

The Power Transition – Trends and the Future

3rd HAEE Conference

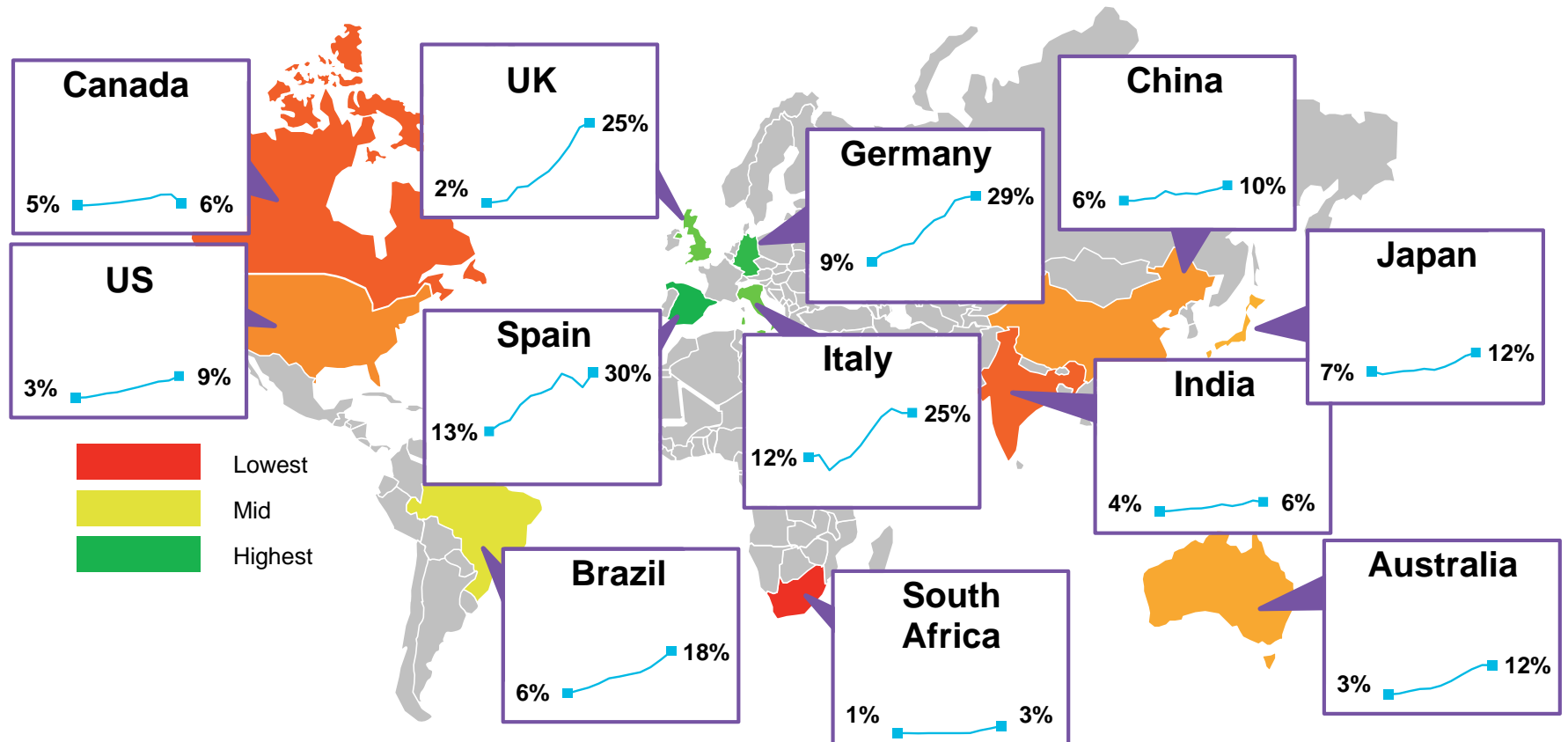
Elena Giannakopoulou
Head of Energy Economics

May 4, 2018



**Bloomberg
New Energy Finance**

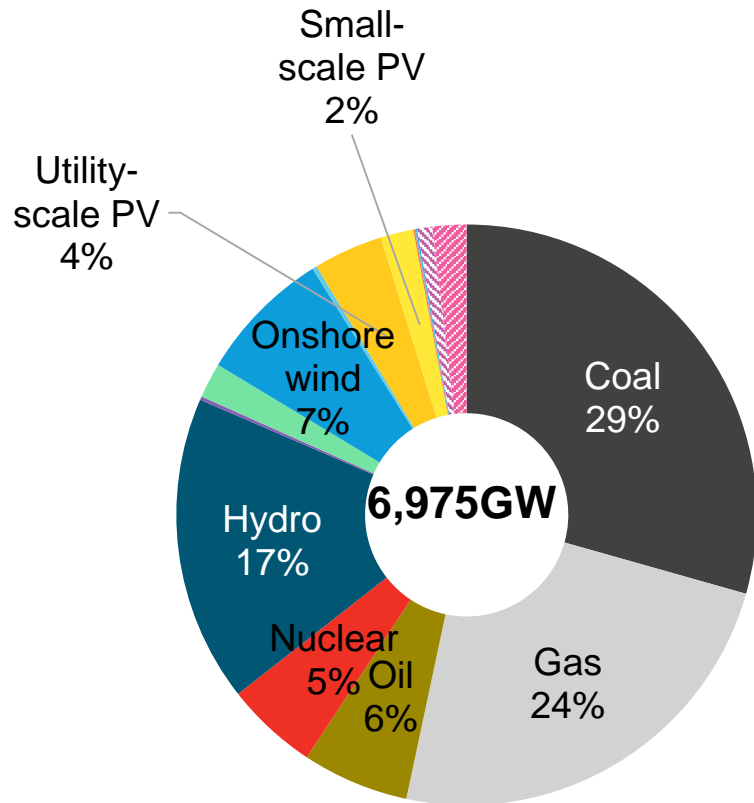
Renewable energy proportion of power generation, 2006-16



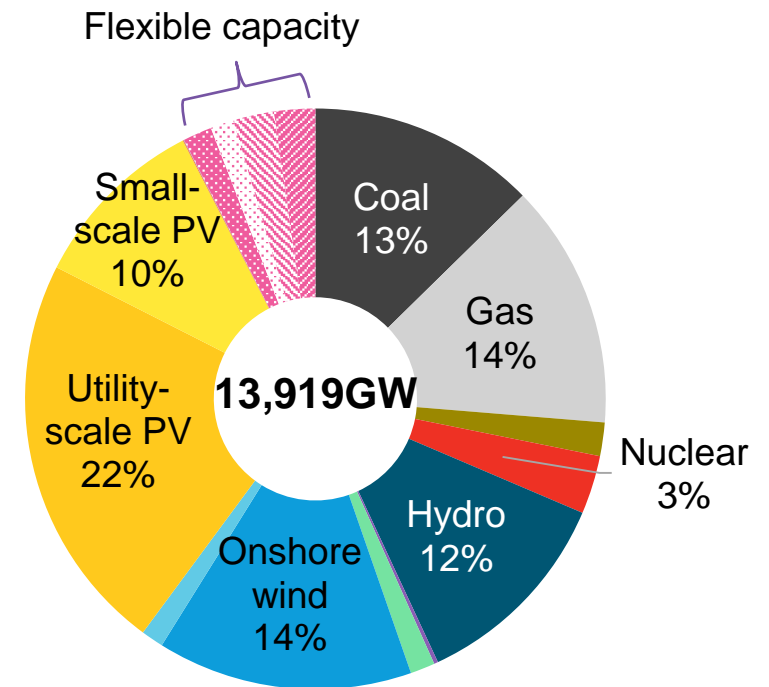
Source: Bloomberg New Energy Finance

Solar and wind dominate the future of electricity

Global cumulative installed capacity: 2017



Global cumulative installed capacity: 2040

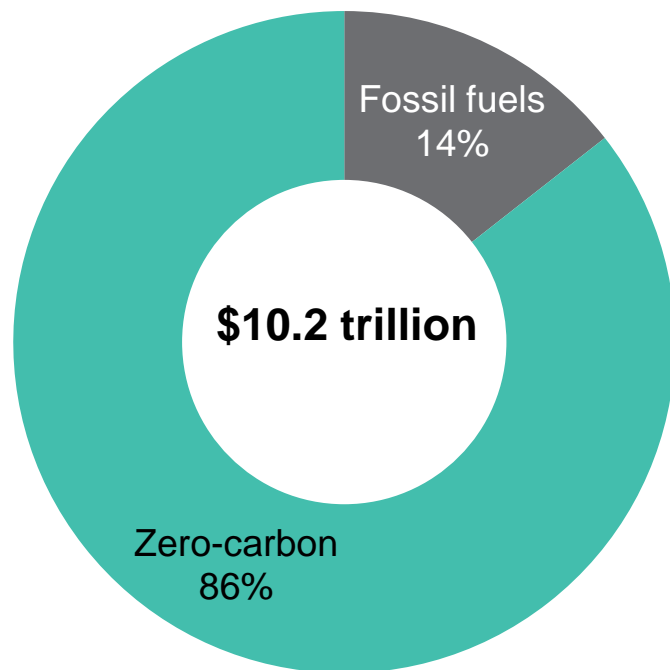


Source: Bloomberg New Energy Finance, NEO2017

Source: Bloomberg New Energy Finance, NEO2017

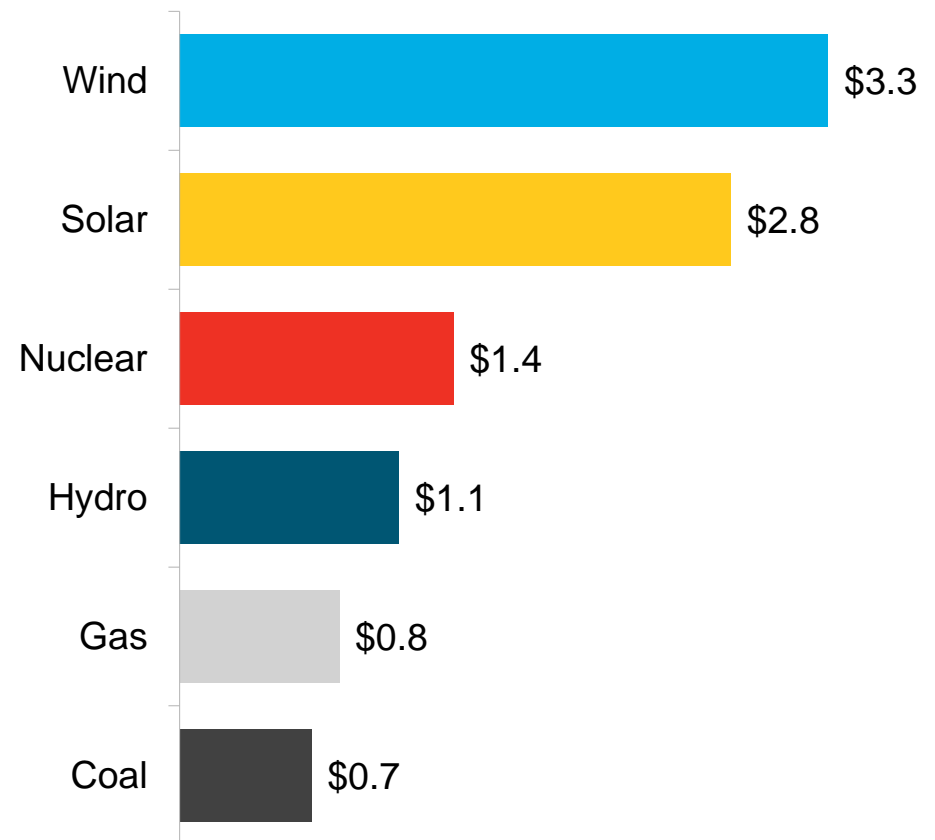
Wind and solar attract 73% of total investment

Investment, by technology, 2017-2040



Investment, by technology, 2017-2040

(\$ trillion - 2016 real)

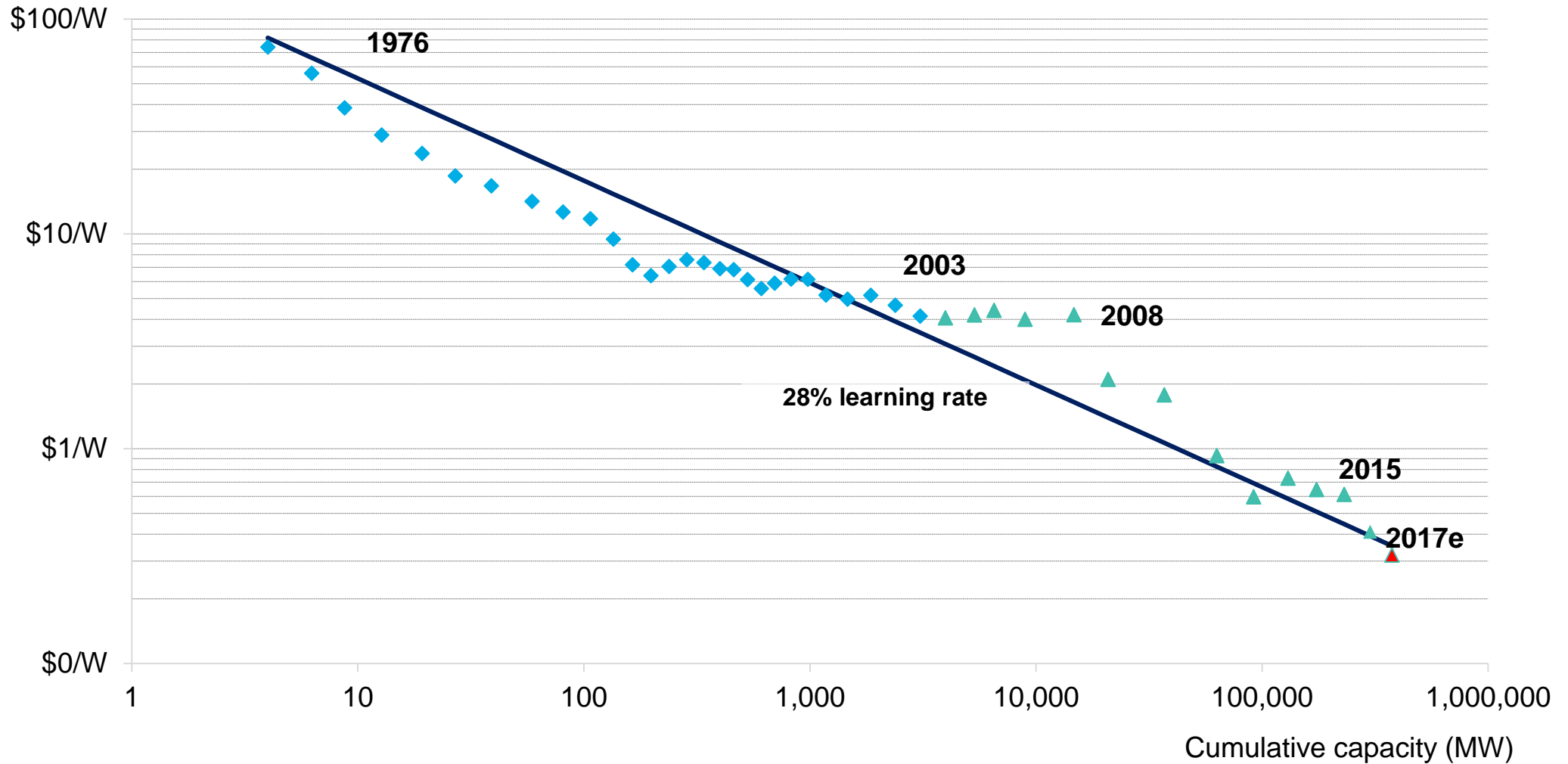


Source: Bloomberg New Energy Finance, NEO2017

Source: Bloomberg New Energy Finance, NEO2017

Technology is fundamentally changing the energy landscape

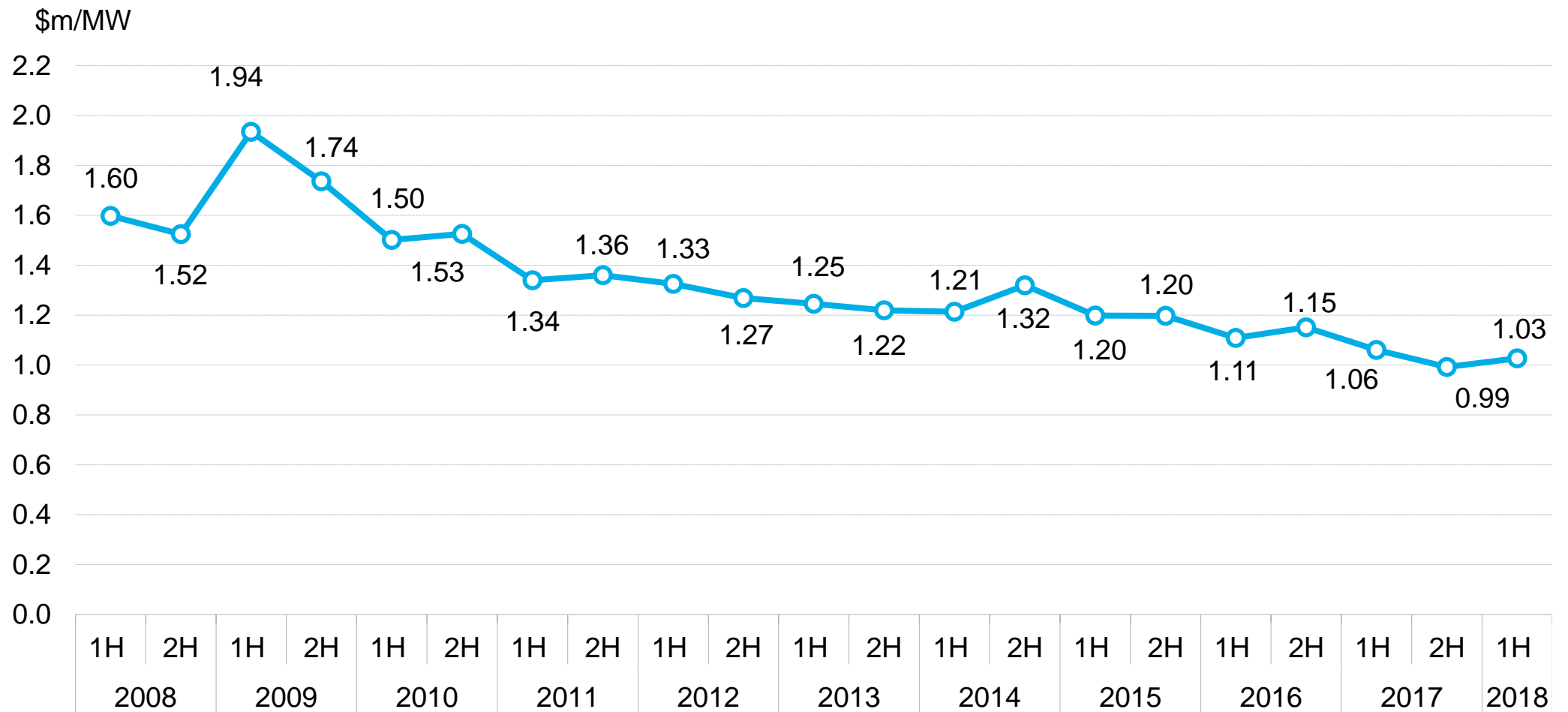
Crystalline silicon solar PV experience curve



Source: Maycock, Bloomberg New Energy Finance

Onshore wind costs fall fast

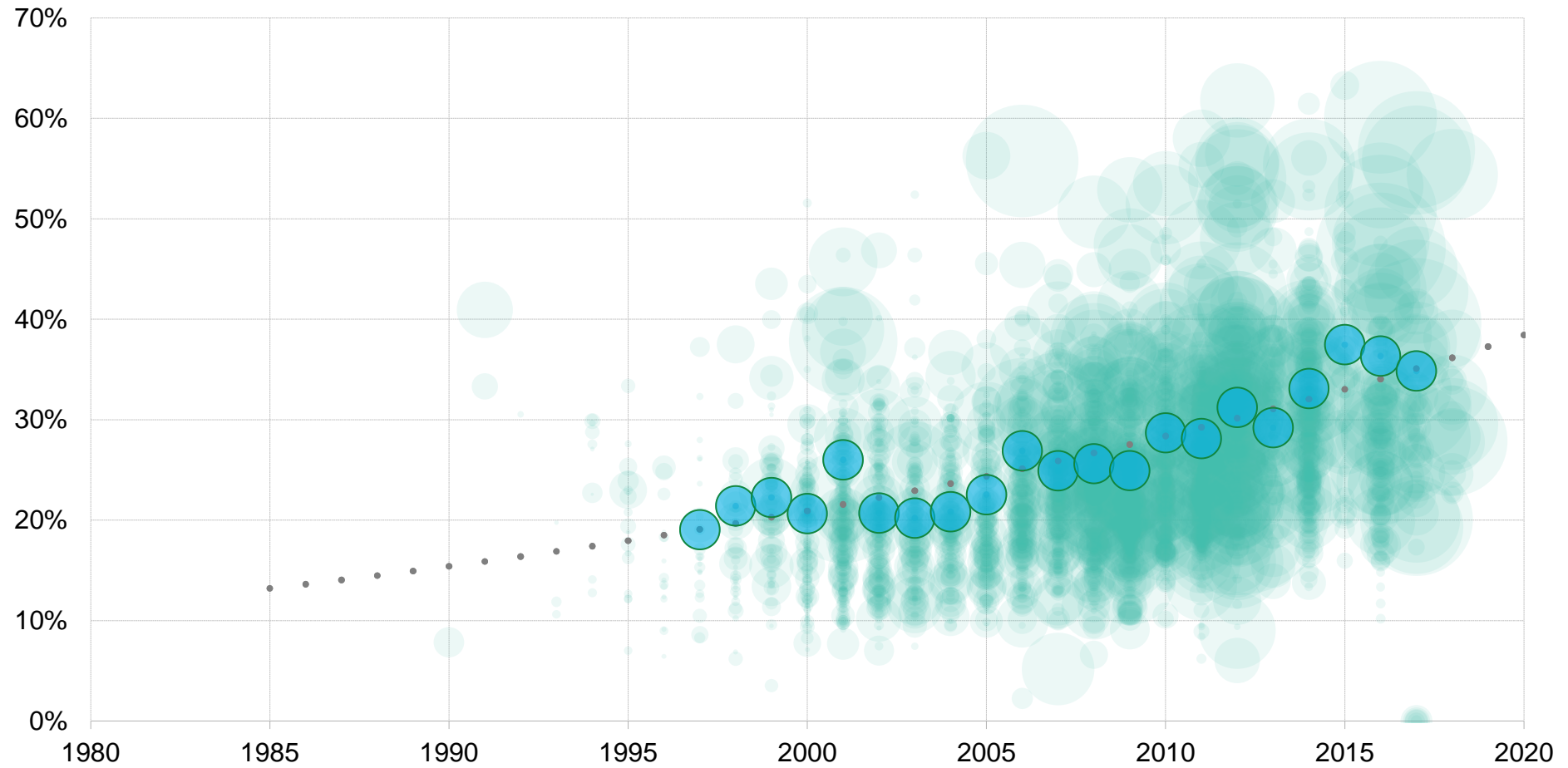
Wind turbine index



Source: Bloomberg New Energy Finance Note: Data by contract signing date

And turbines are getting better

Wind capacity factor (%)



Source: Bloomberg New Energy Finance Note: Averages are capacity-weighted.

Unsubsidised clean energy world record bids – April 2016

Solar PV



Country: Coahuila Mexico
Bidder: Enel Green Power
Signed: March 2016
Construction: 2019
Price: US\$ 3.60 c/kWh

Onshore wind



Country: Morocco
Bidder: Enel Green Power
Signed: January 2016
Construction: 2018
Price: US\$ 3.0 c/kWh

Offshore wind



Country: Denmark
Bidder: Vattenfall
Signed: Dec 2015
Construction: 2019
Price: US\$ 5.3 c/kWh

Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons

Unsubsidised clean energy world record bids – May 2016

Solar PV



Country: United Arab Emirates
Bidder: Masdar/DEWA
Signed: May 2016
Construction: 2018
Price: US\$ 2.99 c/kWh

Onshore wind



Country: Morocco
Bidder: Enel Green Power
Signed: January 2016
Construction: 2018
Price: US\$ 3.0 c/kWh

Offshore wind



Country: Denmark
Bidder: Vattenfall
Signed: Dec 2015
Construction: 2019
Price: US\$ 5.3 c/kWh

Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons

Unsubsidised clean energy world record bids – August 2016

Solar PV



Country: Chile
Bidder: Solarpack Corporation
Signed: August 2016
Construction: 2019
Price: US\$ 2.91 c/kWh

Onshore wind



Country: Morocco
Bidder: Enel Green Power
Signed: January 2016
Construction: 2018
Price: US\$ 3.0 c/kWh

Offshore wind



Country: Denmark
Bidder: Vattenfall
Signed: Dec 2015
Construction: 2019
Price: US\$ 5.3 c/kWh

Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons

Unsubsidised clean energy world record bids – September 2016

Solar PV



Country: Mexico
Bidder: X-Elio
Signed: September 2016
Construction: 2019
Price: US\$ 2.74 c/kWh

Onshore wind



Country: Morocco
Bidder: Enel Green Power
Signed: January 2016
Construction: 2018
Price: US\$ 3.0 c/kWh

Offshore wind



Country: Denmark
Bidder: Vattenfall
Signed: Dec 2015
Construction: 2019
Price: US\$ 5.3 c/kWh

Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons

Unsubsidised clean energy world record bids – March 2017

Solar PV



Country: United Arab Emirates
Bidder: Marubeni & Jinko Solar
Signed: March 2017
Construction: 2019
Price: US\$ 2.4 c/kWh

Onshore wind



Country: Morocco
Bidder: Enel Green Power
Signed: January 2016
Construction: 2018
Price: US\$ 3.0 c/kWh

Offshore wind



Country: Denmark
Bidder: Vattenfall
Signed: Dec 2015
Construction: 2019
Price: US\$ 5.3 c/kWh

Unsubsidised clean energy world record bids – April 2017

Solar PV



Country: United Arab Emirates
Bidder: Marubeni & Jinko Solar
Signed: March 2017
Construction: 2019
Price: US\$ 2.4 c/kWh

Onshore wind



Country: Morocco
Bidder: Enel Green Power
Signed: January 2016
Construction: 2018
Price: US\$ 3.0 c/kWh

Offshore wind



Country: Germany
Bidder: DONG/EnBW
Signed: April 2017
Construction: 2024
Merchant Price: US\$ 4.9 c/kWh

Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons Note: The offshore wind merchant price is estimated based on project LCOE in real 2016 terms

Unsubsidised clean energy world record bids – October 2017

Solar PV



Country: Saudi Arabia
Bidder: Masdar & EDF
Signed: October 2017
Construction: 2019
Price: US\$ 1.8 c/kWh (?)

Onshore wind



Country: Morocco
Bidder: Enel Green Power
Signed: January 2016
Construction: 2018
Price: US\$ 3.0 c/kWh

Offshore wind



Country: Germany
Bidder: DONG/EnBW
Signed: April 2017
Construction: 2024
Merchant Price: US\$ 4.9 c/kWh

Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons Note: The offshore wind merchant price is estimated based on project LCOE in real 2016 terms

Electric vehicle sales are accelerating



Time to sell one million electric vehicles



Source: Bloomberg New Energy Finance

Electric vehicle sales are accelerating

Time to sell one million electric vehicles



Source: Bloomberg New Energy Finance

Electric vehicle sales are accelerating

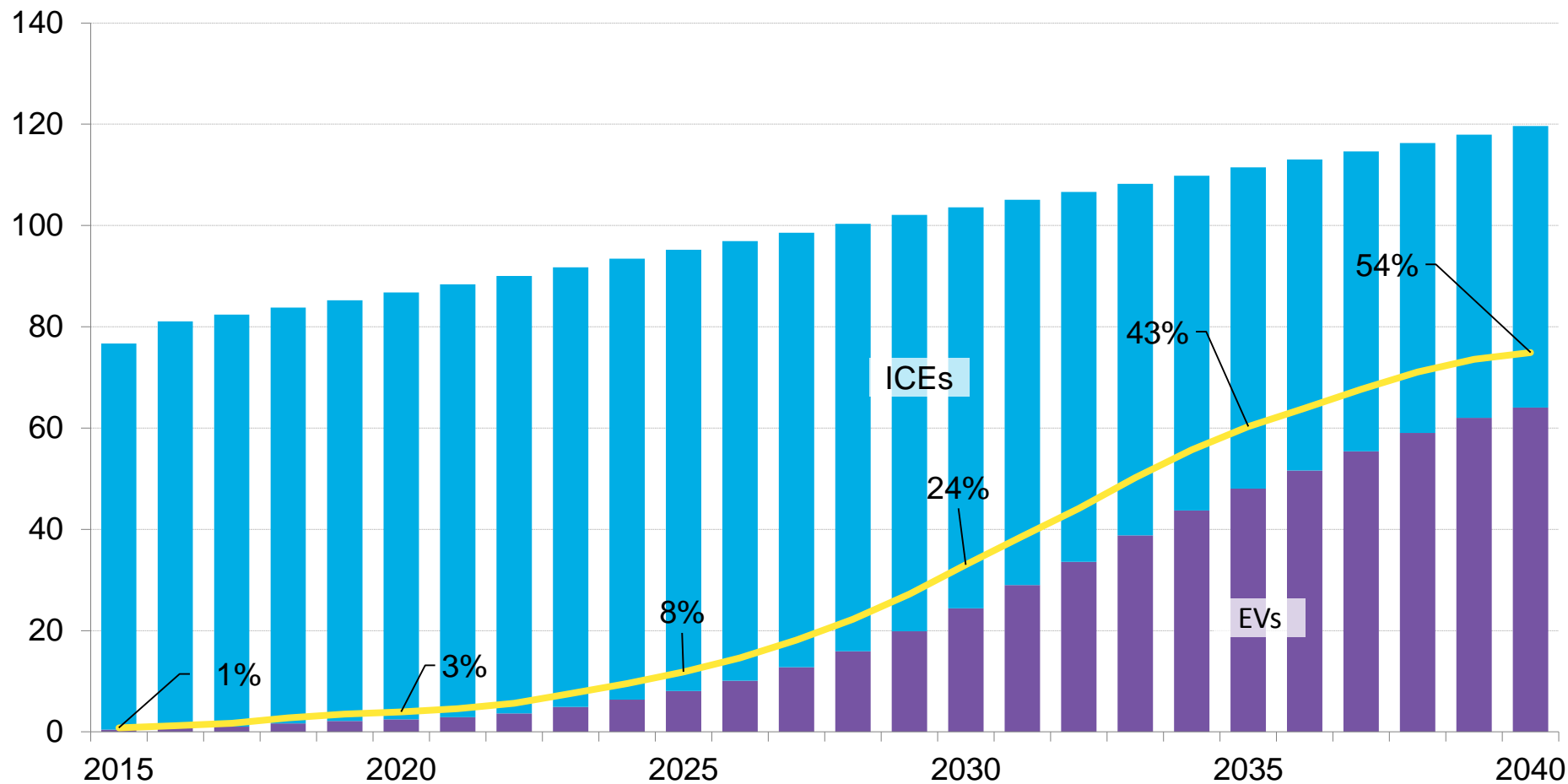
Time to sell one million electric vehicles



Source: Bloomberg New Energy Finance

Electric vehicle outlook to 2040

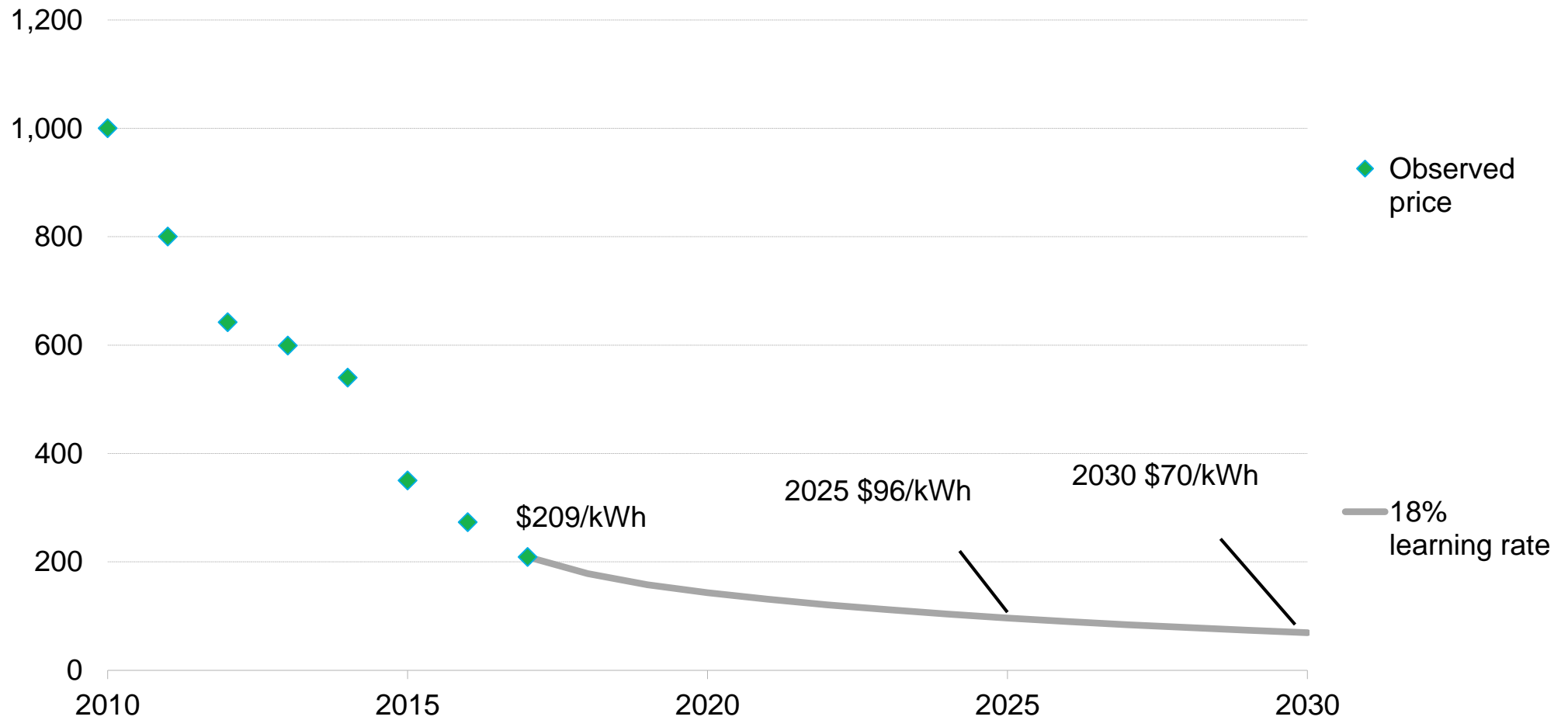
Global light duty vehicle sales (million vehicles)



Source: Bloomberg New Energy Finance Note: ICE is internal combustion engine, EV is electric vehicle

This investment, and scale-up will drive further cost reductions

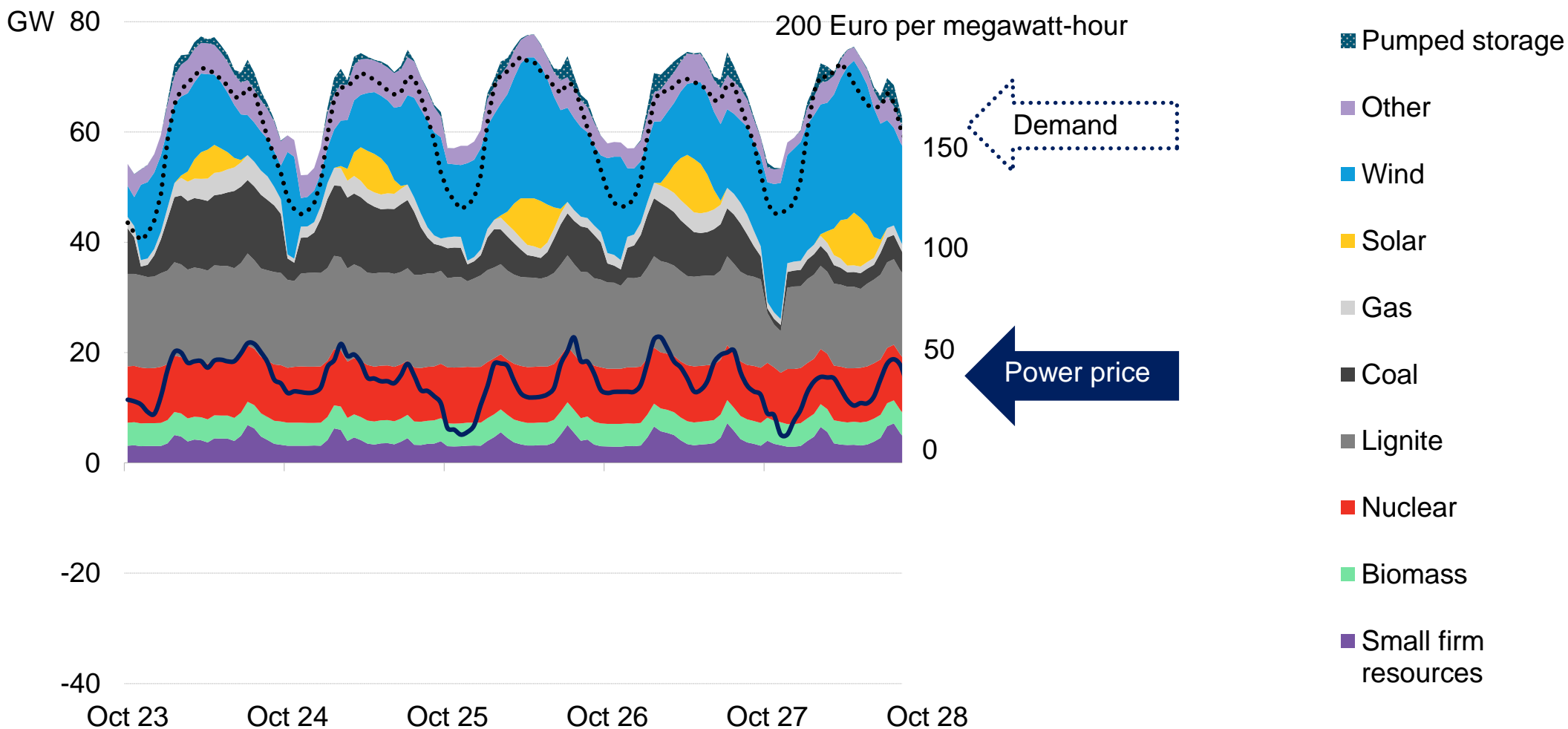
Lithium-ion battery pack price (\$/kWh)



Bloomberg New Energy Finance Note: Prices are an average of BEV and PHEV batteries and include both cell and pack costs. Cell costs alone will be lower. Historical prices are nominal, future ones are in real 2016 U.S. dollars.

The market design challenge

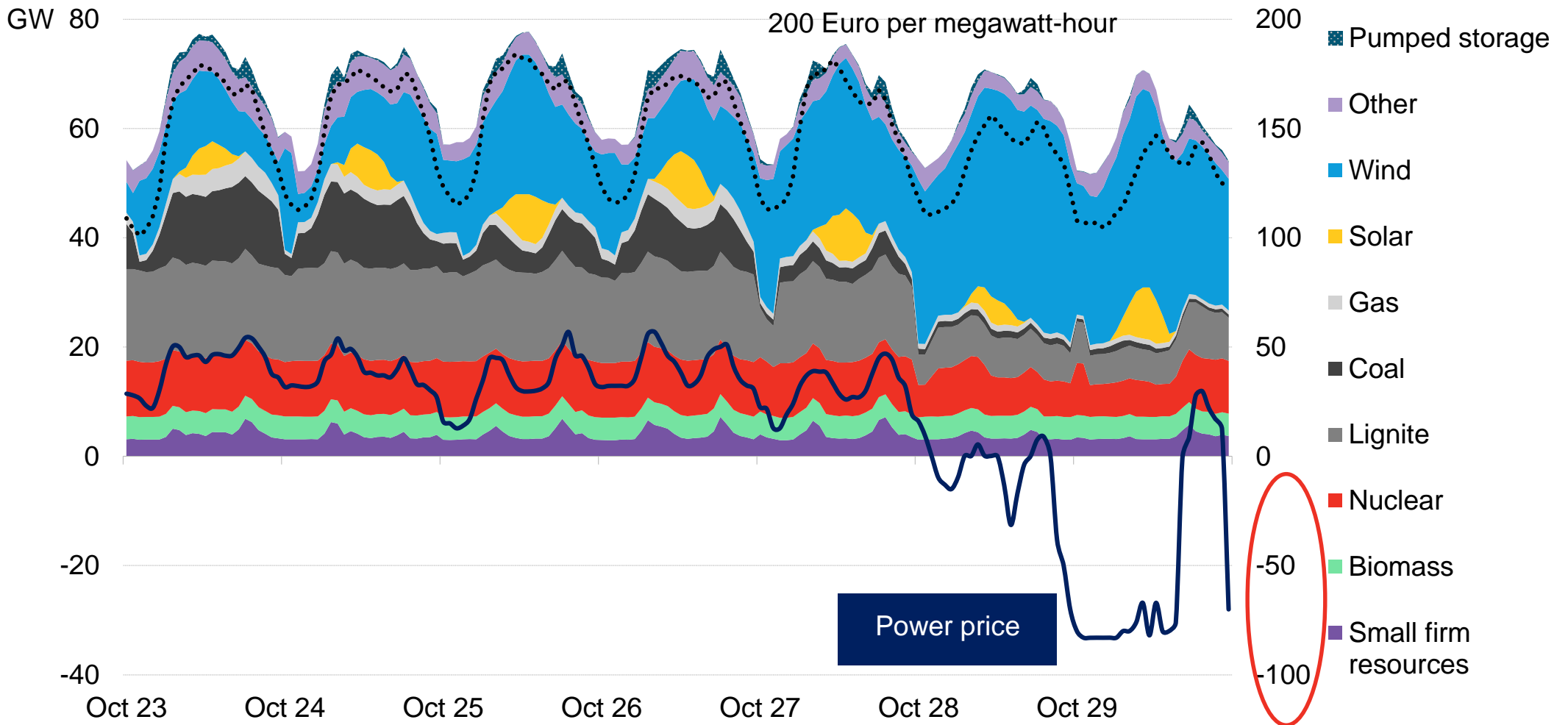
A week in Germany, October 2017



Source: Bloomberg New Energy Finance

The market design challenge

A week in Germany, October 2017



Source: Bloomberg New Energy Finance

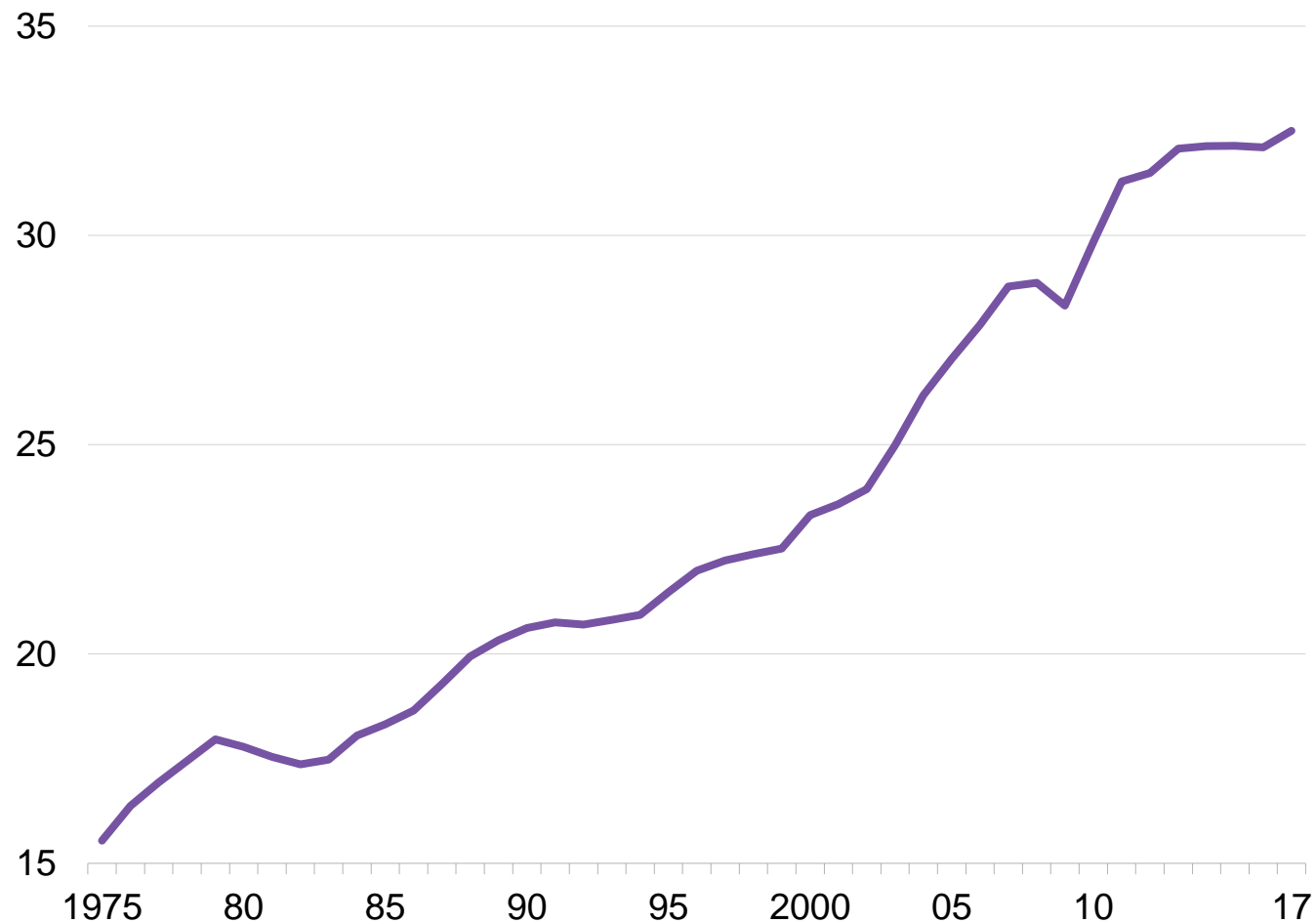
The global challenge



Source: Bloomberg

Global energy CO₂ emissions ticked up to a new record

World energy-related CO₂ emissions (Gigatonnes)

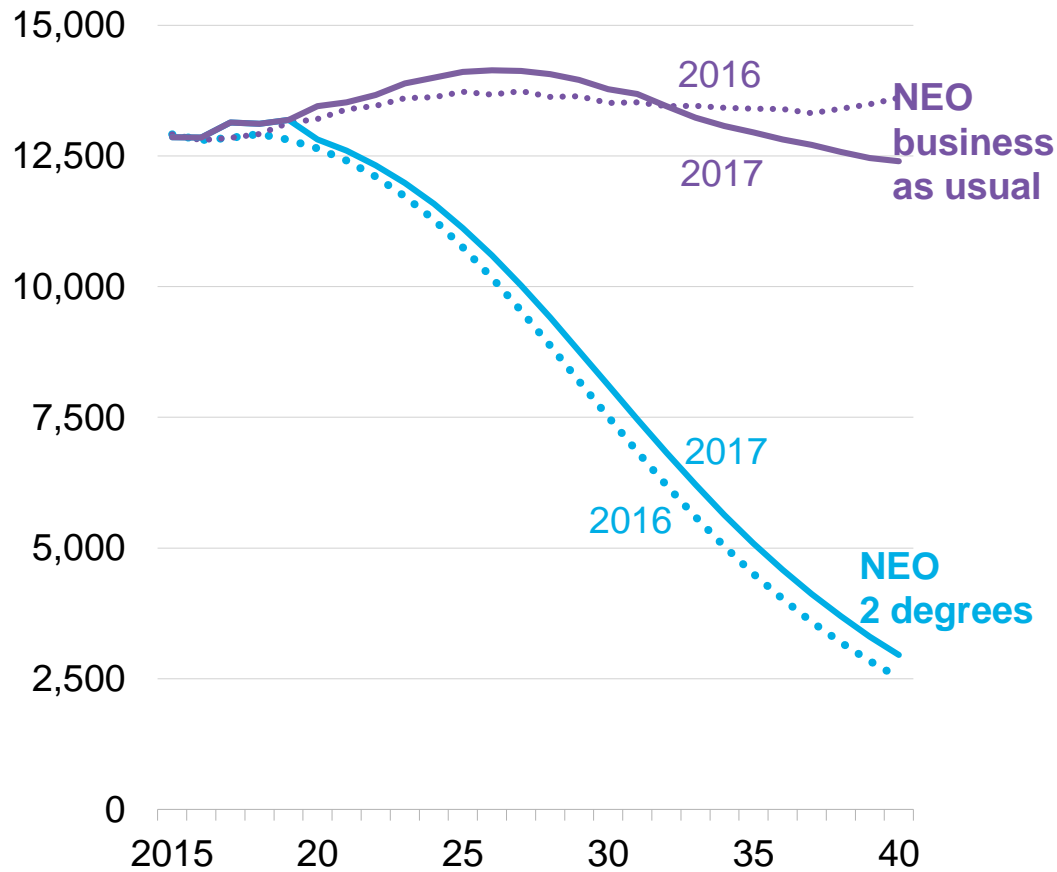


+1.4%
Year-on-year

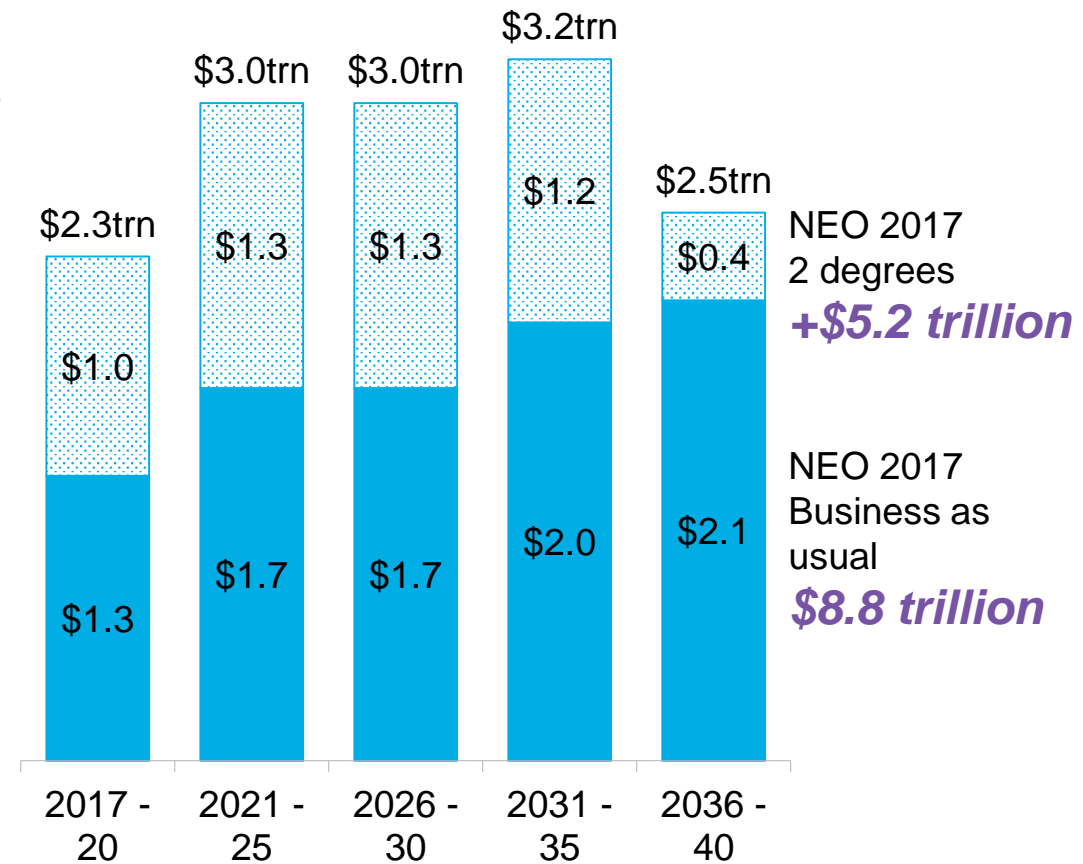
Source: IEA

Current investment estimates will not hit a 2-degree target

Global CO2 emissions (MtCO2e)



Investment in zero-carbon power generation (2016 \$-real)



Source: Bloomberg New Energy Finance

Source: Bloomberg New Energy Finance

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sales.bnef@bloomberg.net

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Elena Giannakopoulou

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