction currently with 5.2 GW tendered only in 2018 under various schemes. The latest tender held by SECI (1.2 GW) in Feb 2019 has seen prices settling at the ceiling of INR 2,830/MWh (~\$40/MWh), with prices inching a notch higher versus auctions held earlier in 2018.
- The Ministry of New and Renewable Energy (MNRE) has also issued an expression of interest from offshore wind energy developers last year.
- We have wind additions at about 5.5 GW/year over the upcoming years, considering the significant tender activity held so far in 2018/19 and likely being ramped up in the future. Infrastructure constraints (inter-regional transmission capacity), land availability and auction delays are still seen as key risks that could delay the deployment in medium-term.

India: changes in installed capacity by source with solar the major source of capacity growth, wind and thermal slow down significantly

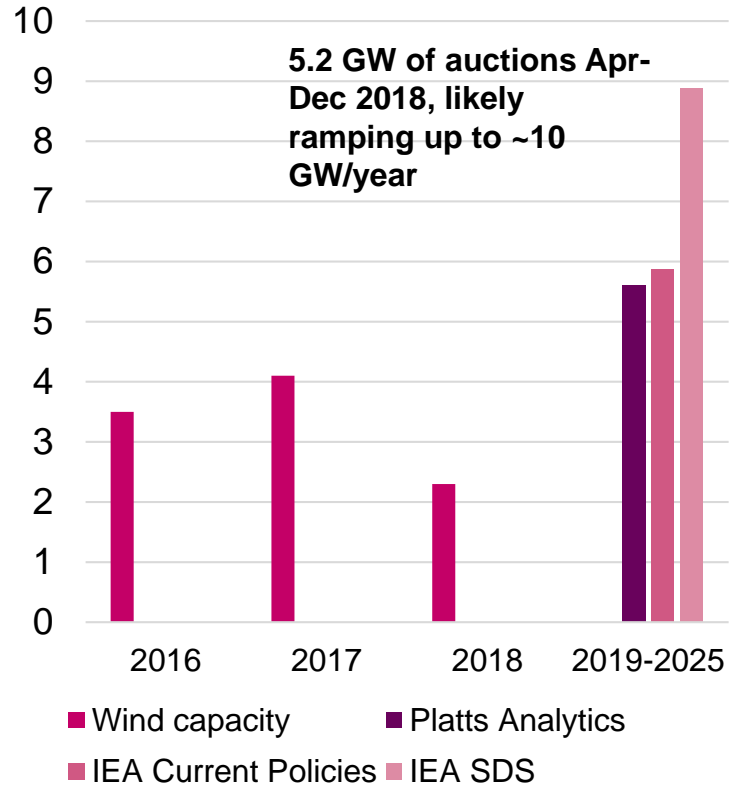


Source: CEA
S&P Global
 Platts

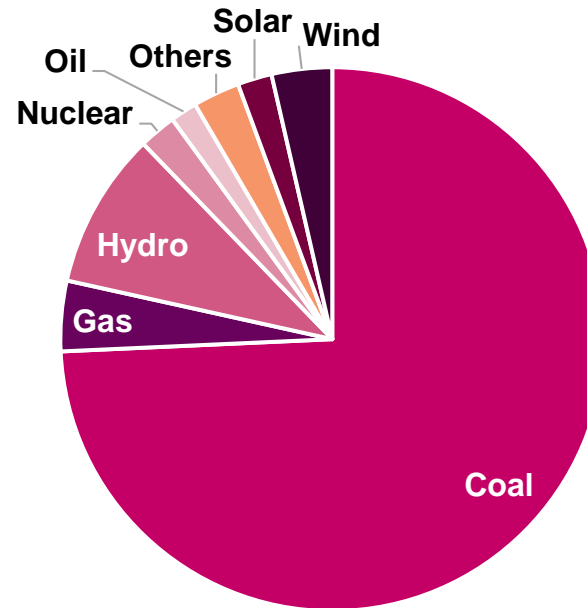
Jan. 2019 only 150 MW of wind added, we estimate 450 MW for 1Q 2019, down from 1.2 GW added during 1Q 2018. Wind additions in 2019 could total ~2 GW

India: limited upsides for wind additions. Coal at risk, role of gas remains limited

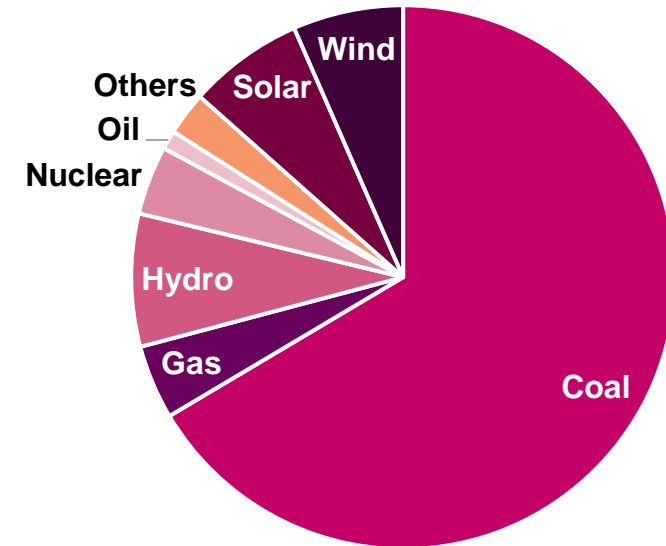
India Annual Additions (GW)



Generation Mix 2018



Generation Mix 2025



Generation mix outlook : While there is a strong political will to diversify the power generation mix, headwinds for the development of renewables have been emerging. We have assumed 5 GW/year of wind additions, an optimistic view considering that 2018 saw only 2 GW of new wind capacity. In our view, LNG is not well placed to grow in the Indian power sector, so the risks bear essentially on the coal side. The share of coal clearly shrinks going forward, but given the strong power demand growth (9 GW/year or ~4% p.a.), coal dispatch continues to grow in the medium-term. Under a more optimistic view for wind deployment (ramping to 10-12 GW/year), the risk for coal is only about 1 GW /year, which is to say that coal will continue to grow in the medium-term.

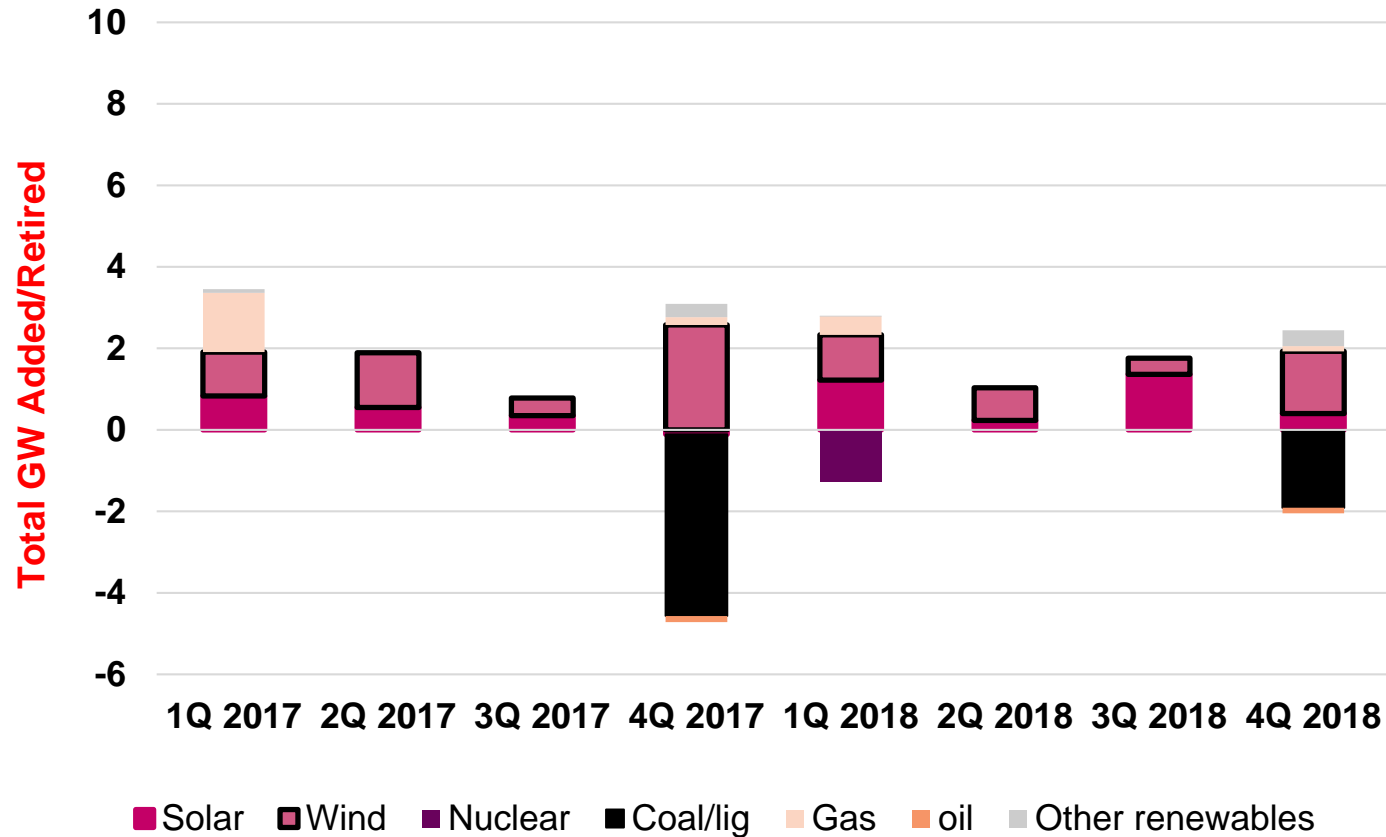
Source: Platts Analytics, World Energy Demand Model, Platts Scenario Planning Service, IEA 2018 World Energy Outlook

Europe: limits emerge to onshore wind expansion, but support from repowering and offshore developments

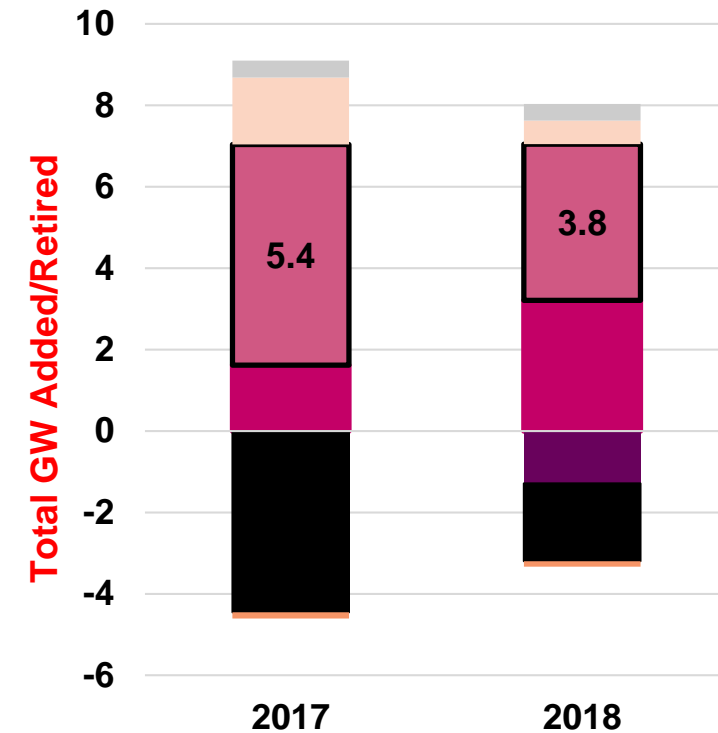
- **Significant slowdown in German onshore additions, due to a number of reasons:**
 - A shift from FiT to auctions from 2017 to make annual deployment more stable and predictable,
 - Introduction of a “Nord congestion zone” in Feb. 2017, with limits for the windy Northern regions to build plants due to grid congestions
 - Introduction of “distance regulations” (e.g. “10H rule”: site distance from dwelling at least 10 times the total turbine height)
 - Permits backlog
 - As onshore projects become larger and taller, increasing logistic complexity and lengthier execution especially in densely populated areas.
 - Citizens’ projects were allowed to participate in auctions without construction permits

12+ GW of tenders are planned by 2021, but the prior three auctions were undersubscribed
- **French additions have been fairly stable, with over 1.5 GW of wind connected in 2018 and additions accelerating in 4Q 2018. France will auction 1.6 GW of onshore wind in 2019, ramping up to 2 GW/year through 2024. About 0.5 GW of offshore will be actioned in 2019, following by 1 GW in 2020 for a total of 4 GW through 2024.**
- **The UK has over 8 GW of off-shore capacity installed and 20 GW+ of off-shore projects. The recently announced “off-shore wind sector deal” between the government and the industry indicates that 30% of the total demand would be met by off-shore wind by 2030, which would imply some 25+ GW of offshore would be installed by then. Although ambitious, this appears feasible given the current pipeline of projects and higher electricity prices. The government plans to hold a third Contracts for Difference (CfD) auction in May and further biennial tenders from 2021 to award long-term contracts for additional capacity.**

German changes in installed capacity by source: wind expansion decelerating



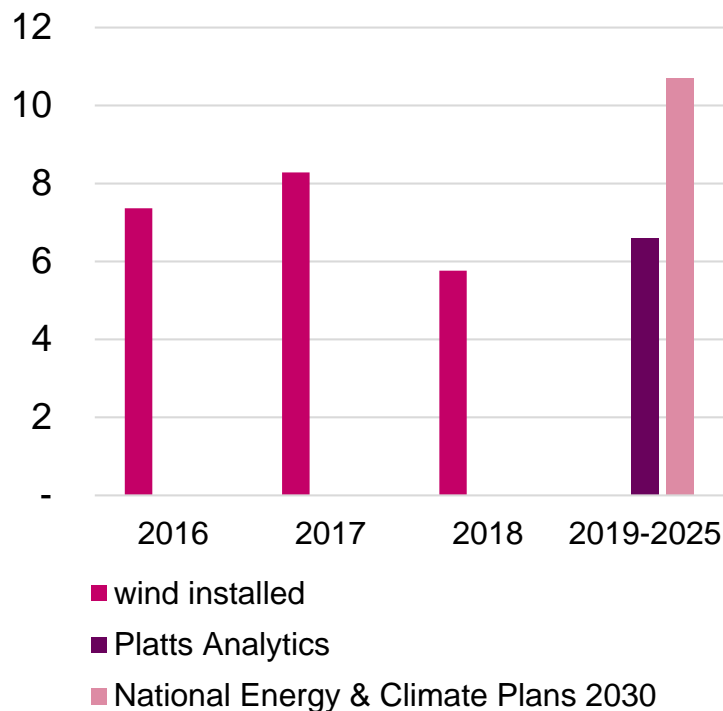
Source: BNetZa, Fraunhofer ISE, Platts Analytics



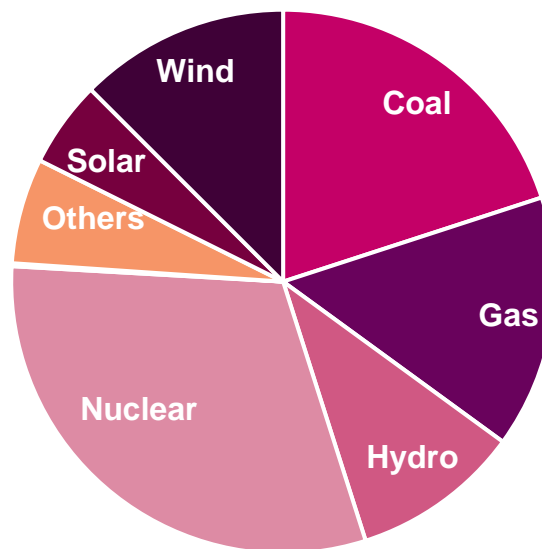
Wind additions in Jan. and Feb. 2019 totaled 0.4 GW, we estimate 0.6GW for 1Q 2019, down from 1.1 GW added during 1Q 2018

Europe big 5 (Germany, France, Spain, Italy, Netherlands): downside risks for onshore capacity expansion

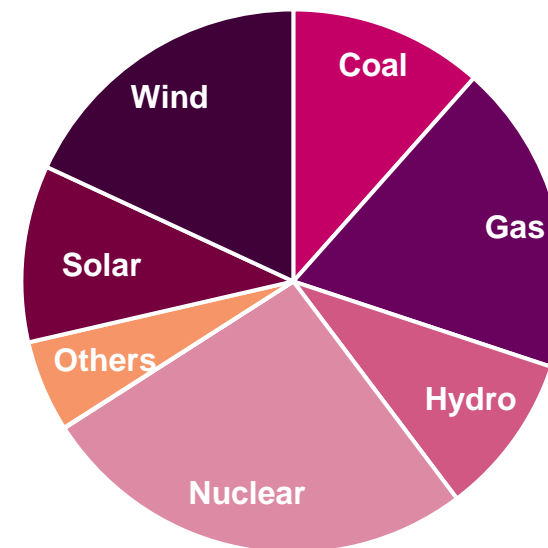
Europe Annual Additions
(GW)



Generation Mix 2018



Generation Mix 2025

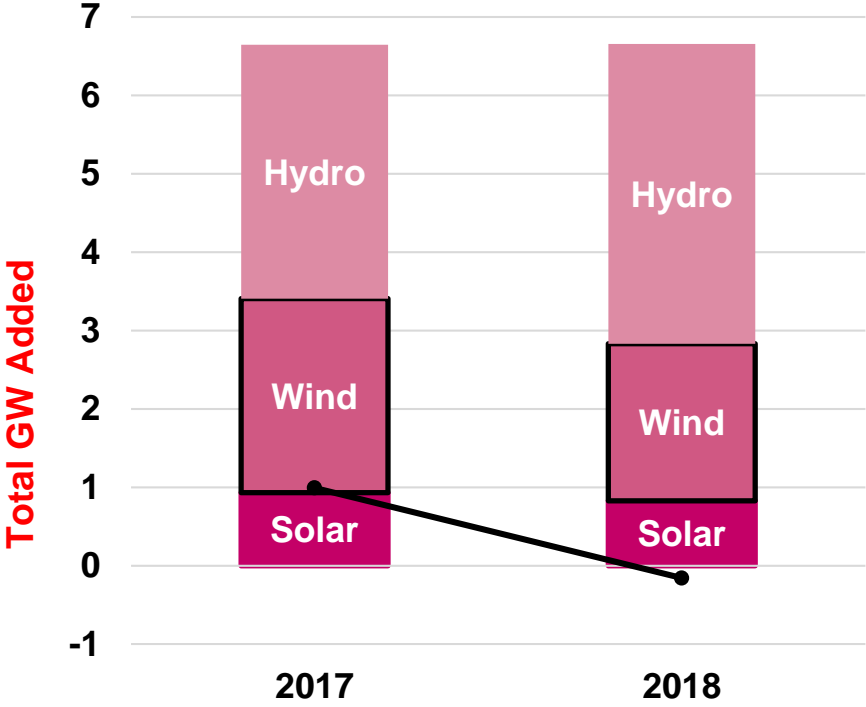
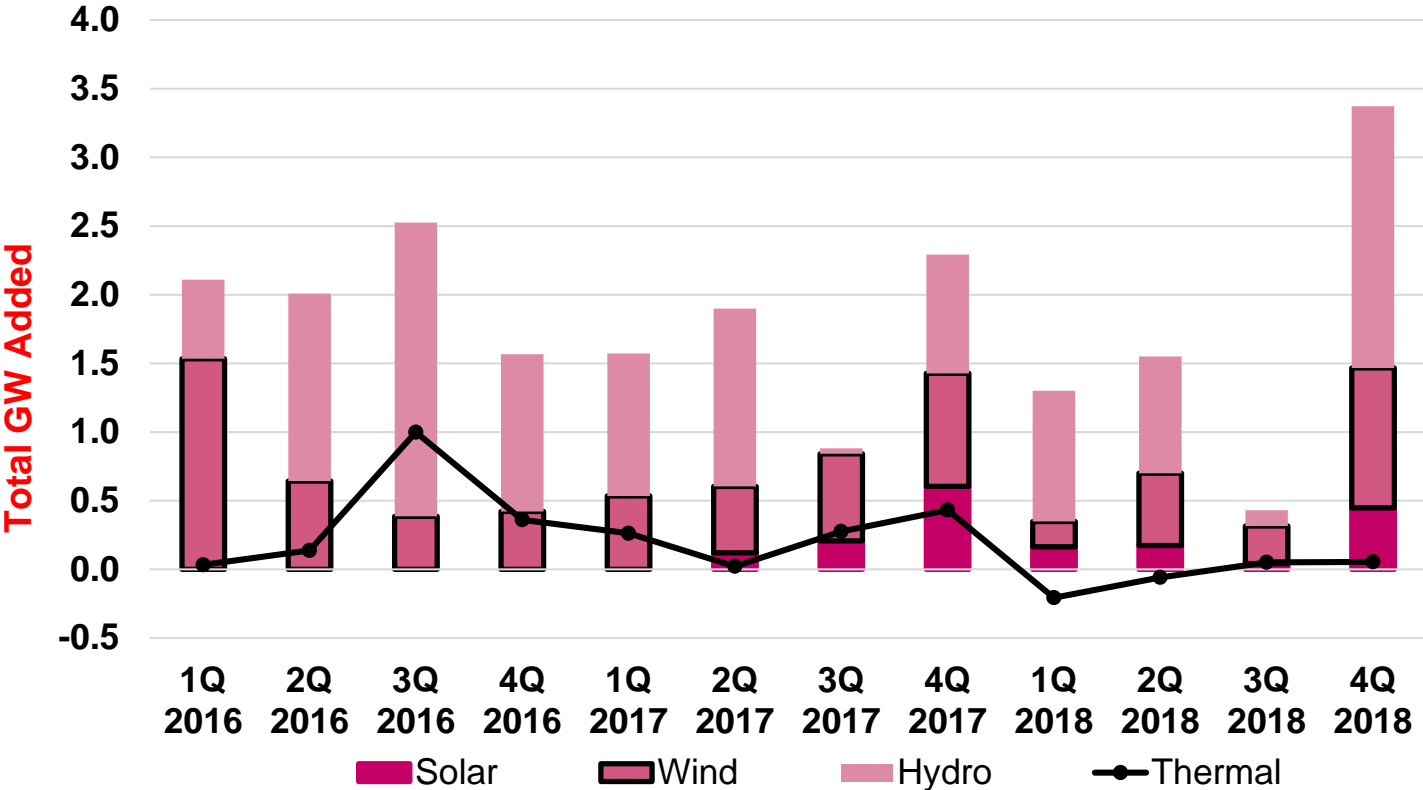


Generation mix outlook: wind growth is facing challenges, due to a shift to auctions across Europe and lengthier permitting and development timeframes. We have additions in Germany slowing down to 1-2 GW/year in the medium-term. Although the prospects for wind capacity growth in Spain are bright, we're assuming 1.2 GW/year against about 3 GW/year in the latest Spanish National Energy & Climate Plan. There are also risks that the French government targets for 2023 may not be reached.

We believe wind growth is adequately factored in our balances going forward, with risks for gas dispatch fairly limited, even under the assumption that the wind additions follow the trajectory indicated in the 2030 National Energy and Climate Plans.

Source: Platts Analytics, World Energy Demand Model, Platts Scenario Planning Service, National Energy & Climate Plans 2030

Brazil: hydro and wind account for vast majority of capacity additions, followed by solar



Jan. 2019: 0.2 GW of wind added, we estimate around 2.5 GW for 2019, up from ~2 GW in 2018 and similar to 2017

Source: National Energy Administration Statistics, China Electricity Council Monthly Statistics

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