



GLOBAL TRENDS IN CLEAN ENERGY AND TRANSPORTATION

April 2017

Michael Liebreich

Chairman of the Advisory Board

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Bloomberg
NEW ENERGY FINANCE



Picture: UNFCCC

“ The Paris Agreement is a monumental triumph for people and our planet. ”

Ban Ki Moon, former UN SG

“ This is a turning point. This gives us the best possible shot to save the one planet we got. ”

Barack Obama, US President

“ It is a sign of hope. It can have a positive influence on the living conditions of billions of people. ”

Angela Merkel, Chancellor of Germany

“ Together we have opened the door to a sustainable and climate-safe future for all. ”

Christiana Figueres, former head, UNFCCC

“ The Paris Agreement has been an unprecedented historic success. ”

Miguel Arias Cañete, European Commissioner for Climate Action and Energy

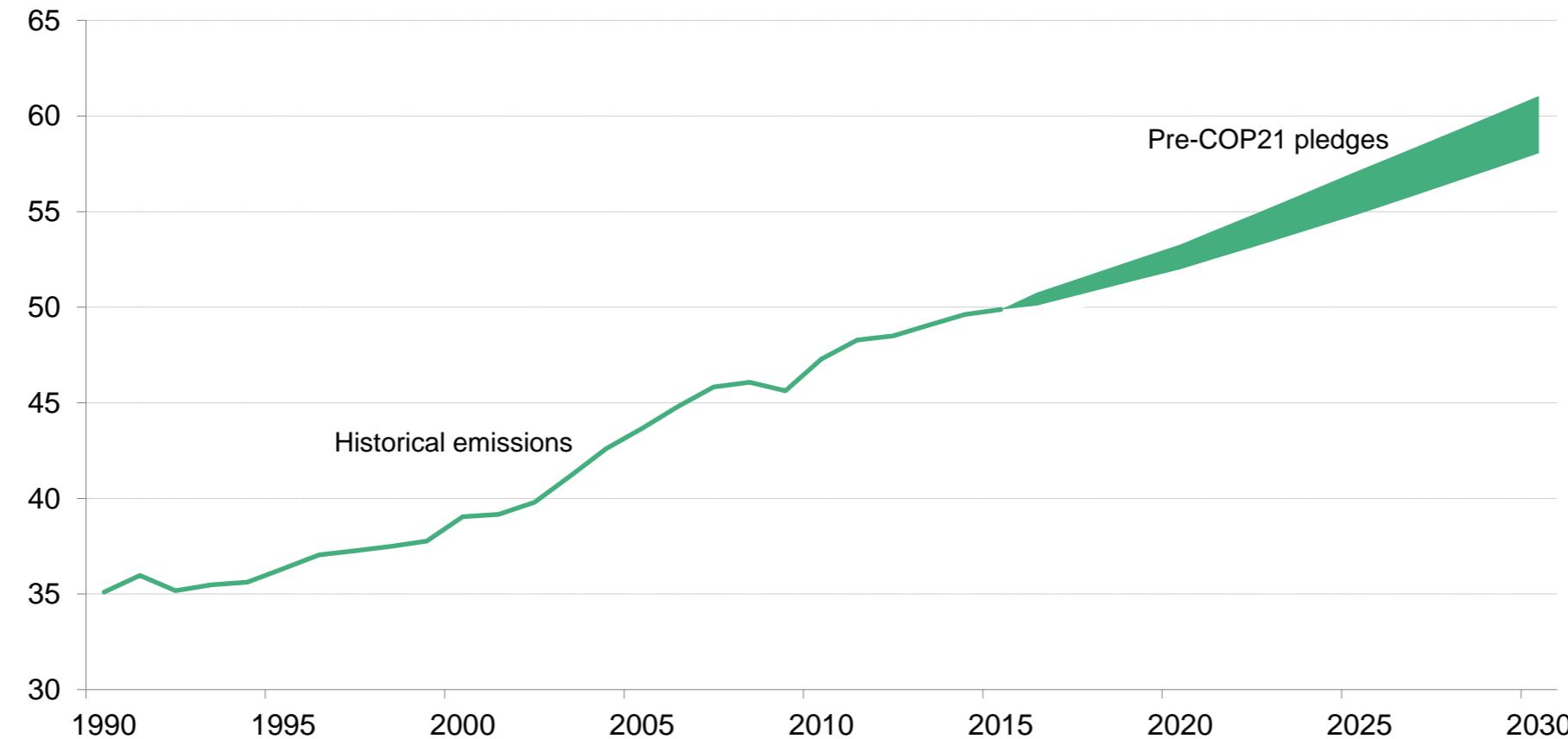
“ Today's agreement signals nothing less than a renaissance for humankind. ”

Mr. Mogens Lykketoft, President, UN General Assembly

GLOBAL GREENHOUSE GAS EMISSIONS

(GTCO₂)

Bloomberg
NEW ENERGY FINANCE

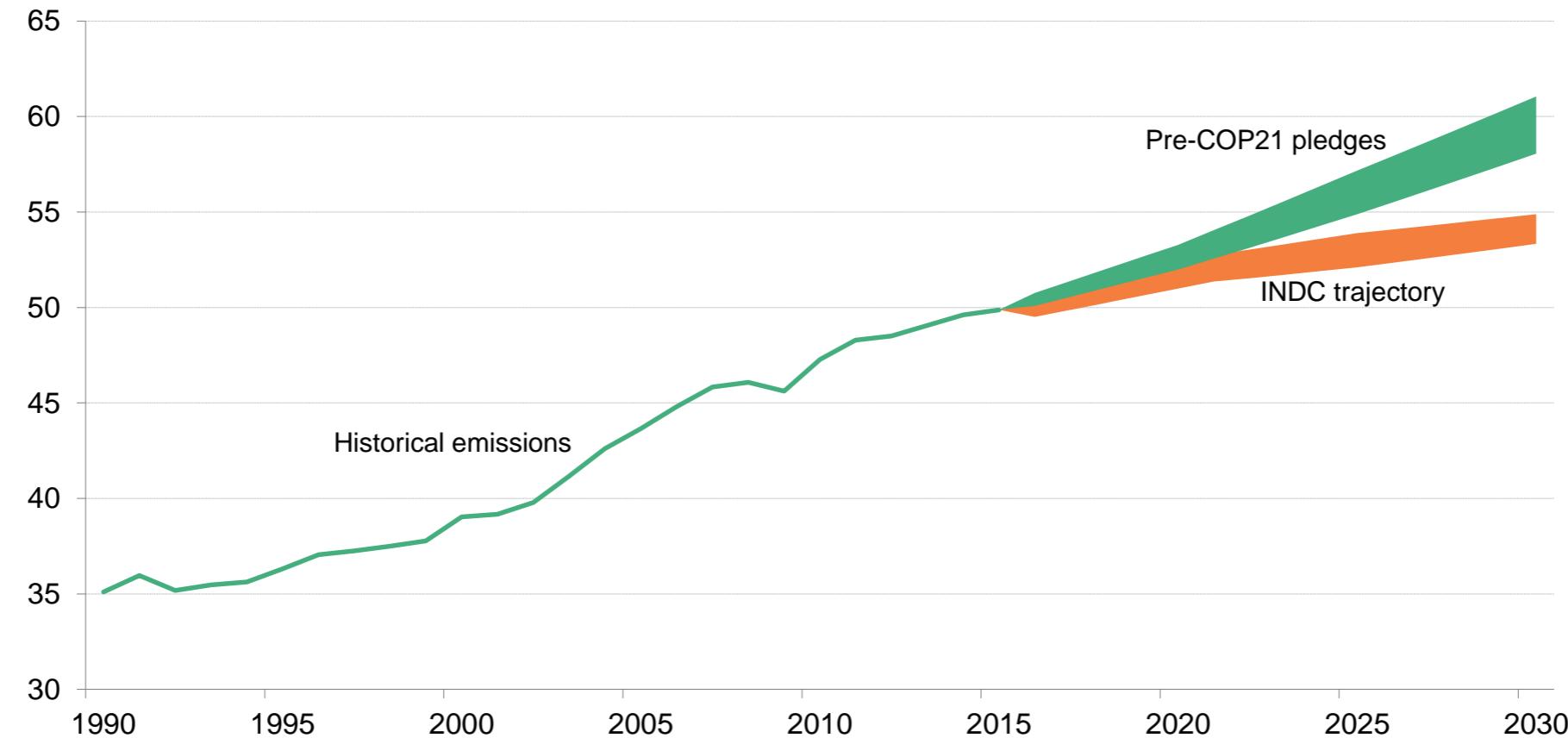


Source: UNFCCC, UNEP, Climate Action Tracker, Bloomberg New Energy Finance

GLOBAL GREENHOUSE GAS EMISSIONS

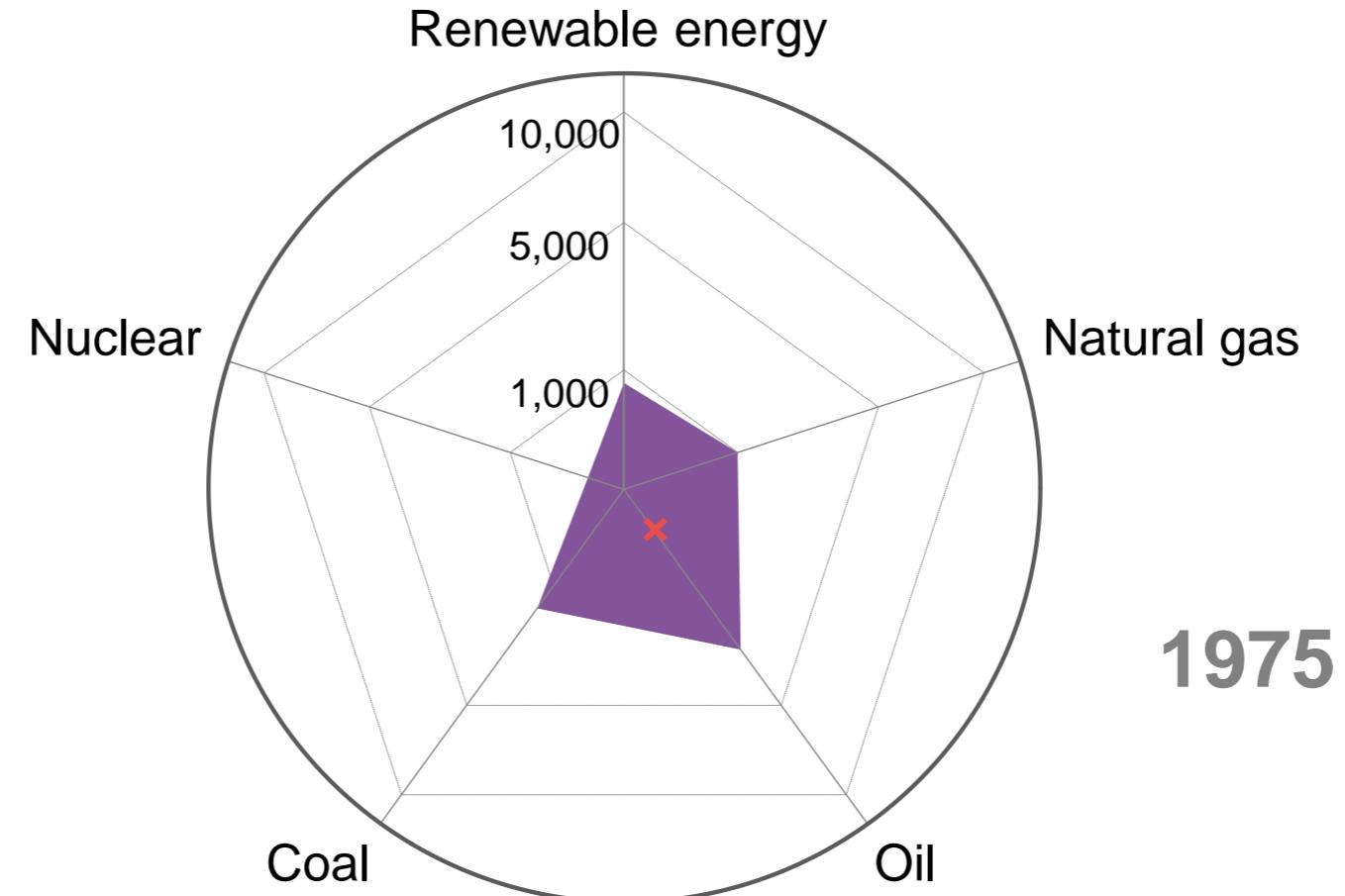
(GTCO₂)

Bloomberg
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Source: UNFCCC, UNEP, Climate Action Tracker, Bloomberg New Energy Finance

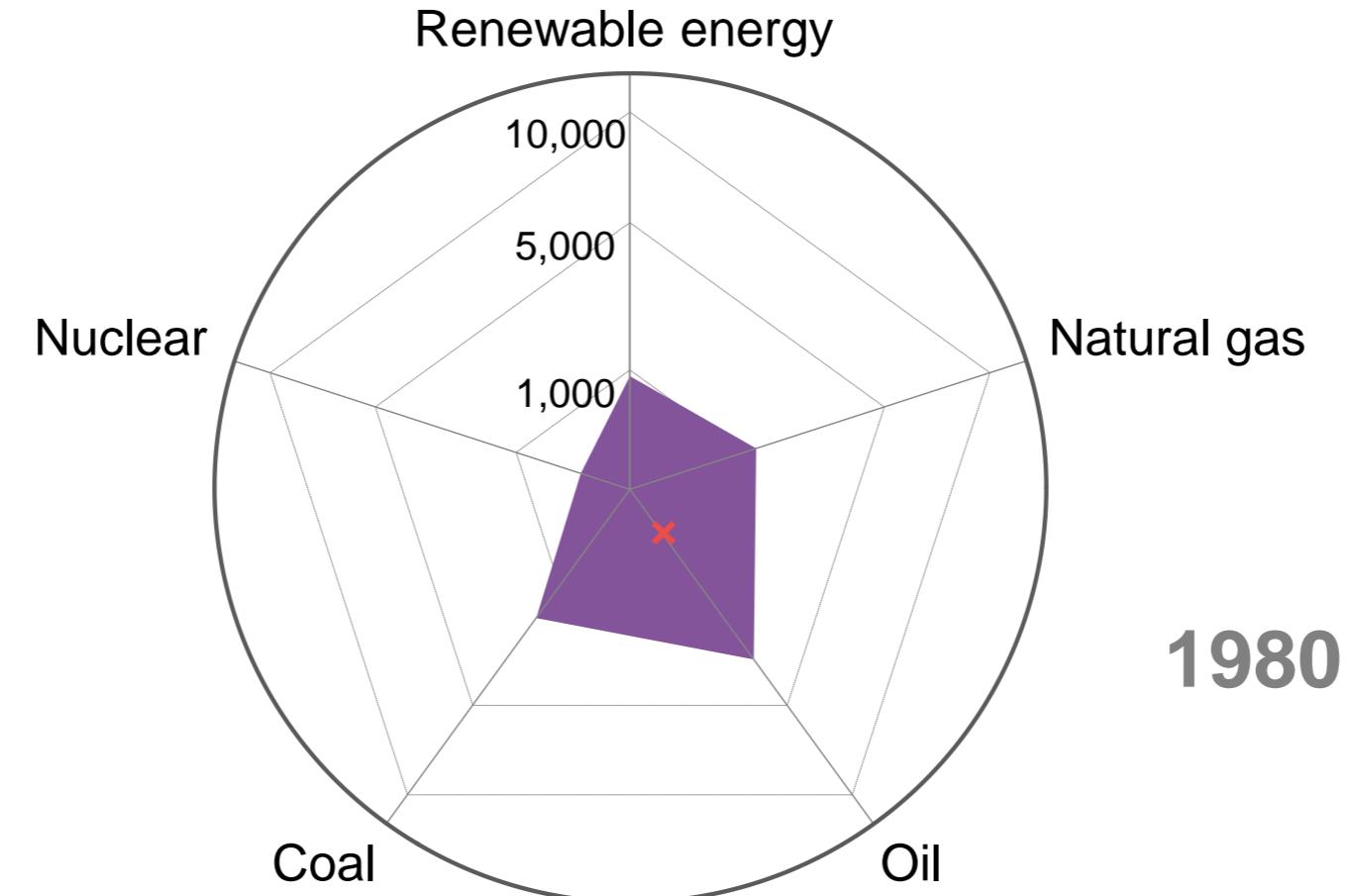
GLOBAL PRIMARY ENERGY SUPPLY, 1975 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

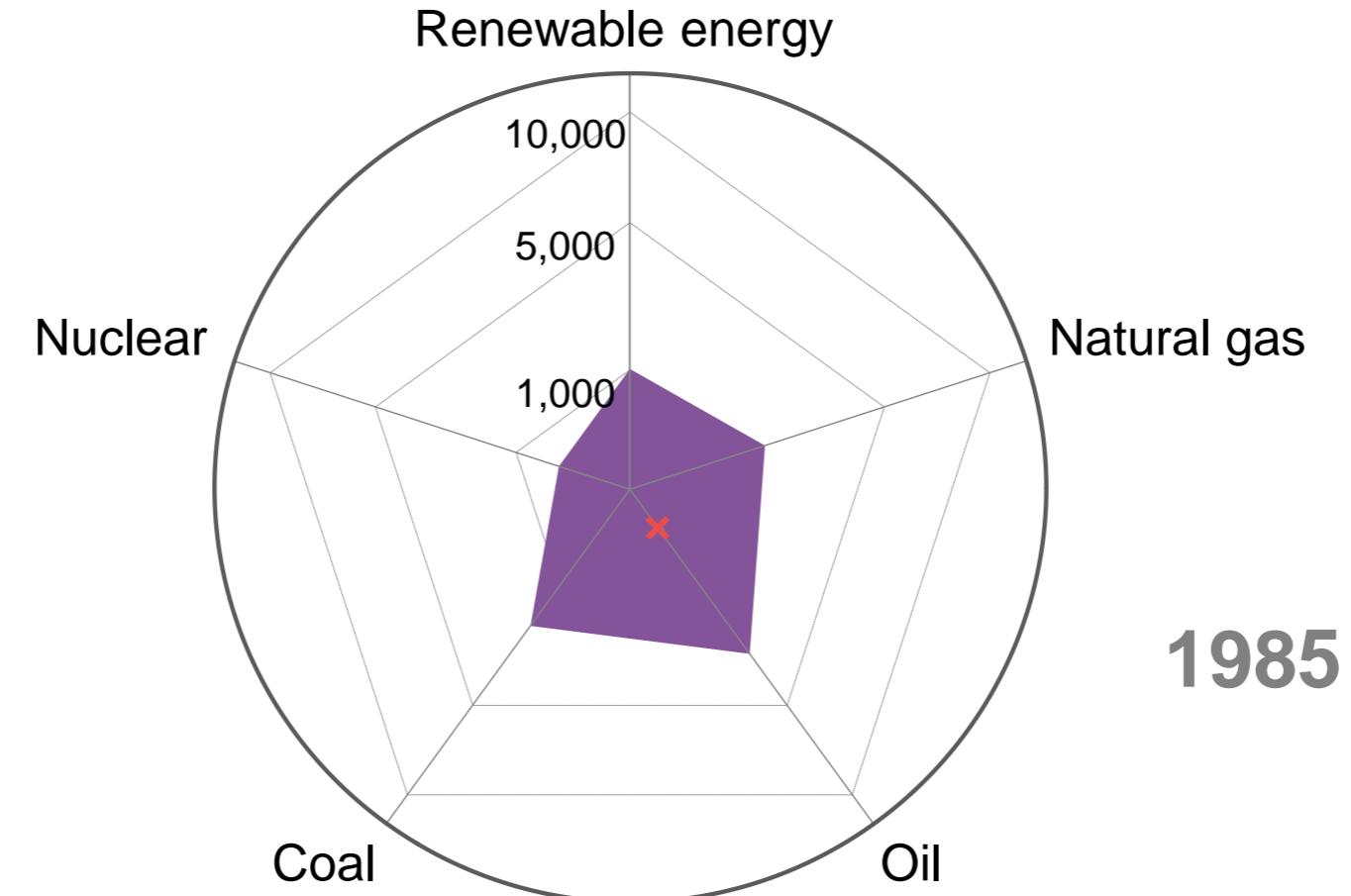
GLOBAL PRIMARY ENERGY SUPPLY, 1980 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

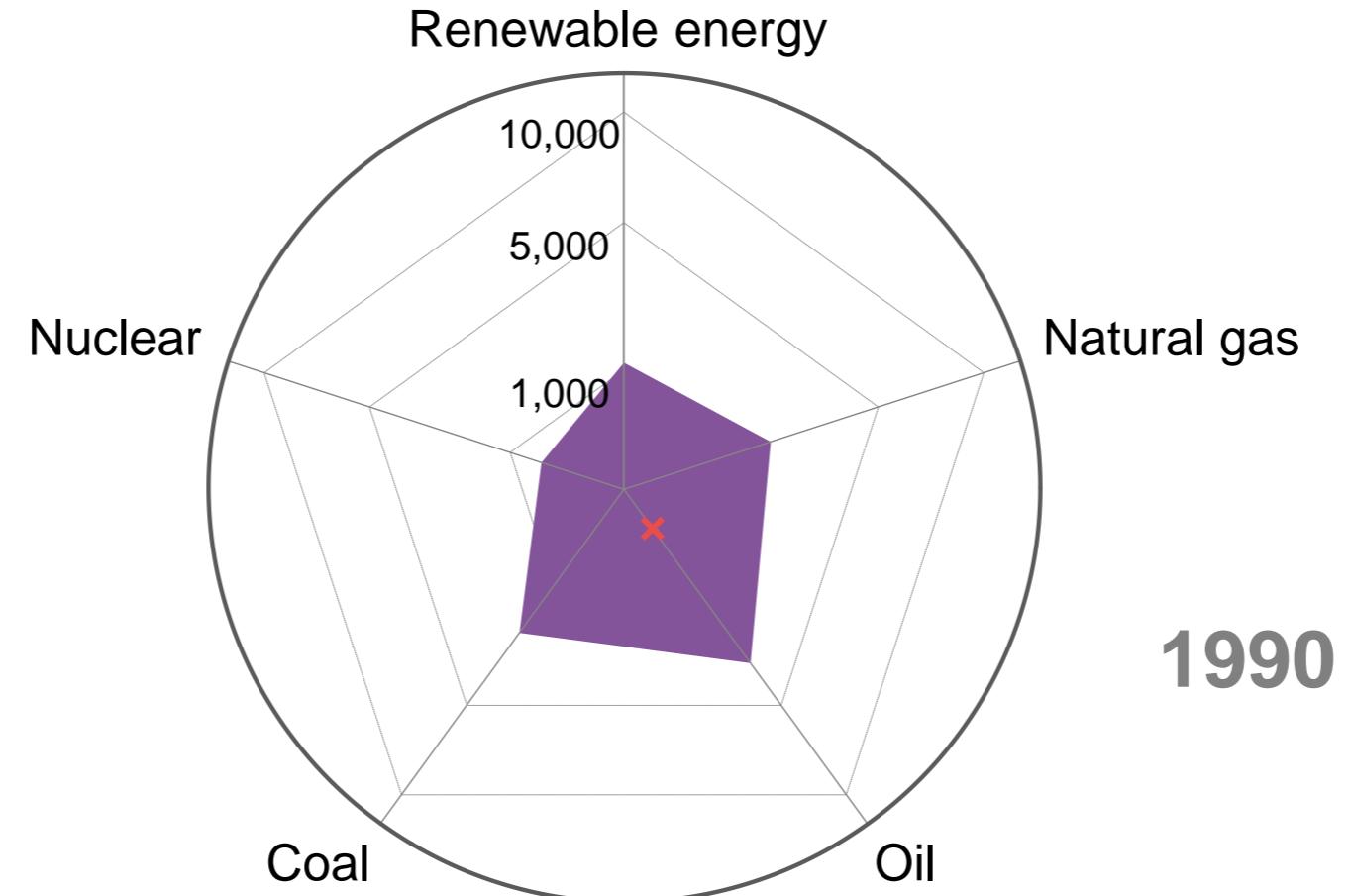
GLOBAL PRIMARY ENERGY SUPPLY, 1985 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

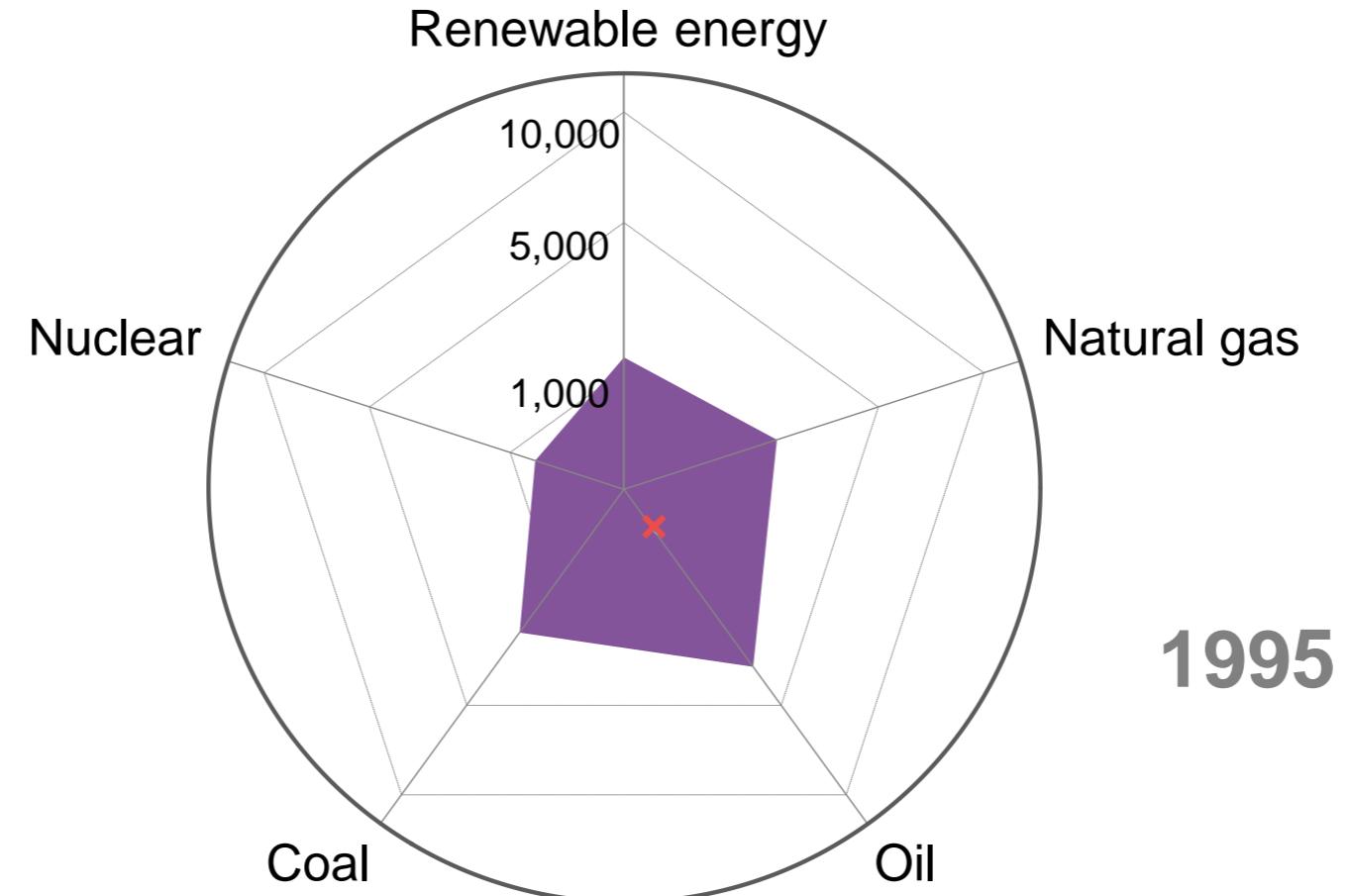
GLOBAL PRIMARY ENERGY SUPPLY, 1990 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

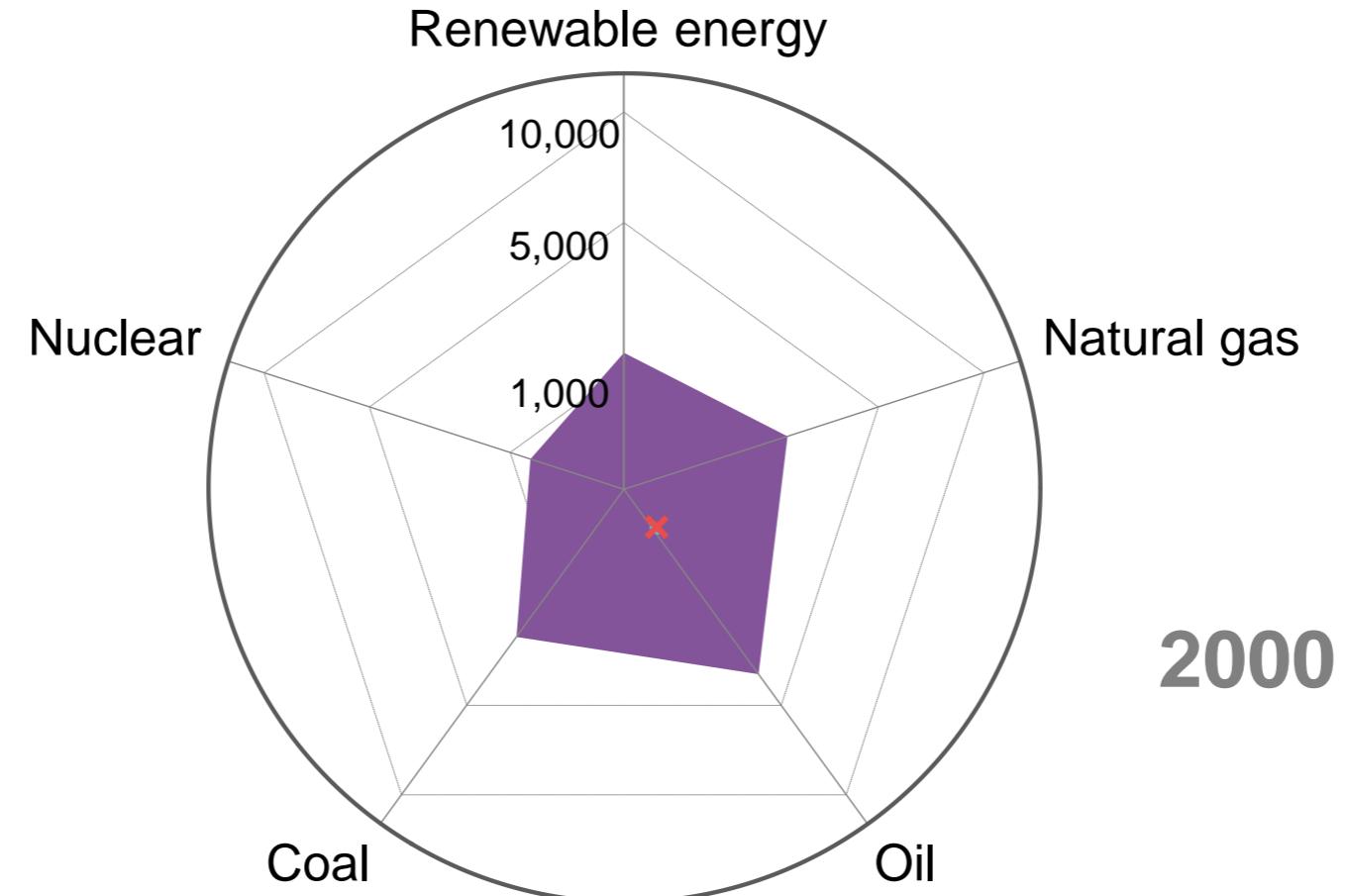
GLOBAL PRIMARY ENERGY SUPPLY, 1995 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

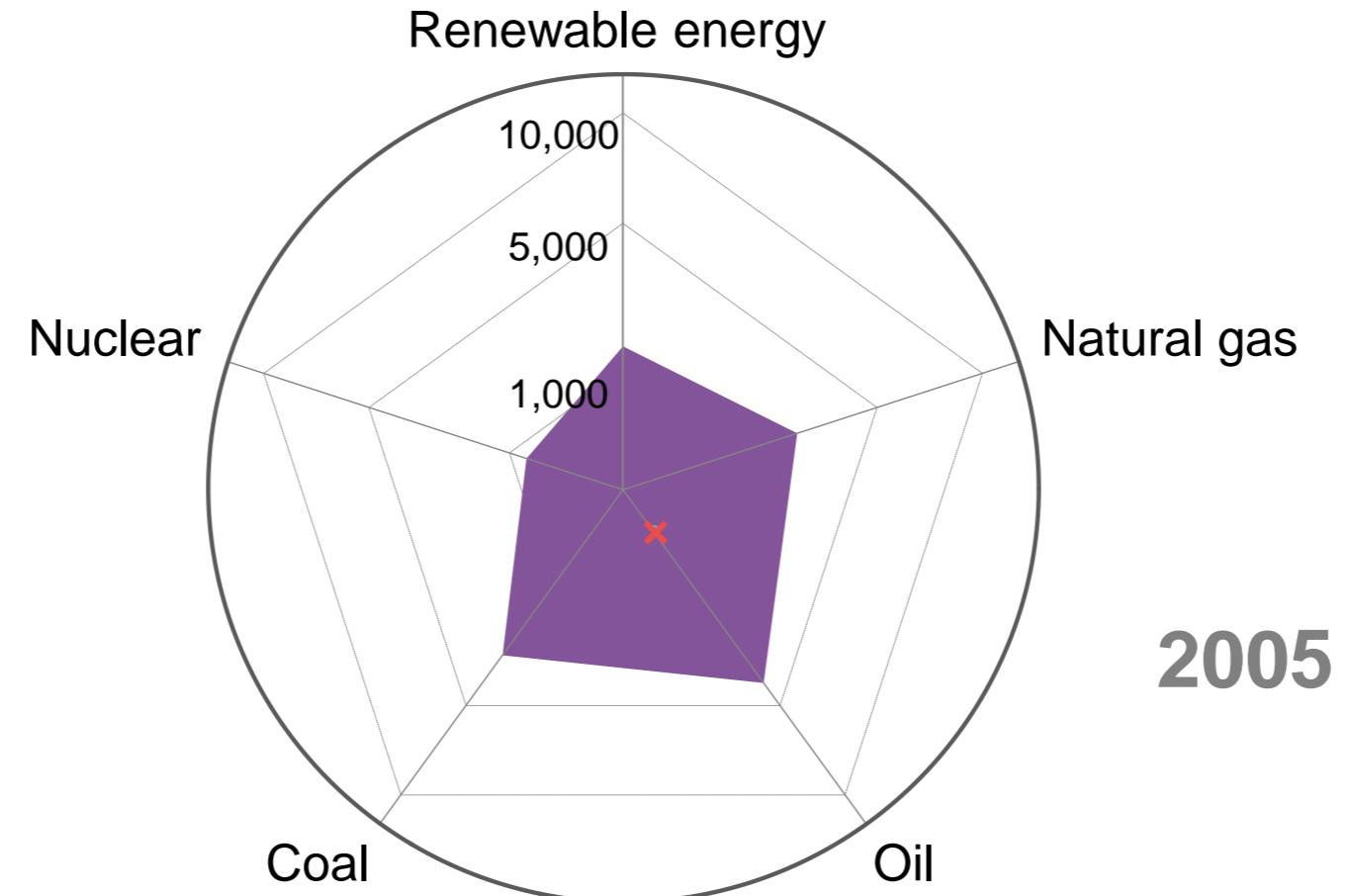
GLOBAL PRIMARY ENERGY SUPPLY, 2000 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

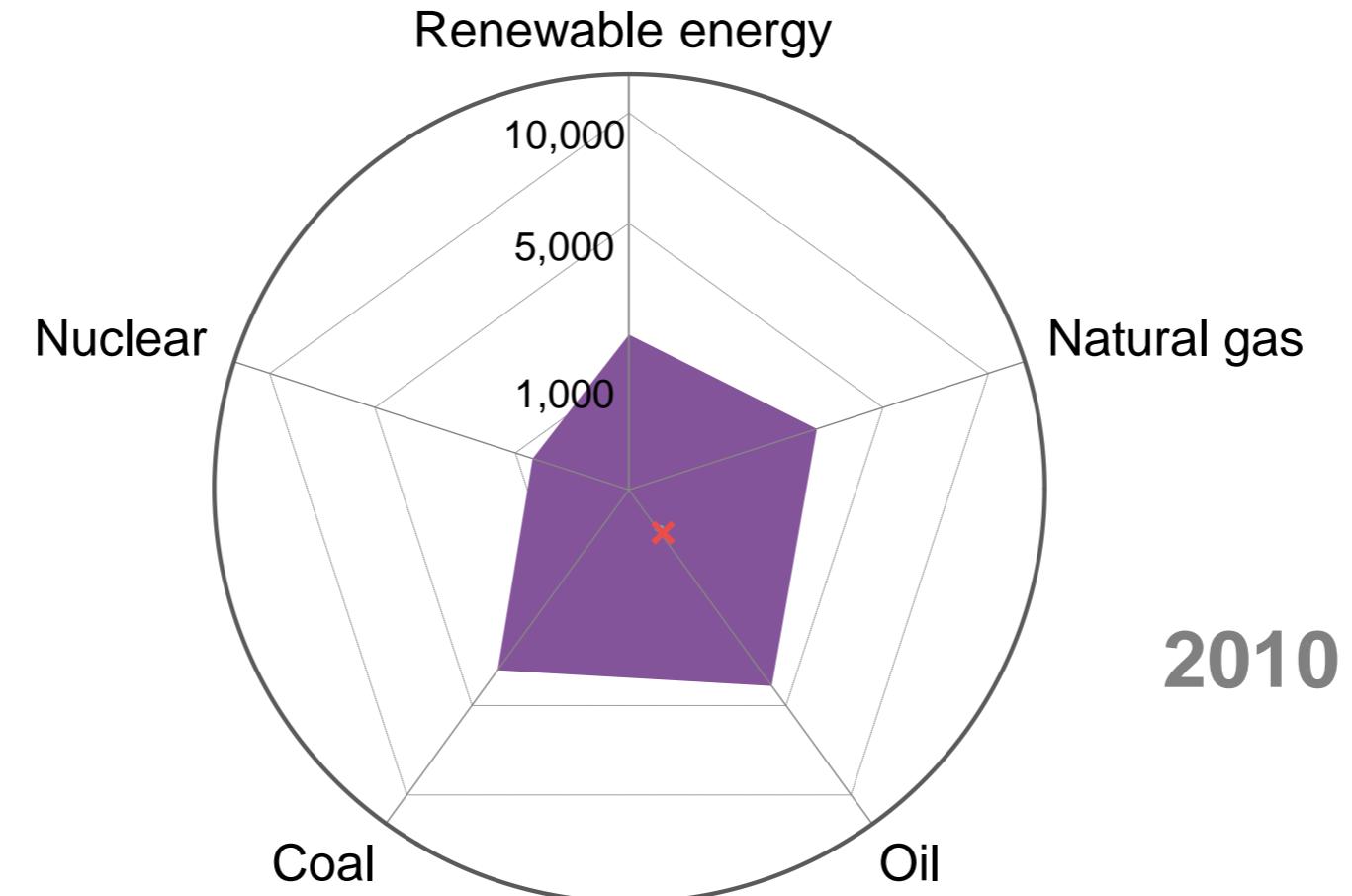
GLOBAL PRIMARY ENERGY SUPPLY, 2005 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

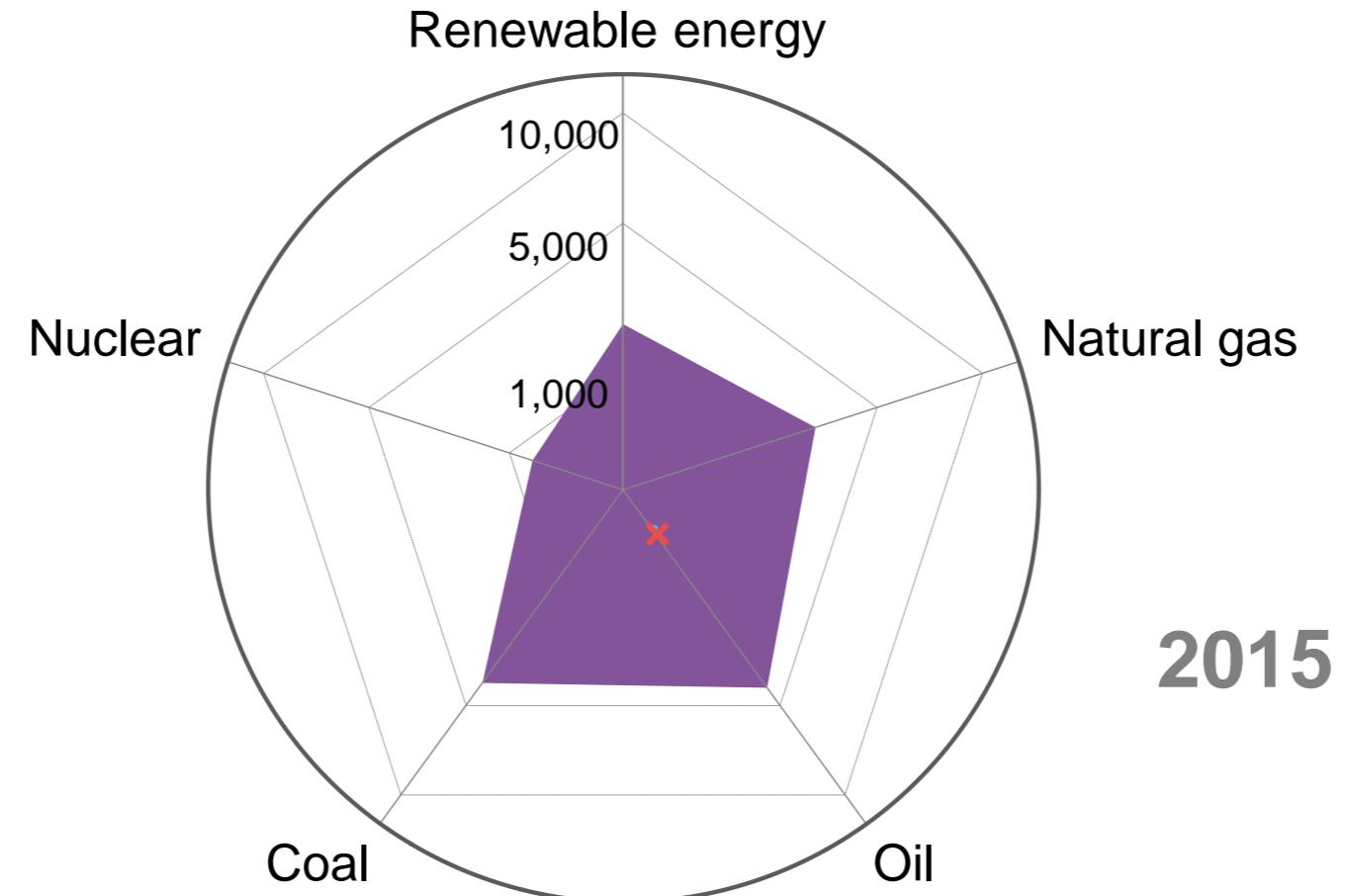
GLOBAL PRIMARY ENERGY SUPPLY, 2010 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

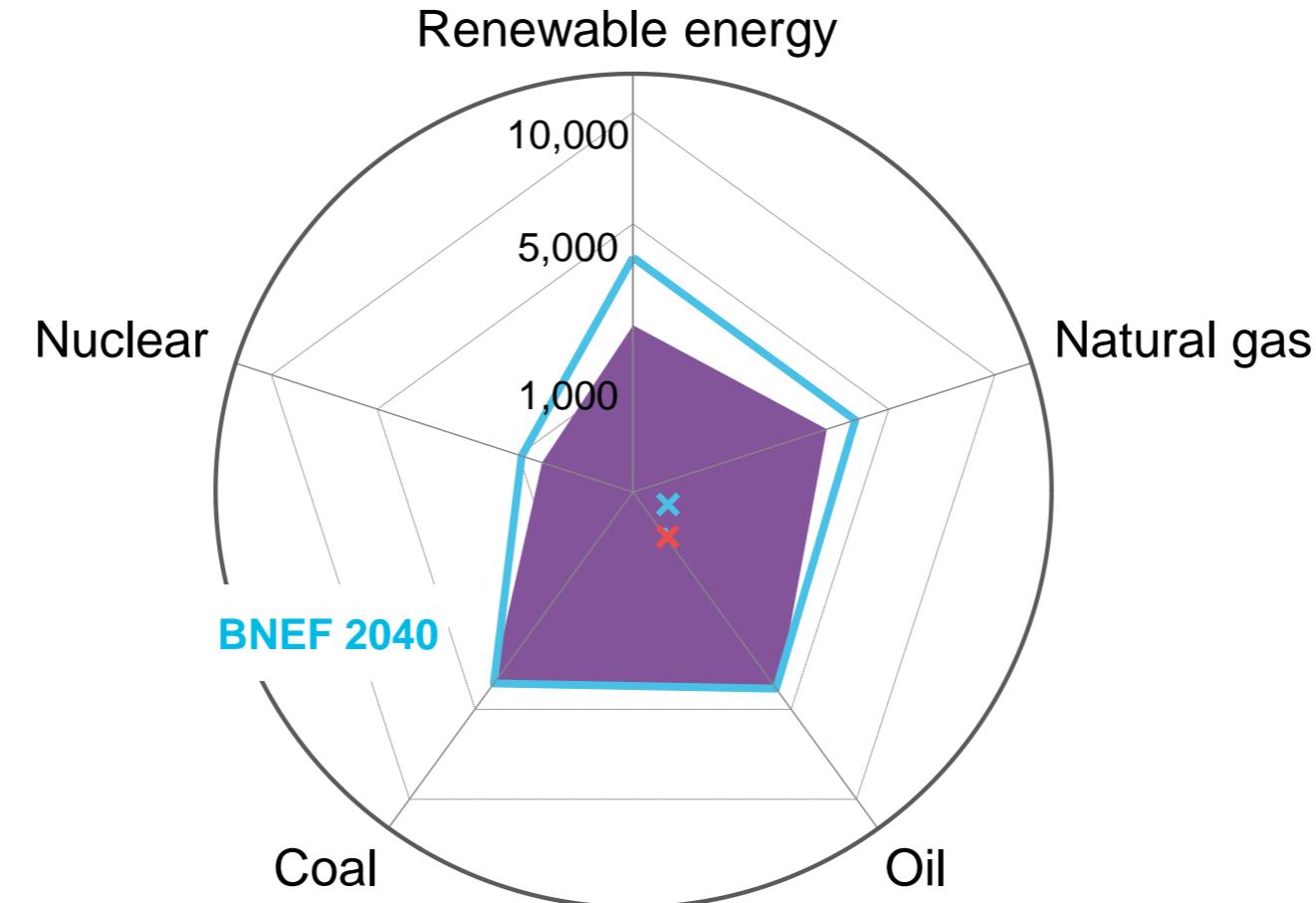
GLOBAL PRIMARY ENERGY SUPPLY, 2015 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

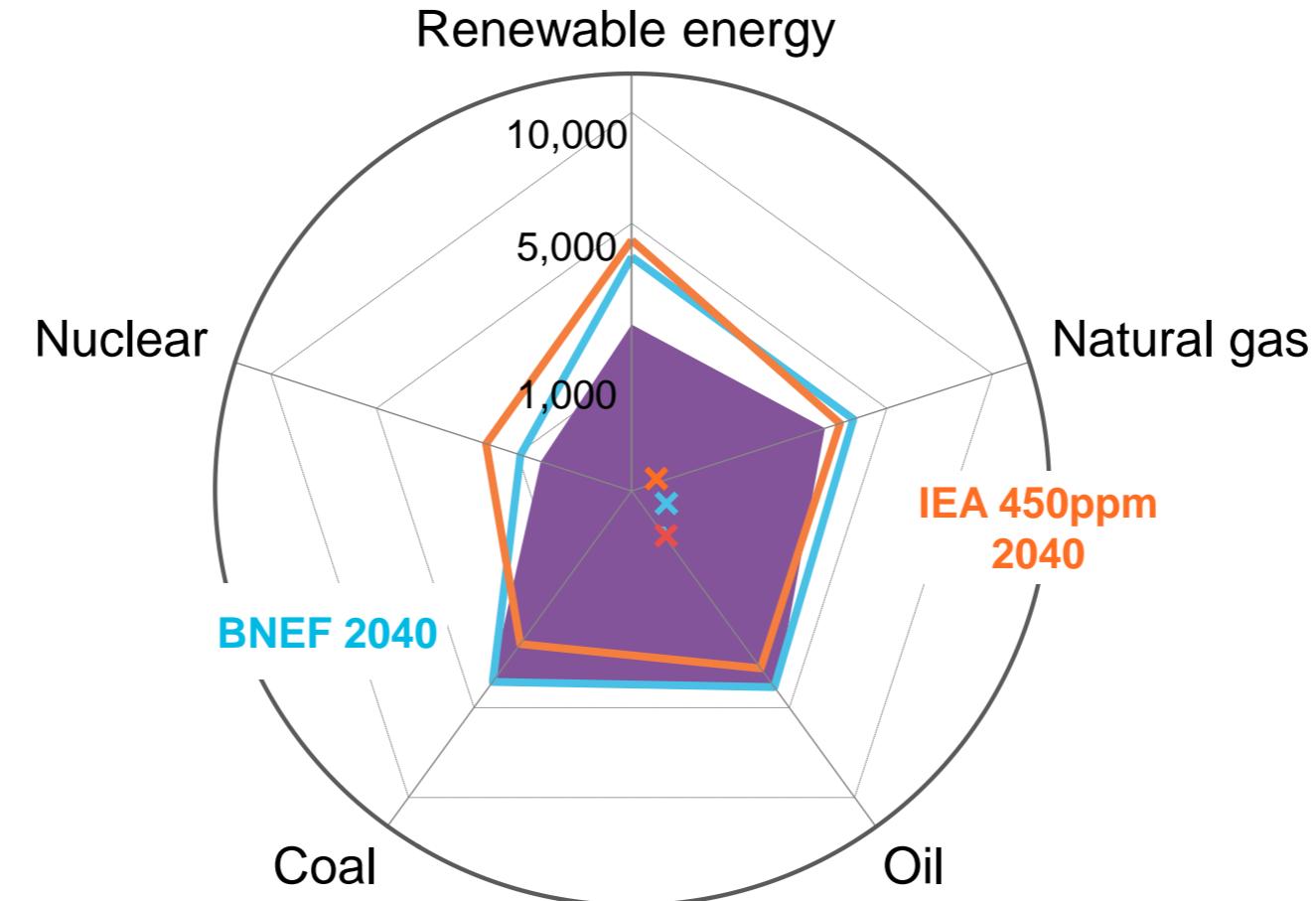
GLOBAL PRIMARY ENERGY SUPPLY (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

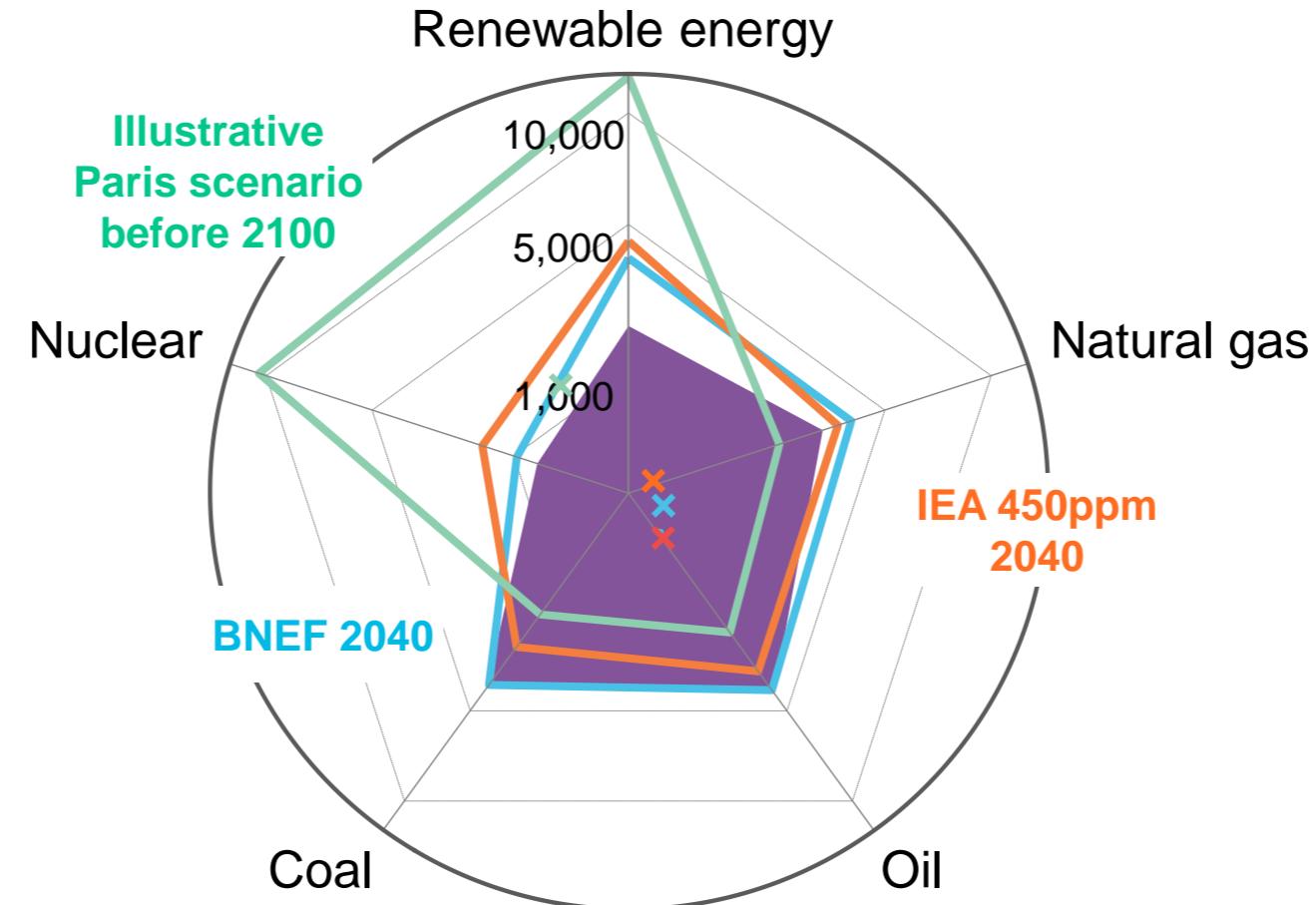
GLOBAL PRIMARY ENERGY SUPPLY (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

GLOBAL PRIMARY ENERGY SUPPLY (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.
Paris illustrative scenario assumes some carbon capture.

Source: Bloomberg New Energy Finance, IEA

“

We need an
energy miracle

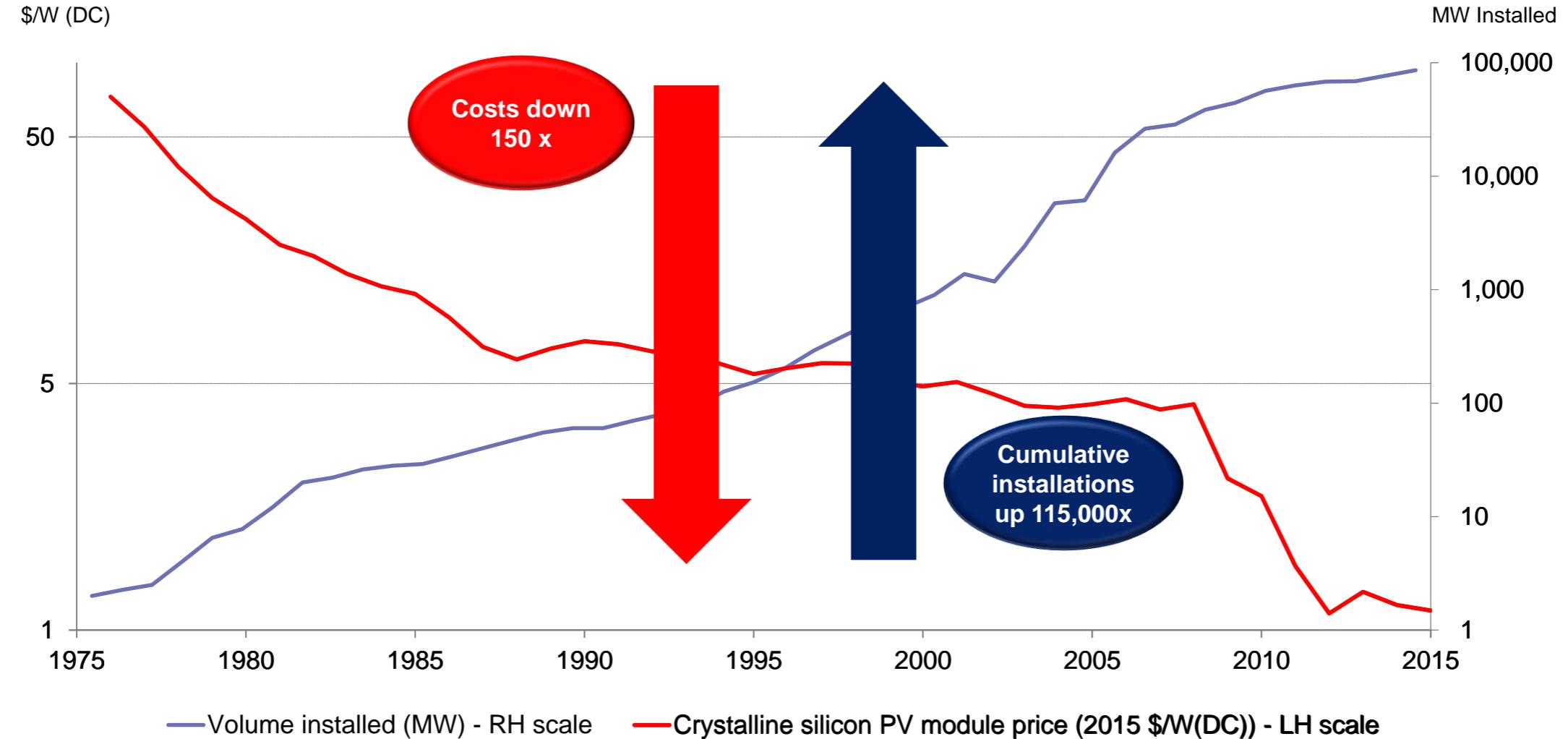
”

*Bill Gates
February 2016*



Picture: Bloomberg

SOLAR – MIRACLE?

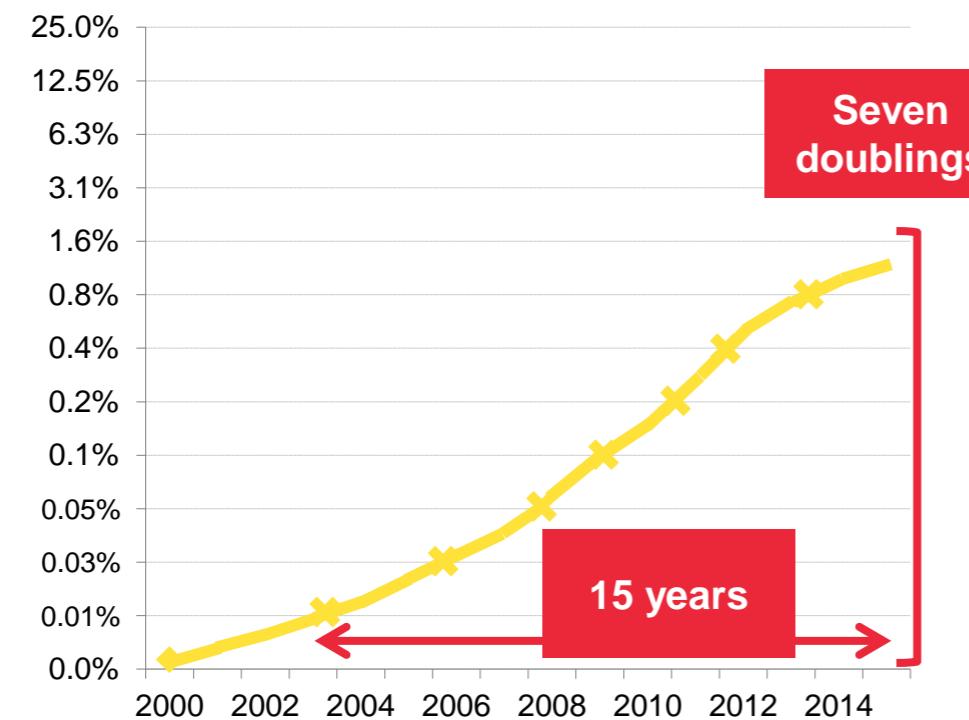


Source: Maycock, Bloomberg New Energy Finance

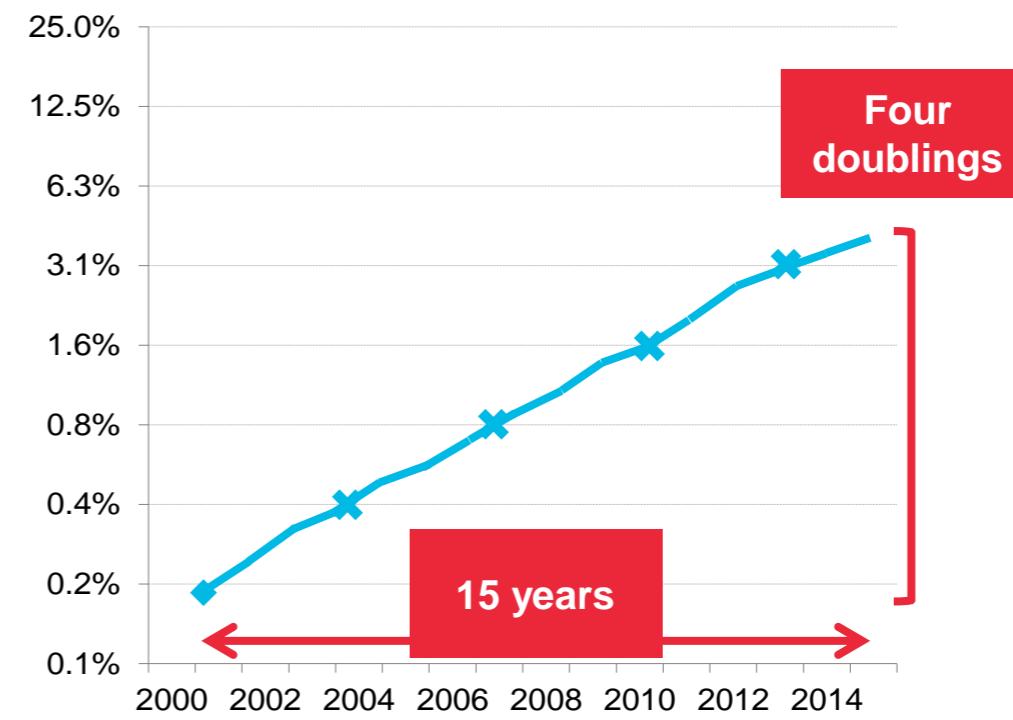
RENEWABLES SHARE OF TOTAL SYSTEM GENERATION, 2000–15 (% OF SYSTEM TOTAL)

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NEW ENERGY FINANCE

SOLAR



WIND



Note: Y-axes are logarithmic with base 2

Source: Bloomberg New Energy Finance, BP, UNEP

CAPACITY FACTOR IMPROVEMENTS

LONGER BLADES



LOW-WIND TURBINES
AT HIGH-WIND SITES



SITE-OPTIMISED POWER CURVES



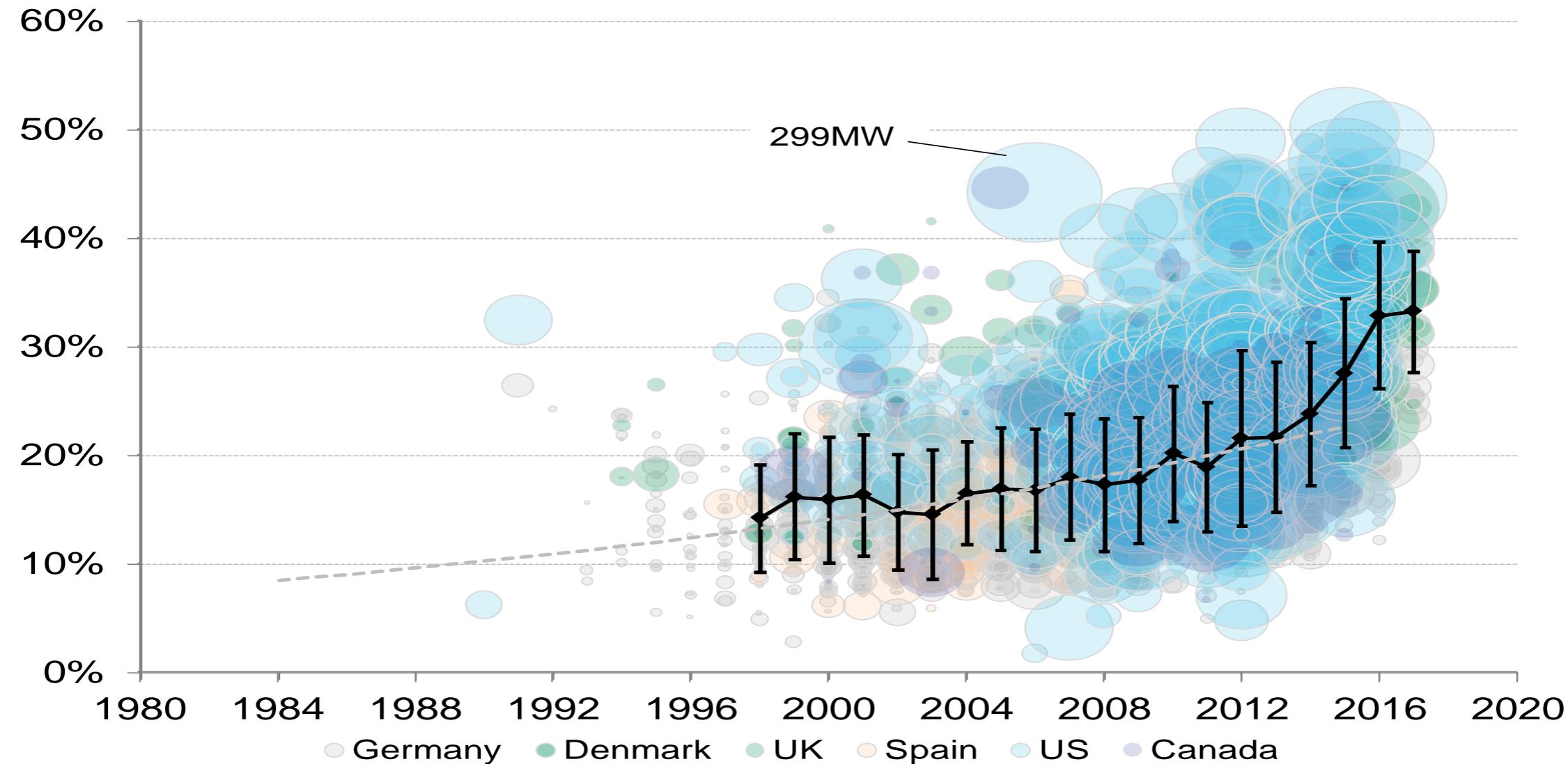
HIGHER TOWERS



Source: Siemens, Nordex, GE, Vestas

GLOBAL (EX. CHINA) ONSHORE WIND CAPACITY FACTOR IMPROVEMENTS, 1997-2015 (%)

Bloomberg
NEW ENERGY FINANCE



Note: Averages are capacity-weighted. We calculate the capacity factor with our proprietary [Wind Farm Capacity Factor Tool](#) using real project data and wind resource data provided by 3TIER by Vaisala. We assume P90 value in the capacity factor tool.

Source: Bloomberg New Energy Finance

2011 UNSUBSIDISED CLEAN ENERGY WORLD RECORDS

ONSHORE WIND



US\$ 6.2 cents/kWh

SOLAR PV



US\$ 17 cents/kWh

Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons

2016 UNSUBSIDISED CLEAN ENERGY WORLD RECORDS

ONSHORE WIND



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

SOLAR PV

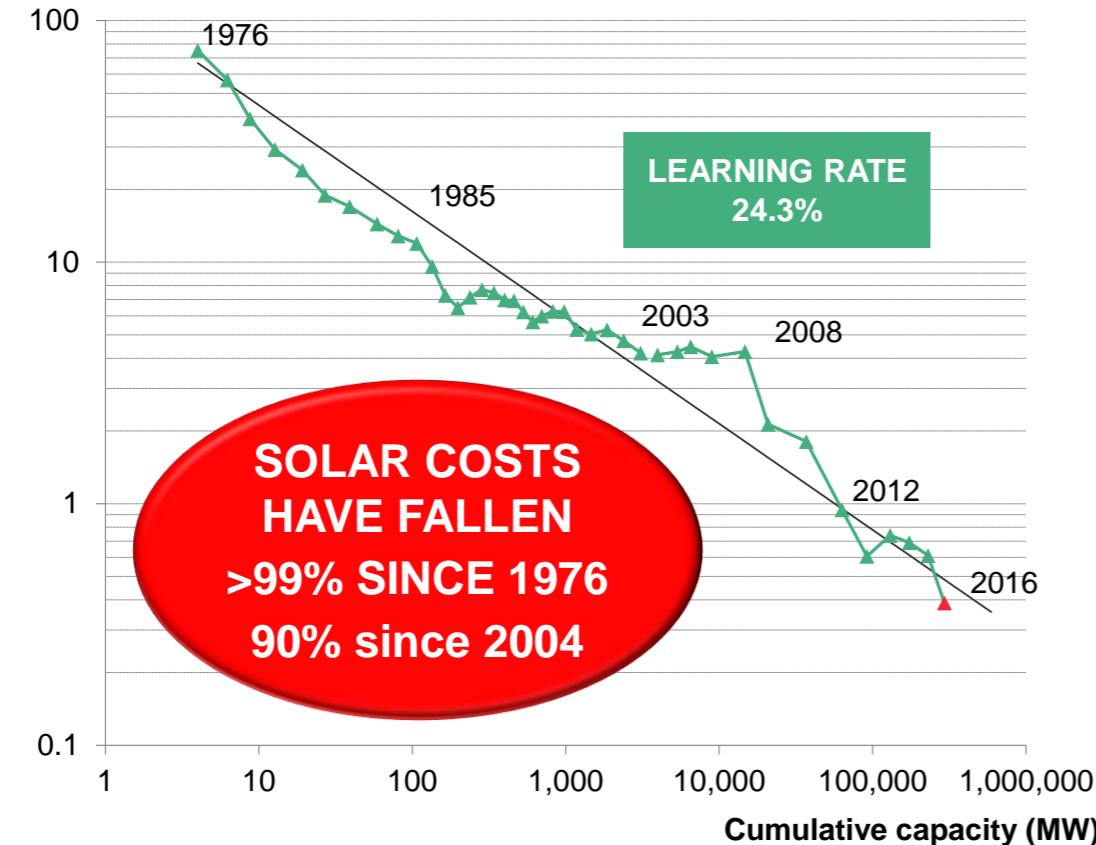


Location: Chile
Bidder: Solarpack Corporation
Signed: August 2016
Construction: 2019
Price: **US\$ 2.91 c/kWh**

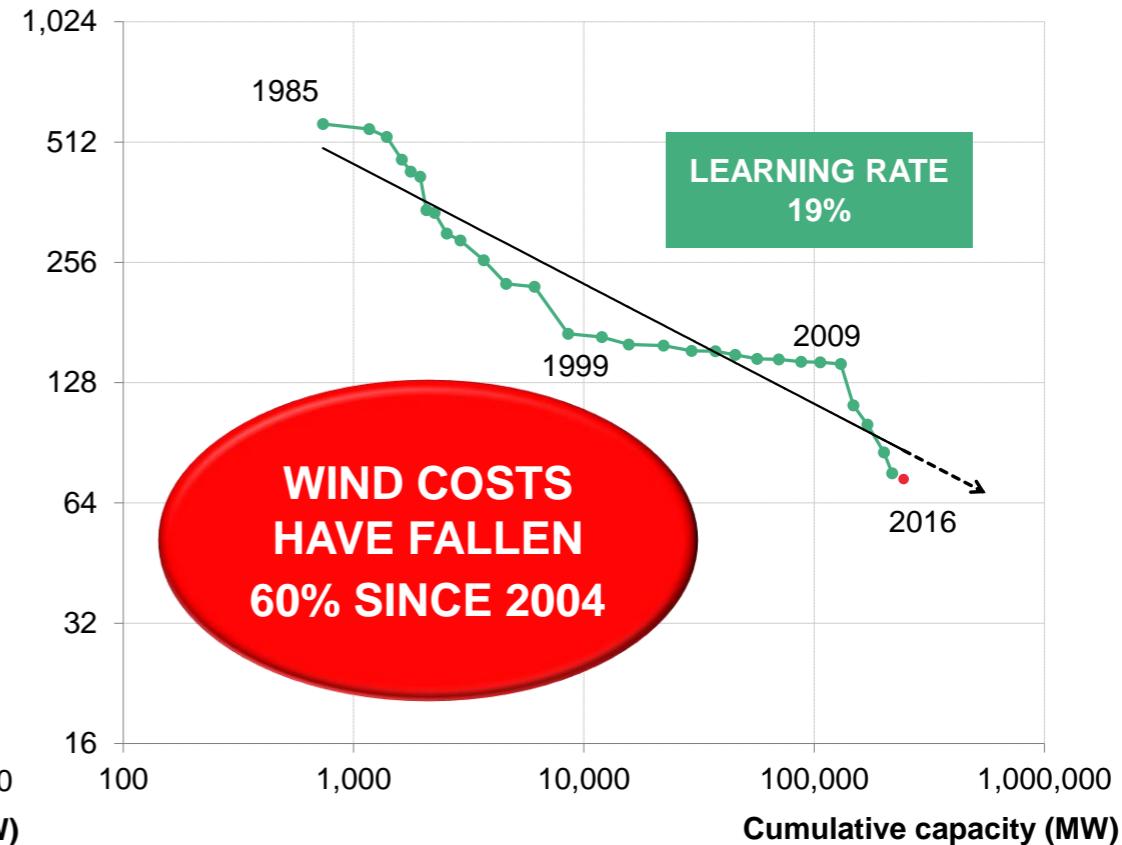
Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons

WIND AND SOLAR EXPERIENCE CURVES

SOLAR PV MODULE COST (\$/W)



ONSHORE WIND LEVELISED COST* (\$/MWH)



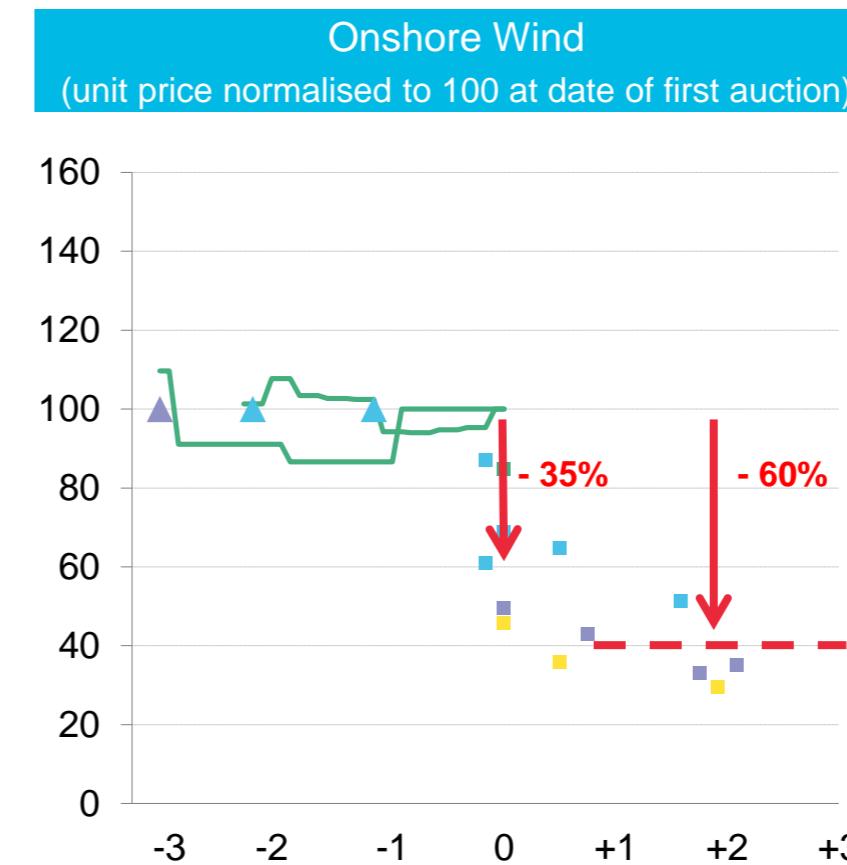
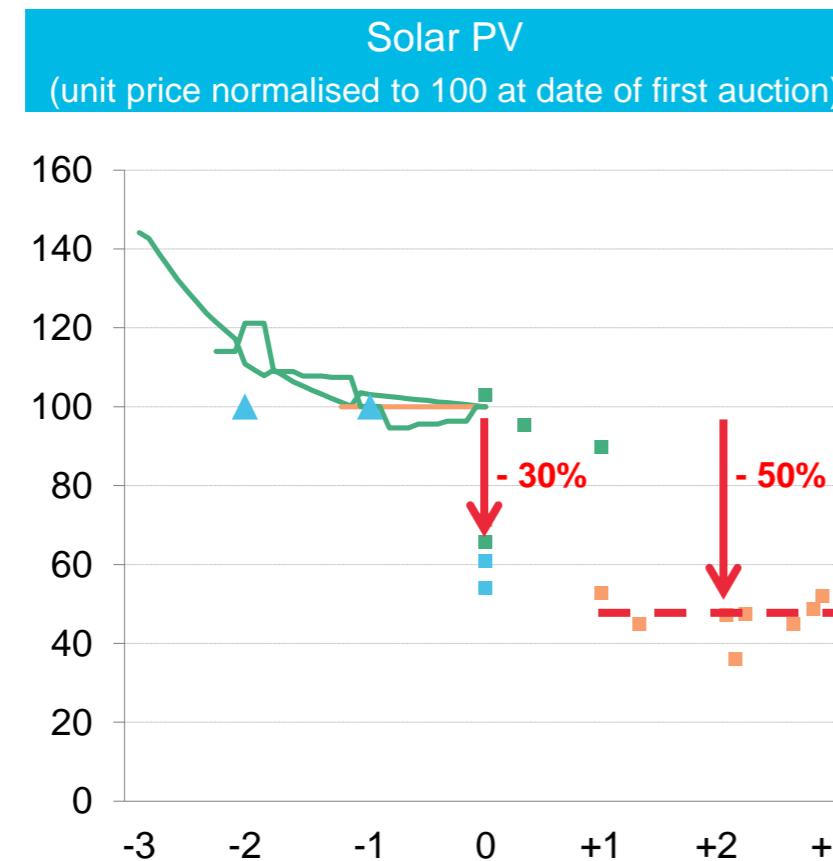
Note: Prices are in real (2015) USD. 'Current price' is \$0.4/W

Source: Bloomberg New Energy Finance, Maycock

Note: Pricing data has been inflation corrected to 2014. We assume the debt ratio of 70%, cost of debt (bps to LIBOR) of 175, cost of equity of 8%. *Data is for Northern Europe.

Source: Bloomberg New Energy Finance

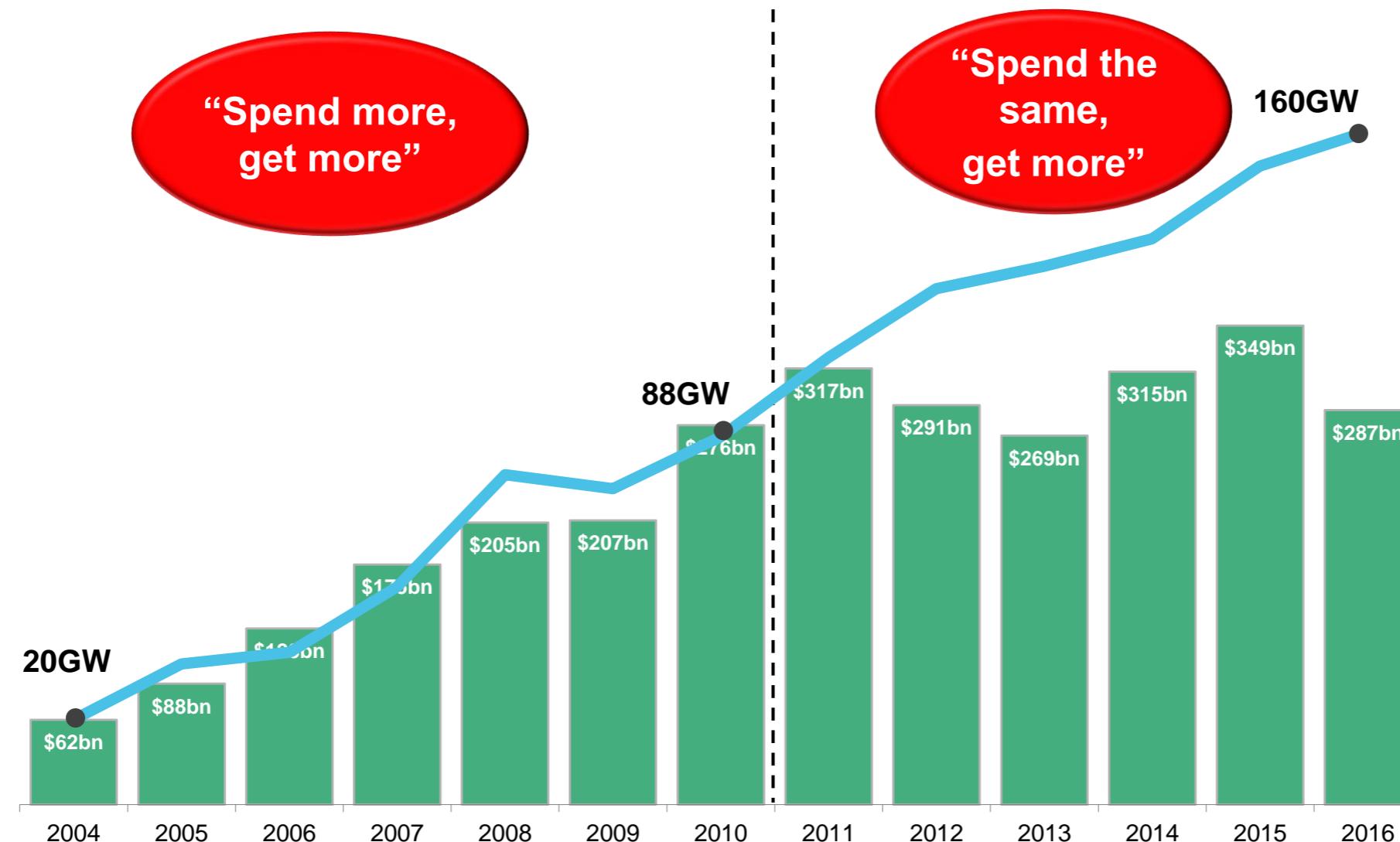
PRICE IMPACT OF SWITCH FROM FIT TO AUCTIONS, SELECTED COUNTRIES (NORMALISED)



KEY

- : tariffs
- ▲ : non-tariff price signals
- : auctions
- EMEA
- Other LatAm
- Brazil
- India
- South Africa

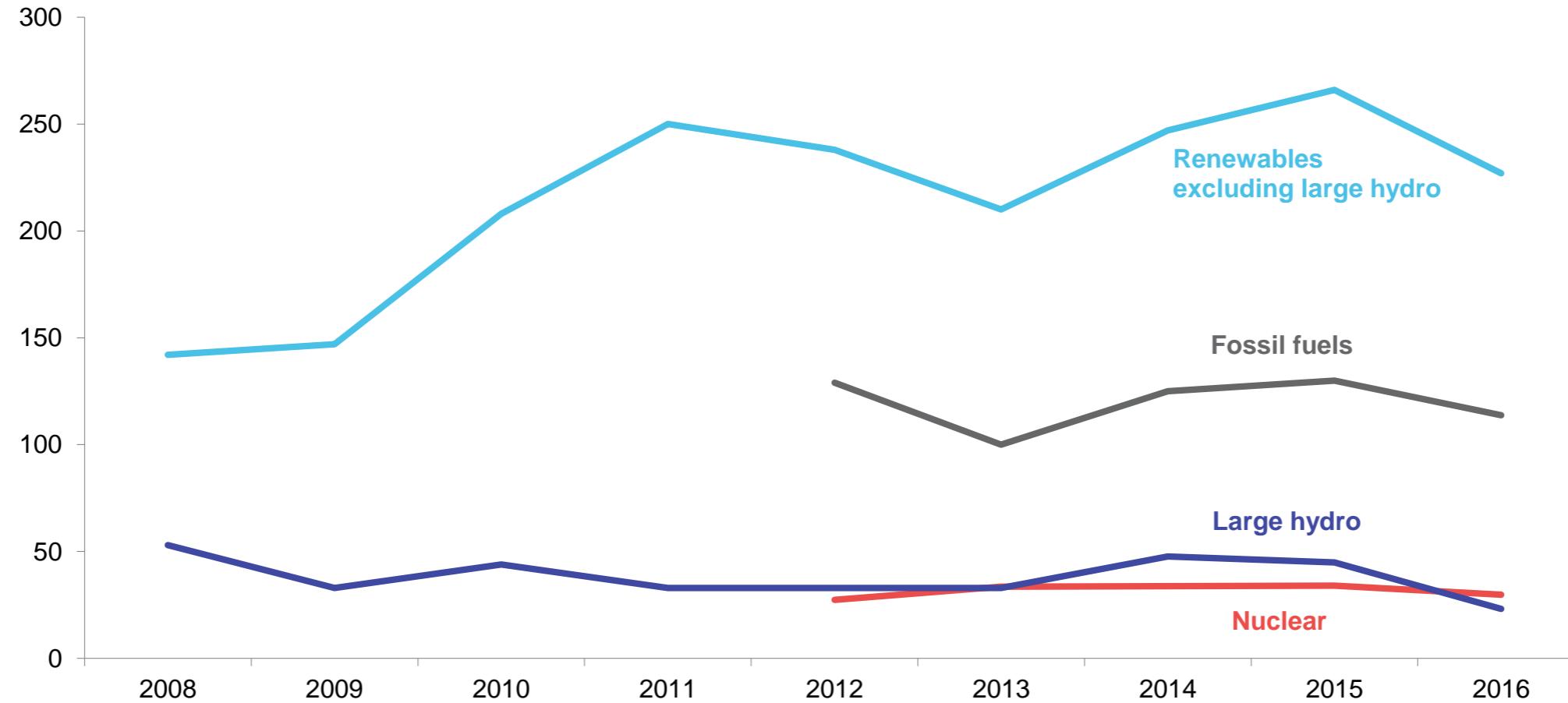
GLOBAL CLEAN ENERGY INVESTMENT & CAPACITY ADDITIONS



Note: Total values include estimates for undisclosed deals. Includes corporate and government R&D, and spending for digital energy and energy storage projects (not reported in quarterly statistics). Excludes large hydro.

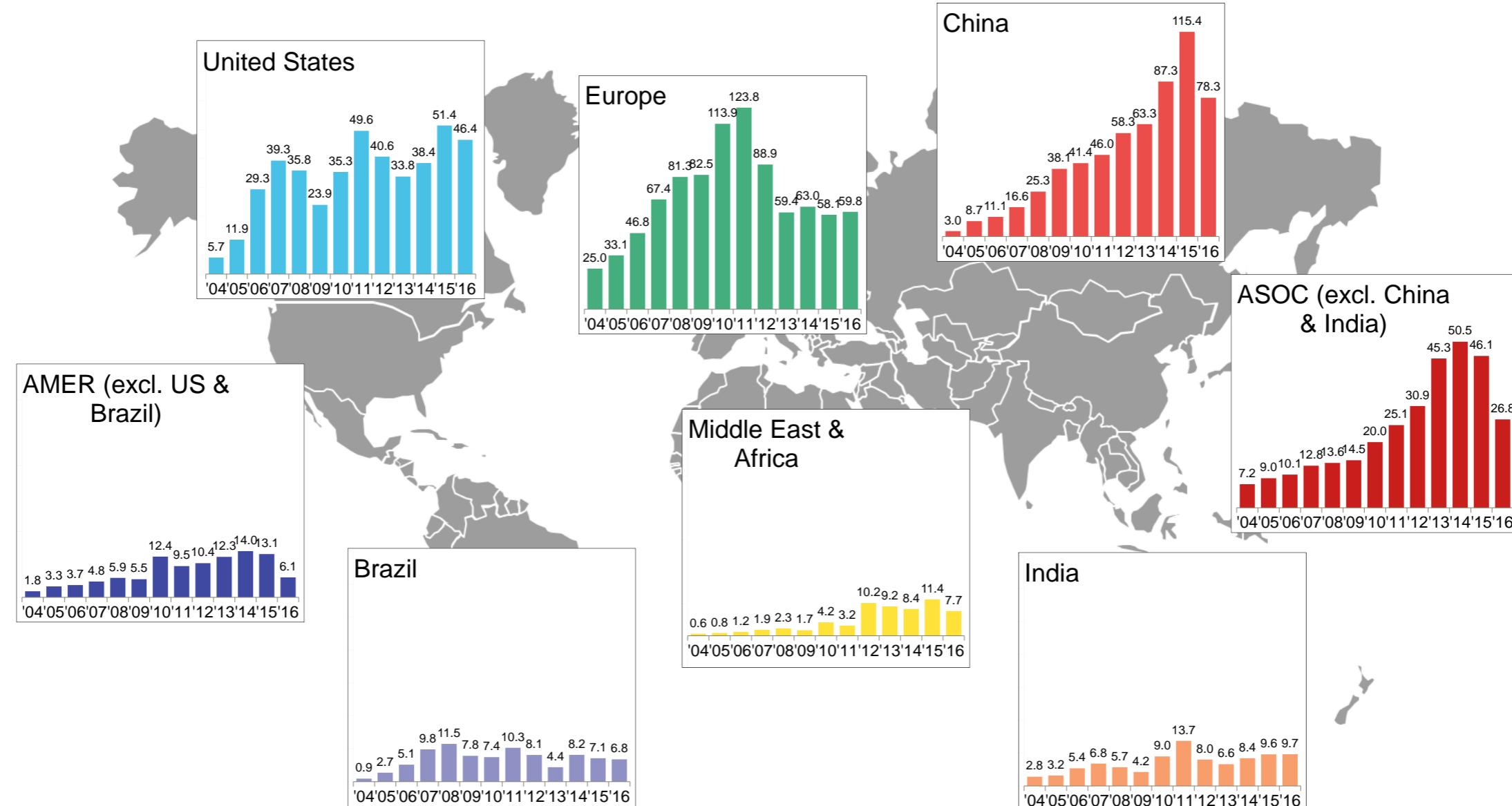
Source: Bloomberg Intelligence, Bloomberg New Energy Finance

INVESTMENT IN POWER CAPACITY, 2008-16 (\$BN)



Source: Bloomberg New Energy Finance, UNEP

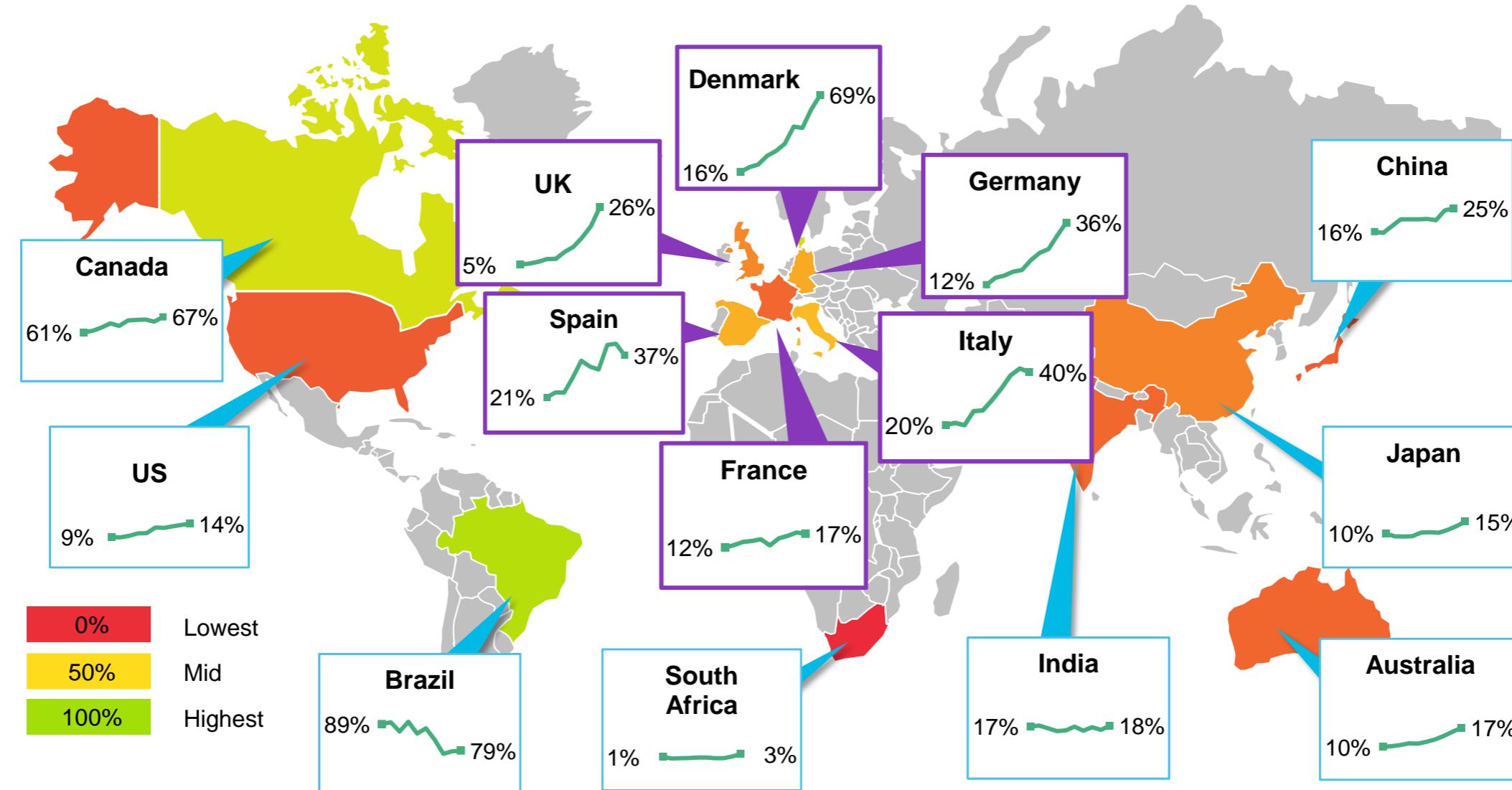
RENEWABLE ENERGY INVESTMENT BY REGION 2004-2016 (\$BN)



Note: New investment value adjusts for re-invested equity. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance

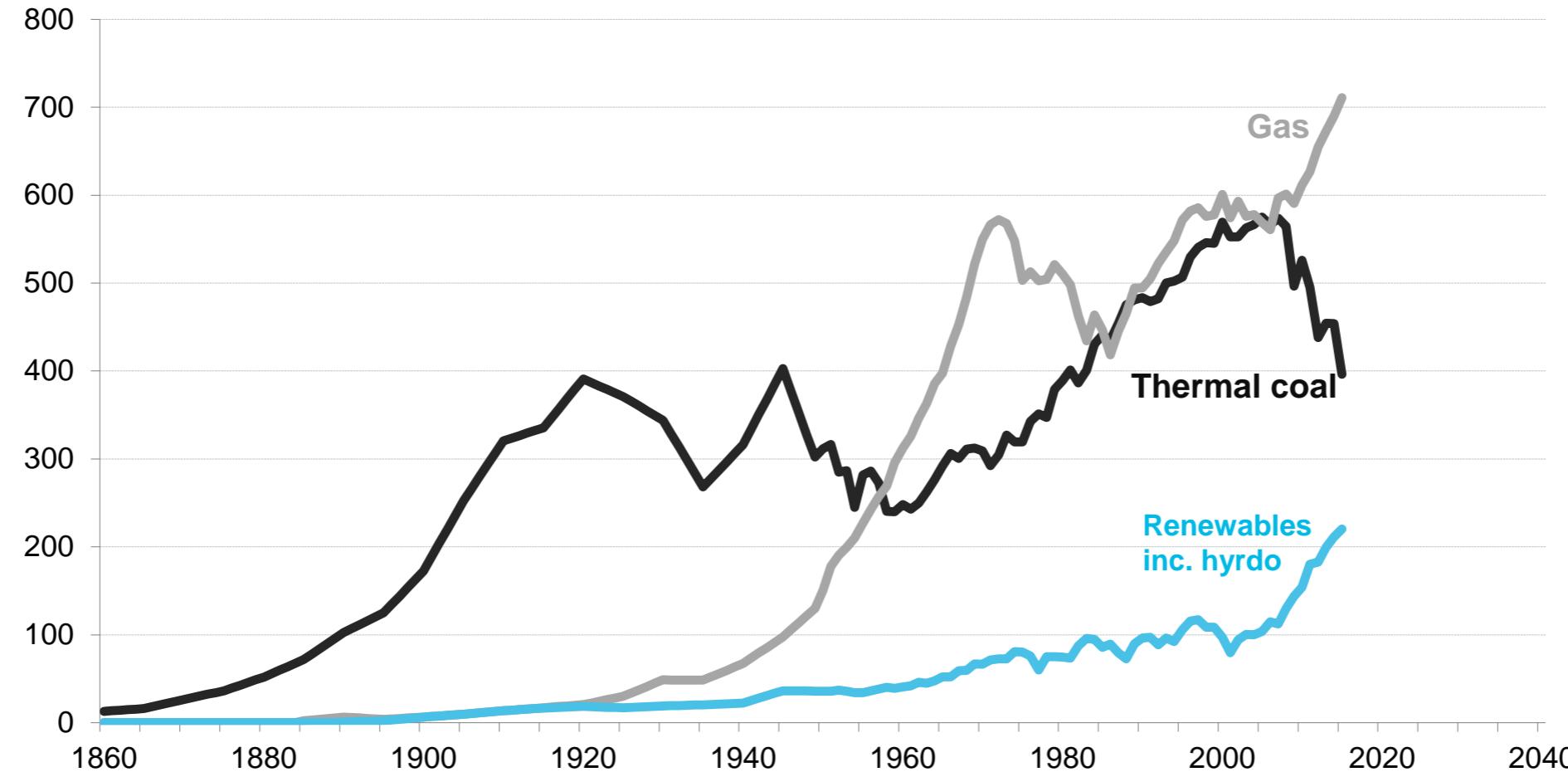
RENEWABLE ENERGY PROPORTION OF POWER GENERATION, 10 YEARS TO 2015 (%)



Note: Includes hydro. Source: BP Statistical Review of Energy, Bloomberg New Energy Finance

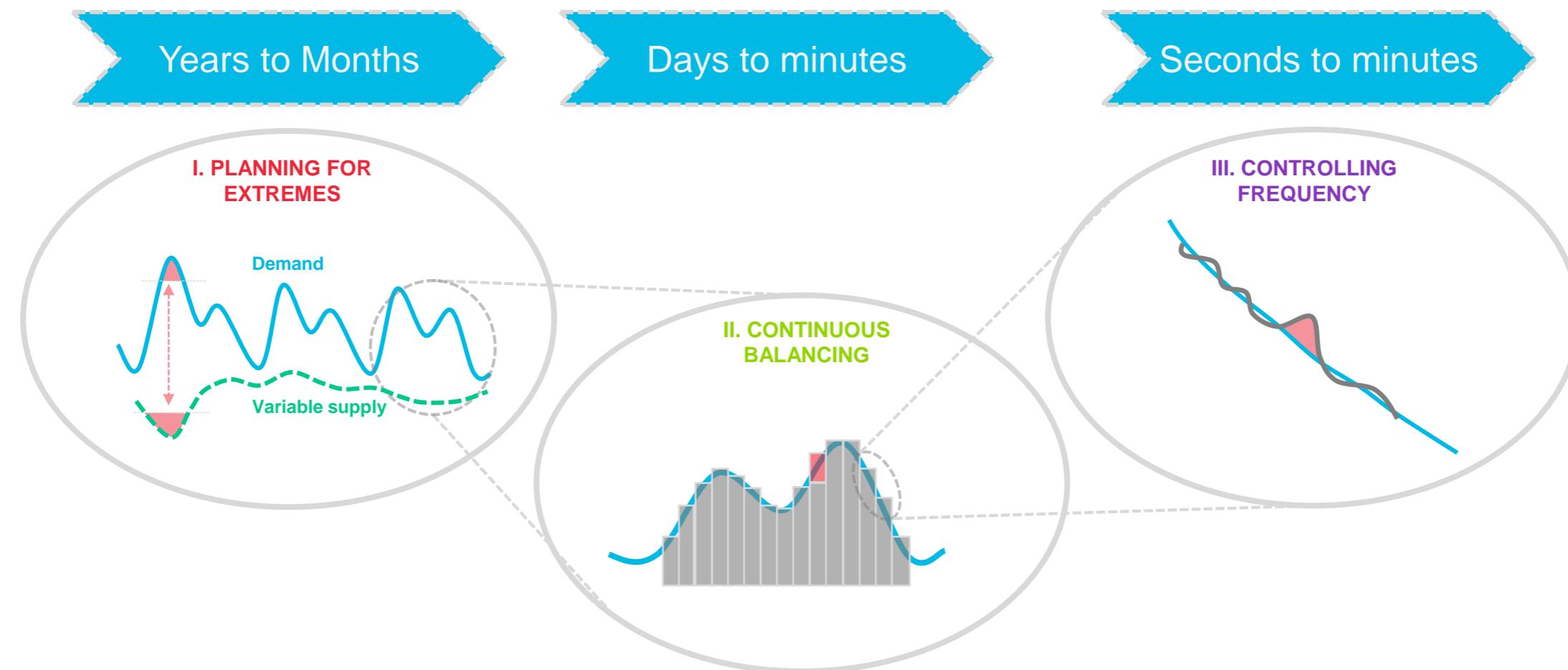
US COAL CONSUMPTION VS GAS AND RENEWABLES, PRIMARY ENERGY (MTOE/YR)

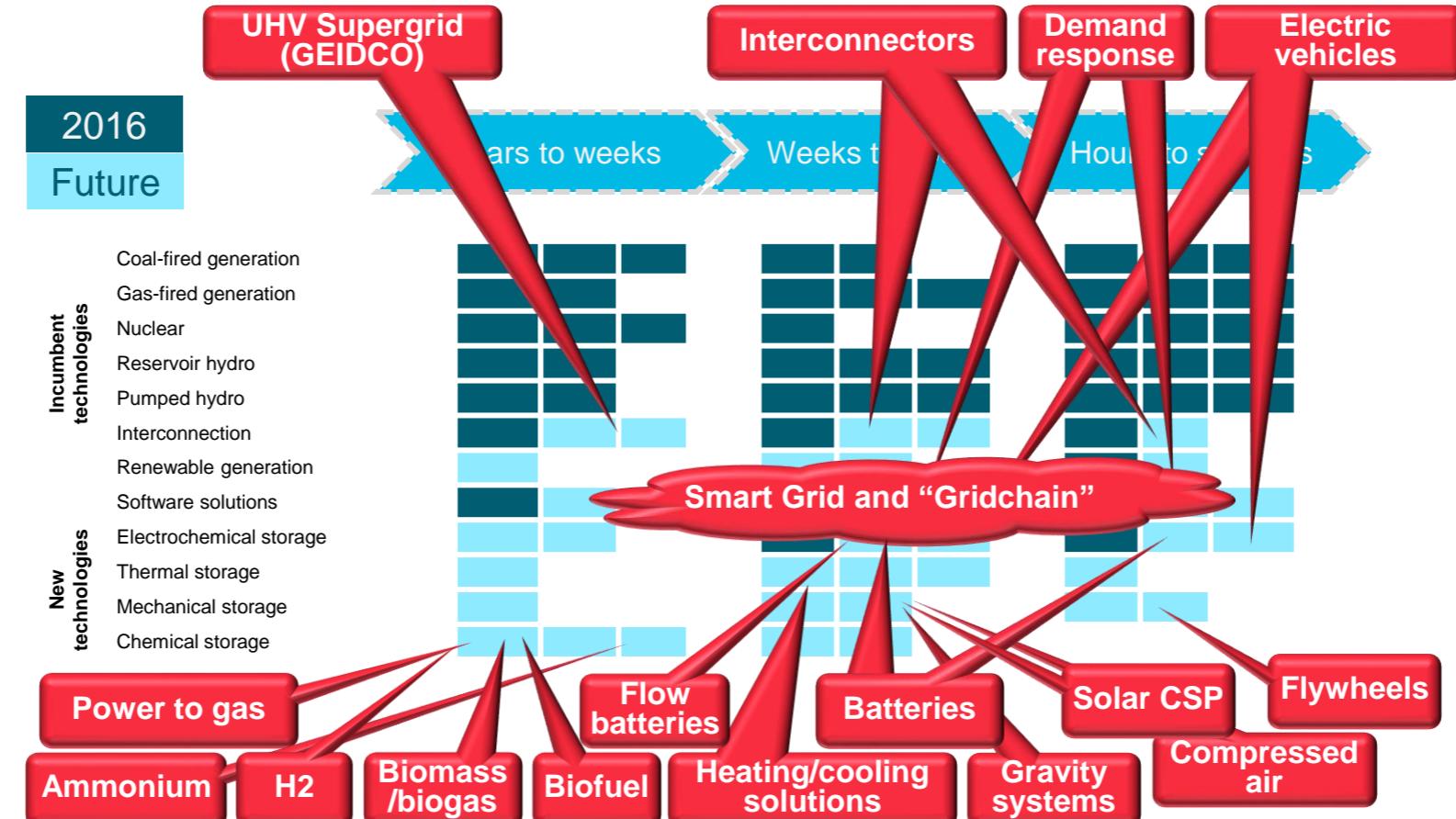
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Source: EIA

MATCHING SUPPLY AND DEMAND IS DONE DIFFERENTLY DEPENDING ON THE TIMESCALE





Source: Bloomberg New Energy Finance

ELECTRIFICATION OF TRANSPORT

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Image: Tesla

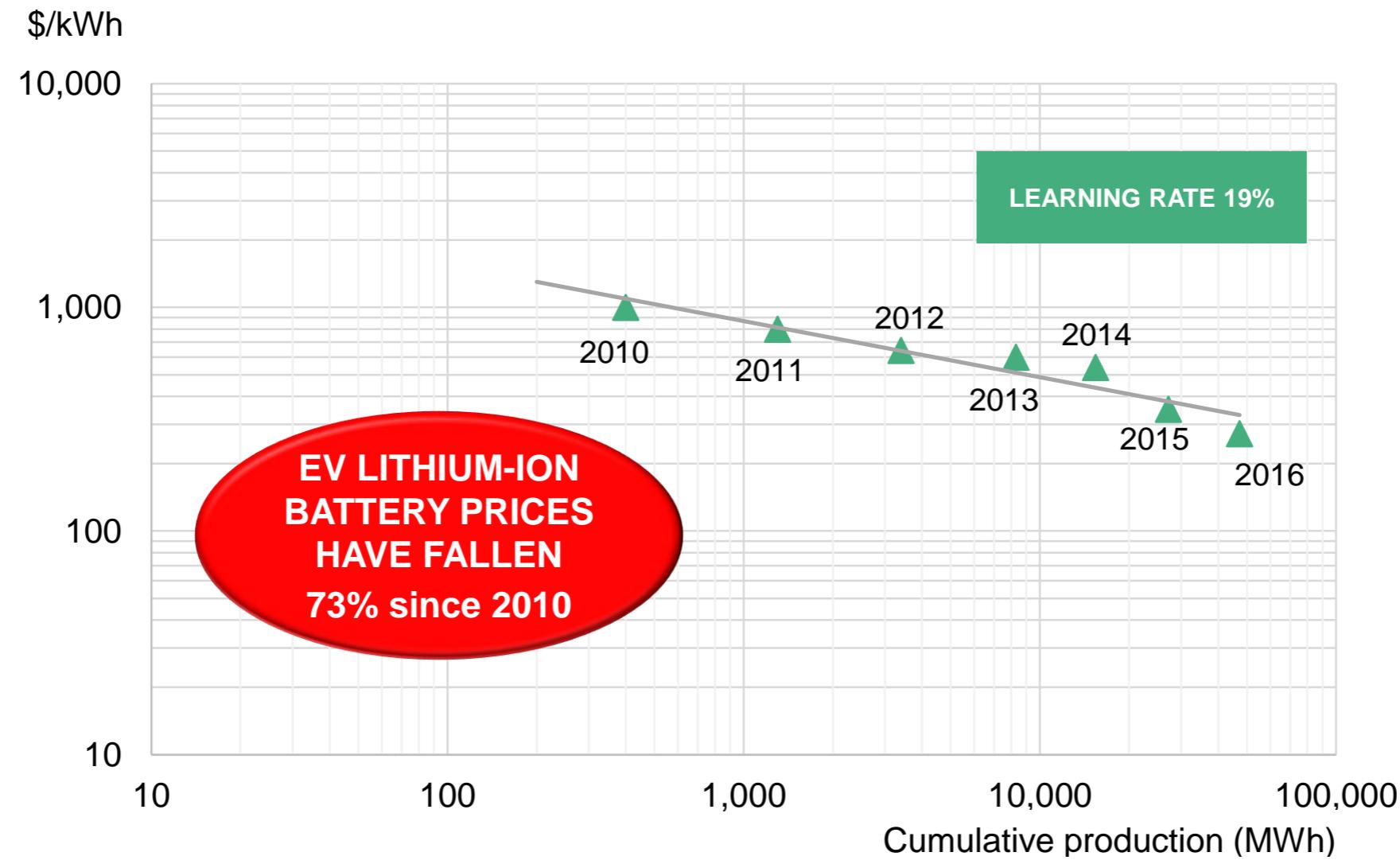
CARS AND TRUCKS IN USE
WORLDWIDE, 2016
1.3 billion



**ELECTRIC VEHICLES IN USE
WORLDWIDE, END 2016
1.8 million (to scale)**

Source: Bloomberg New Energy Finance, International Organization of Motor Vehicle Manufacturers

BNEF BATTERY PRICE LEARNING RATE 2013-2016 (\$ PER KWH)



Notes: This includes cells plus pack prices. For years where there were two surveys, the data in this chart is an average for the year. Prices are nominal.

Source: Bloomberg New Energy Finance

BEV MODEL AVAILABILITY, 2008-20

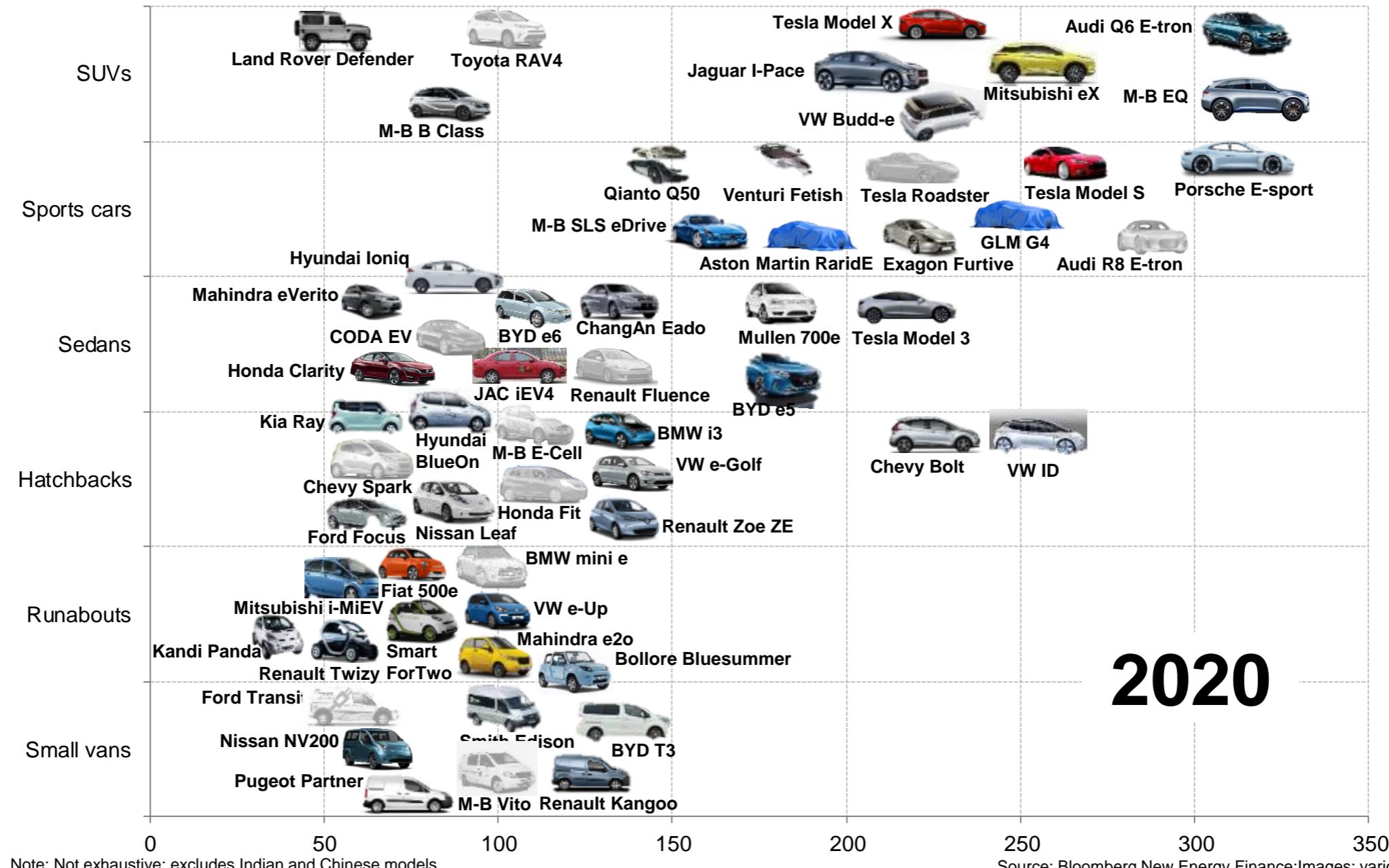




Photo: Michael Liebreich



Photo: Greenpacks



Picture: Wikimedia Commons



Photo: Shinil GCP



Photo: Thomas Hobbs



Photo: UCLA



Photo: DENNIS/Creative Commons

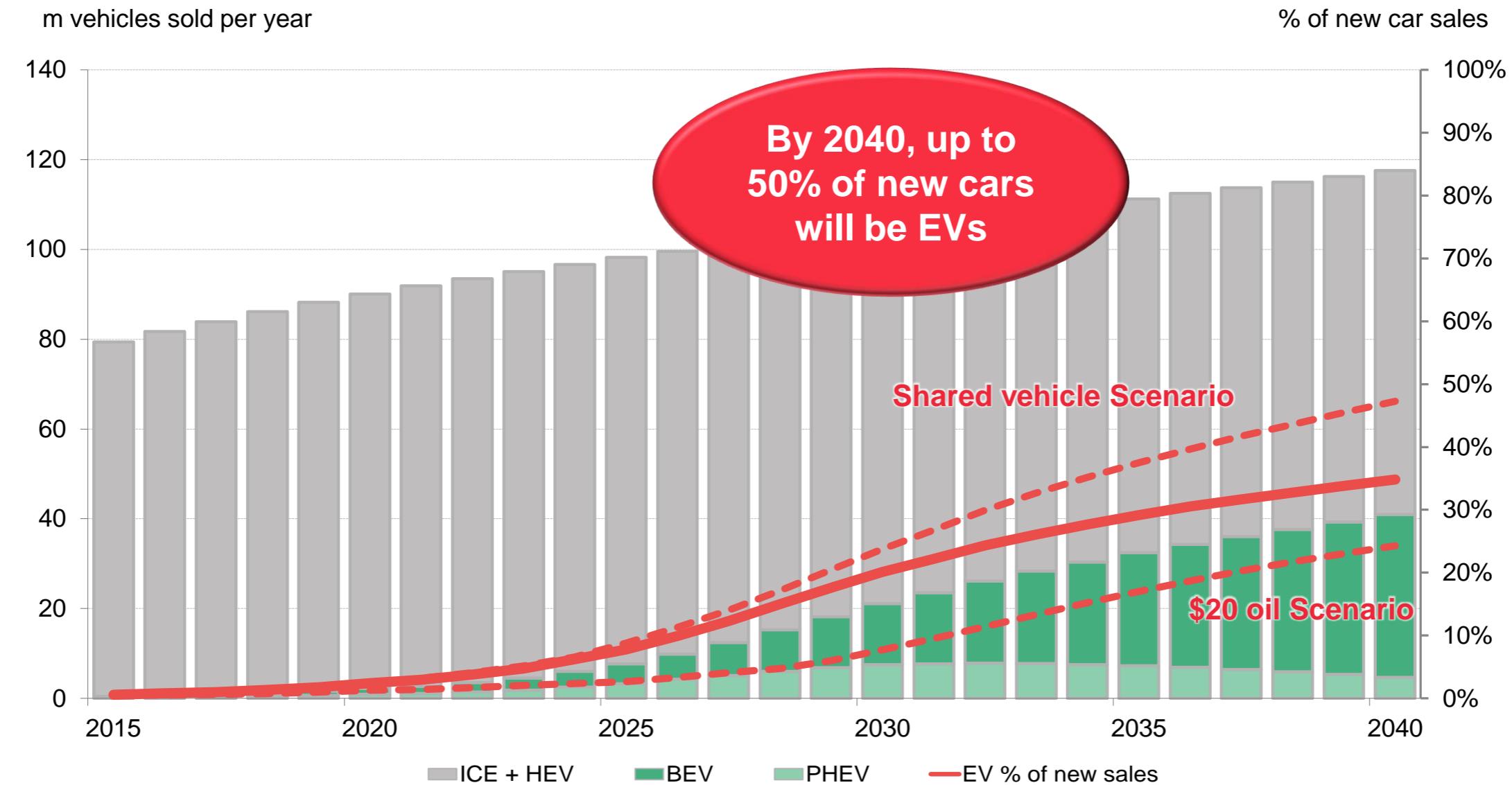


Photo: HHRCA

GLOBAL LIGHT DUTY VEHICLE AND EV ANNUAL SALES, 2015–40

(M VEHICLES SOLD PER YEAR, %)

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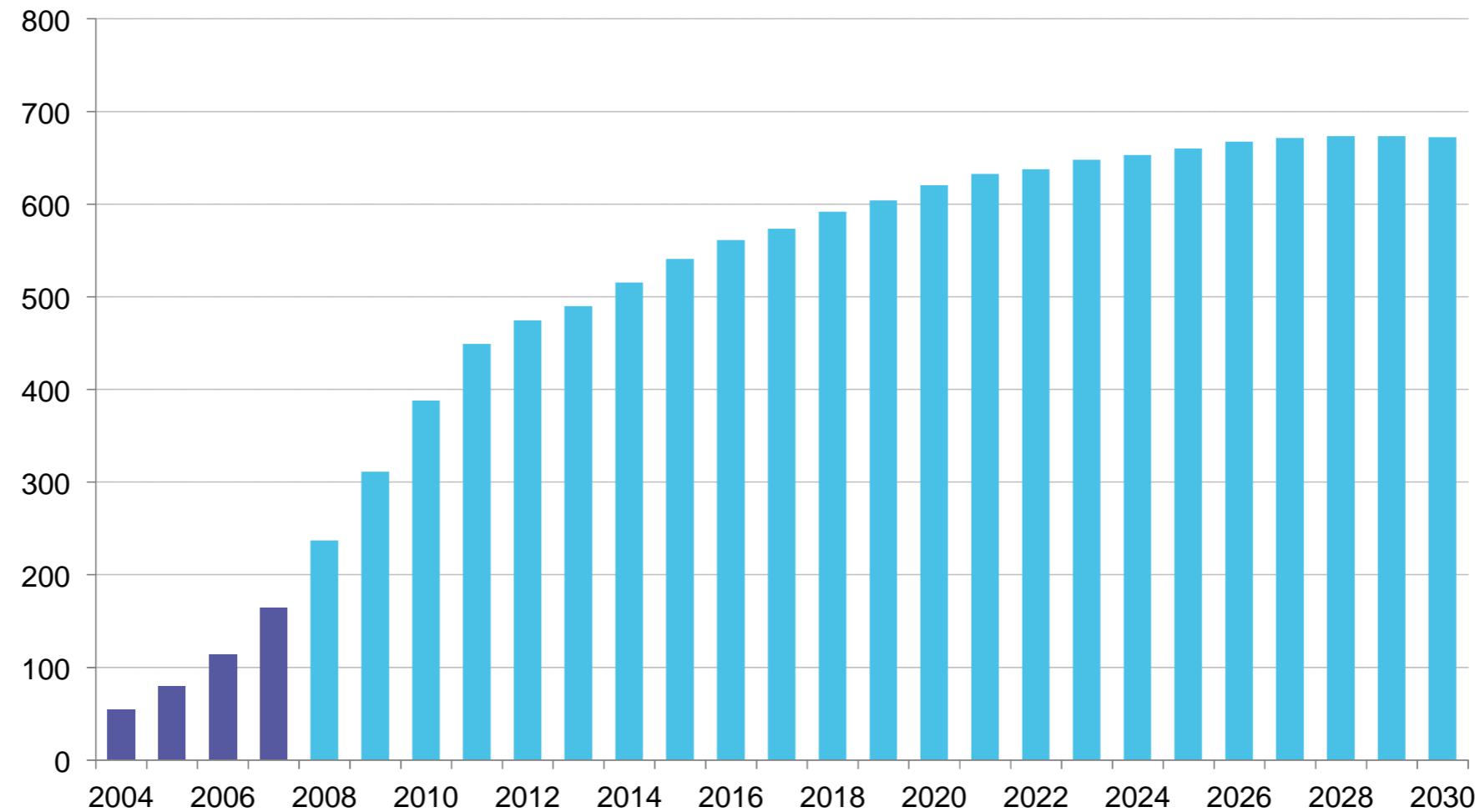


Note: forecast uses Gasoline and electricity prices from EIA's 2015 Annual Energy Outlook 'Low Oil Price' scenario (ranging from \$50 to \$65 per barrel between 2015 and 2025). High scenario assumes greater vehicle utilisation. Low scenario assumes \$20 per barrel oil price

Source: Bloomberg New Energy Finance

CLEAN ENERGY CAPITAL REQUIREMENT TO 2030 (\$BN)

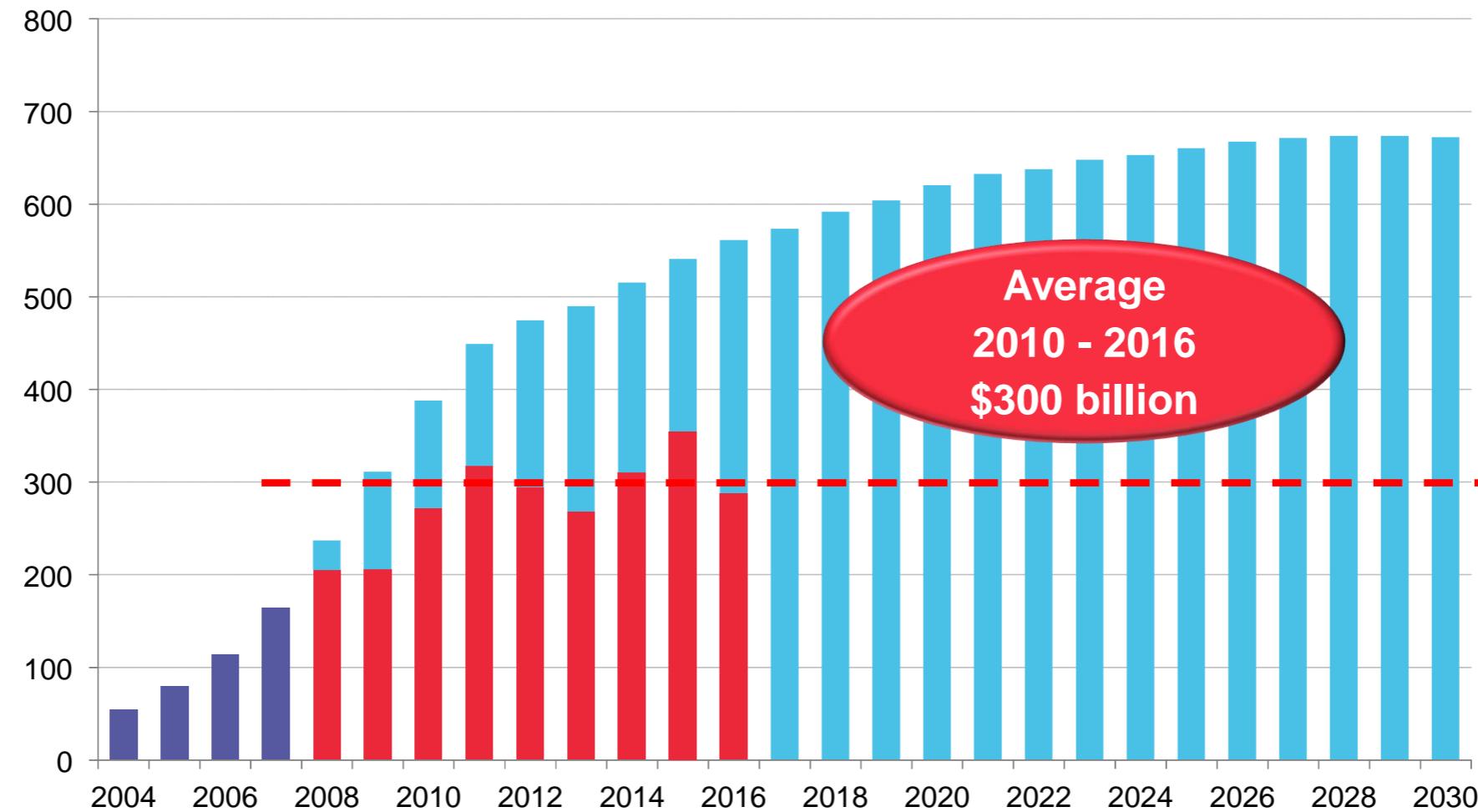
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NEW ENERGY FINANCE



Note: Global Futures figures from 2008 restated to reflect current investment calculation methodology

Source: New Energy Finance Global Futures 2008,
Bloomberg New Energy Finance

CLEAN ENERGY CAPITAL REQUIREMENT TO 2030 (\$BN)

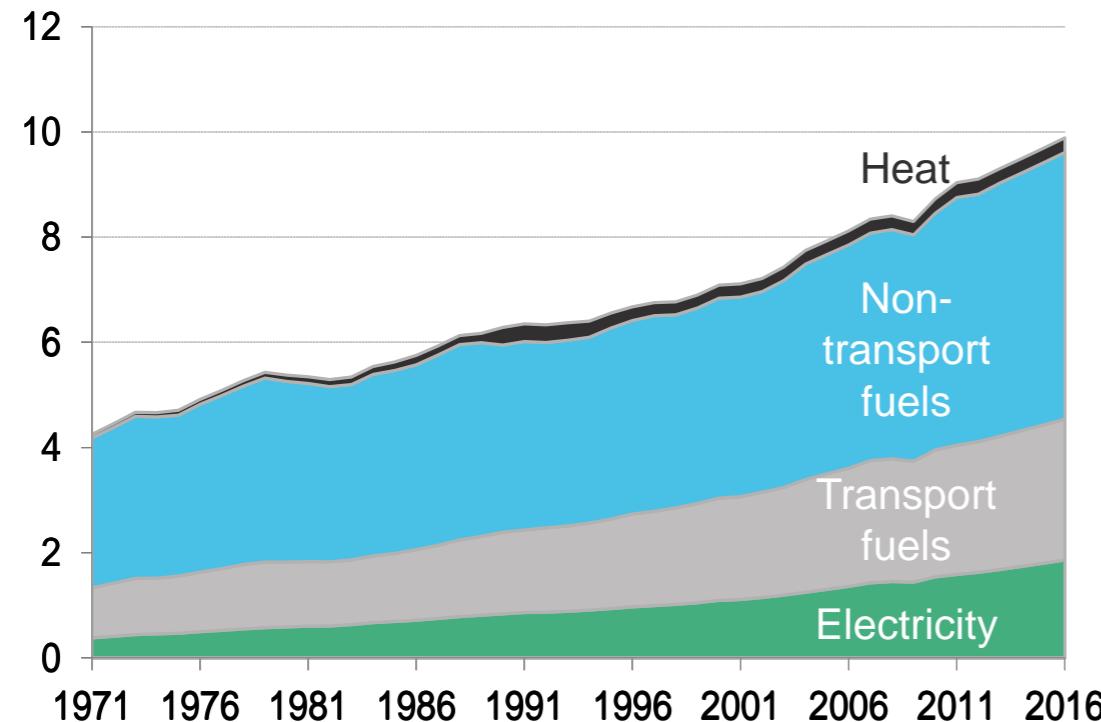


Note: Global Futures figures from 2008 restated to reflect current investment calculation methodology

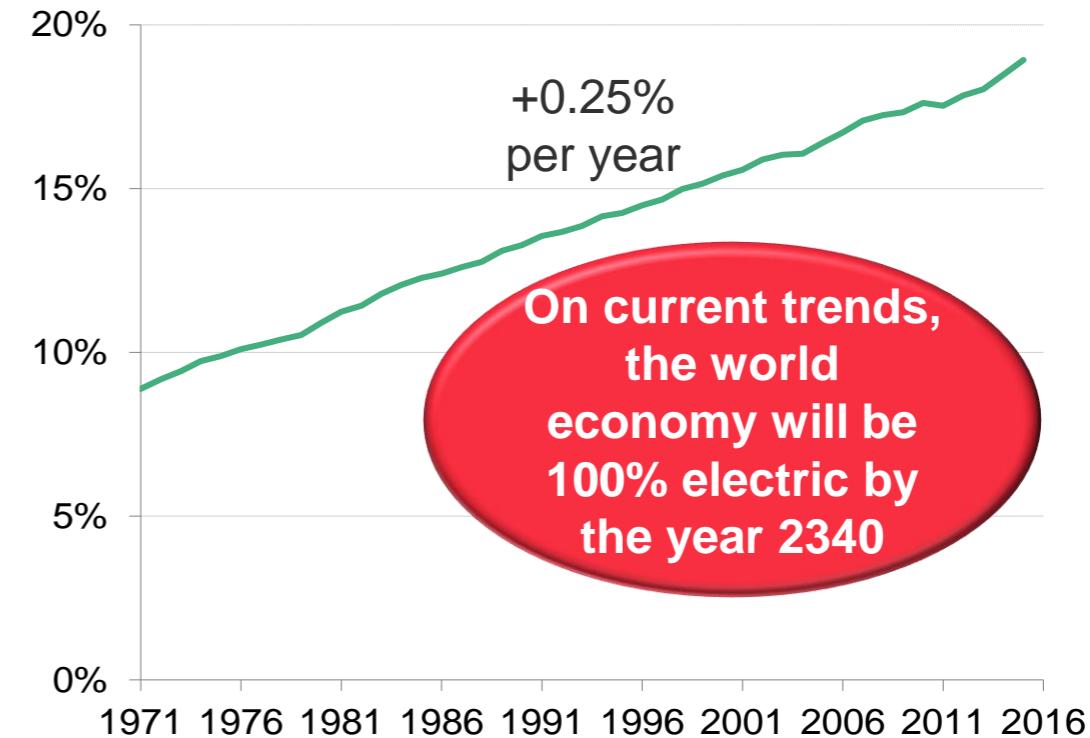
Source: New Energy Finance Global Futures 2008,
Bloomberg New Energy Finance

ELECTRIFICATION OF GLOBAL ENERGY DEMAND

STRUCTURE OF FINAL ENERGY (BN TOE)

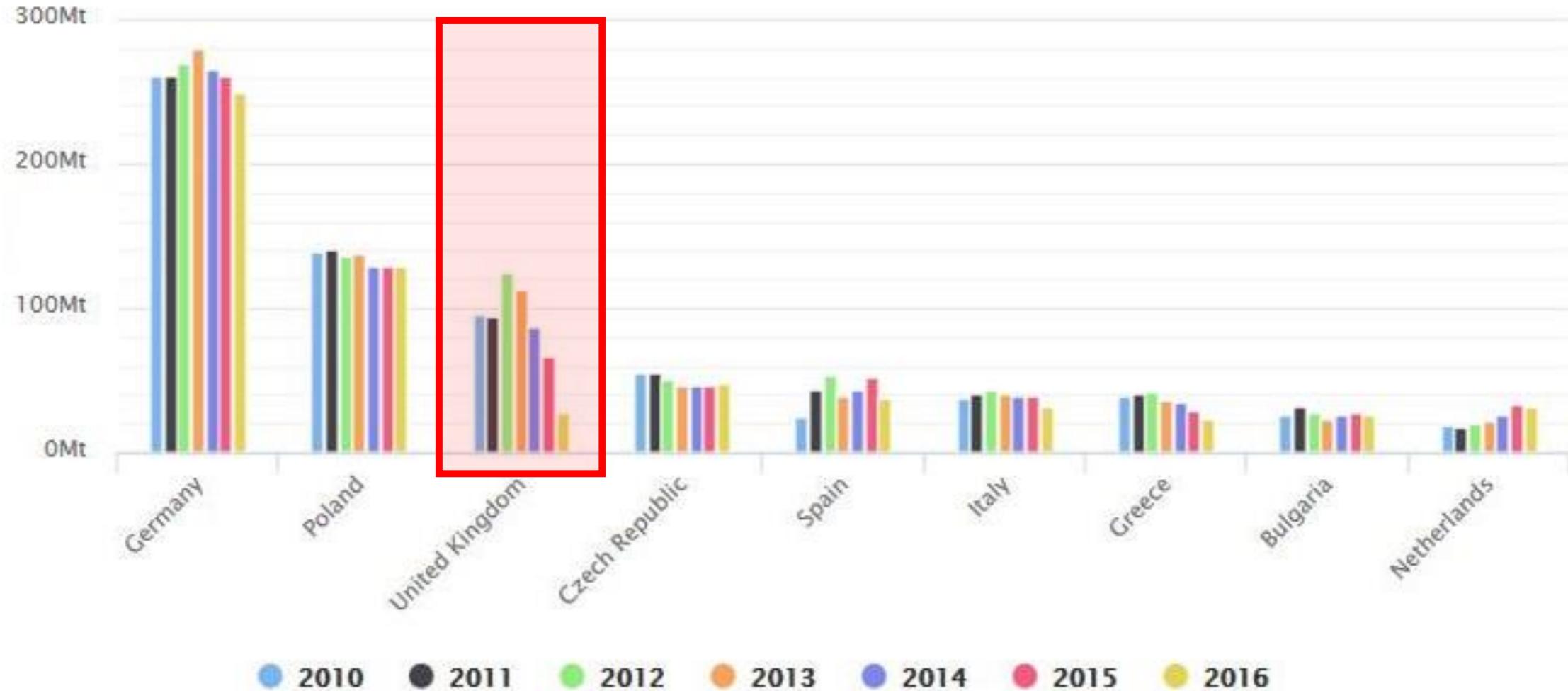


ELECTRICITY SHARE OF FINAL ENERGY CONSUMPTION (%)



Note: TOE is tonnes of oil equivalent

PERFORMANCE OF LARGEST EU COAL-BASED EMITTERS, 2010-2016 (MT)

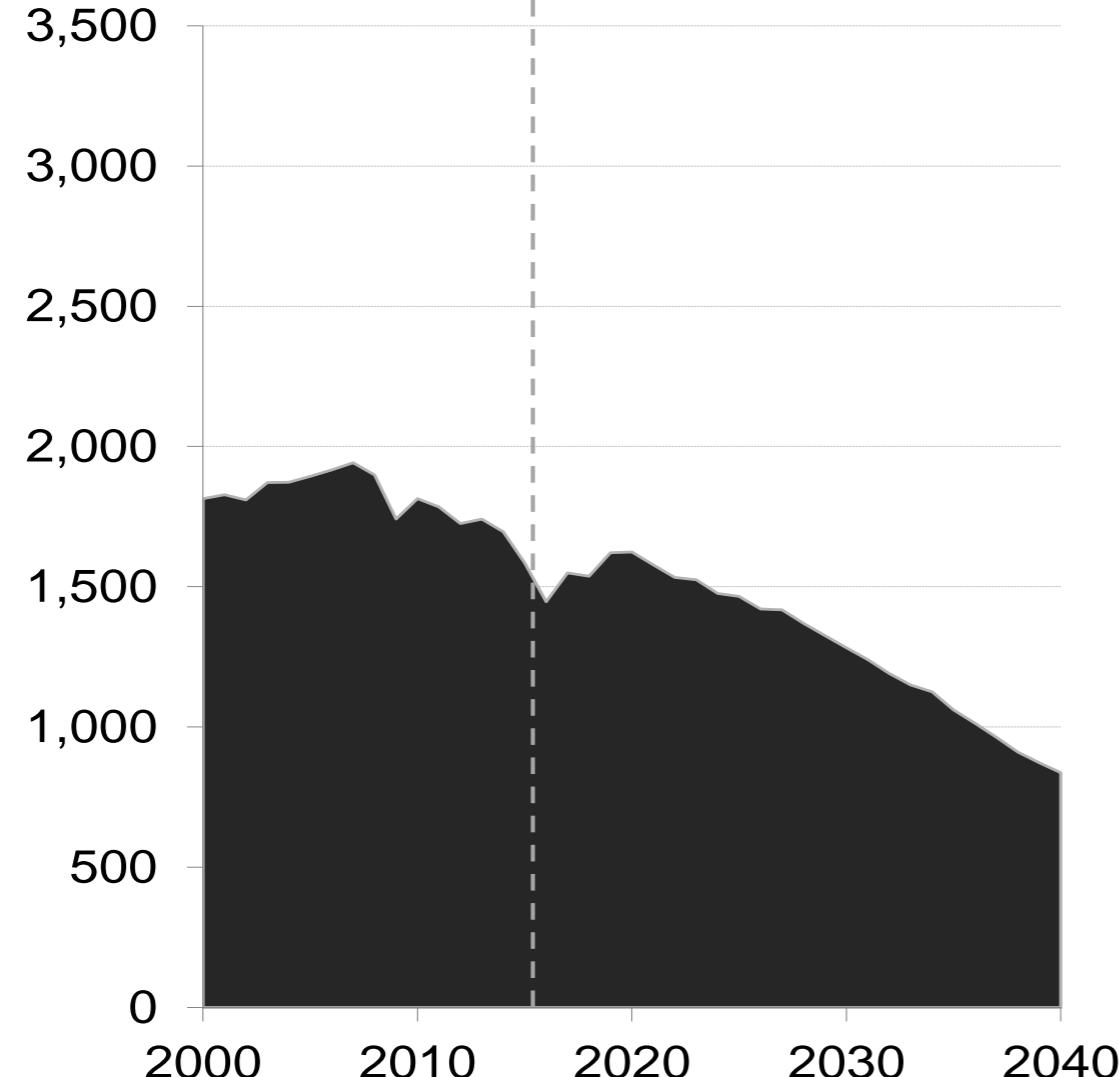


Source: Sandbag

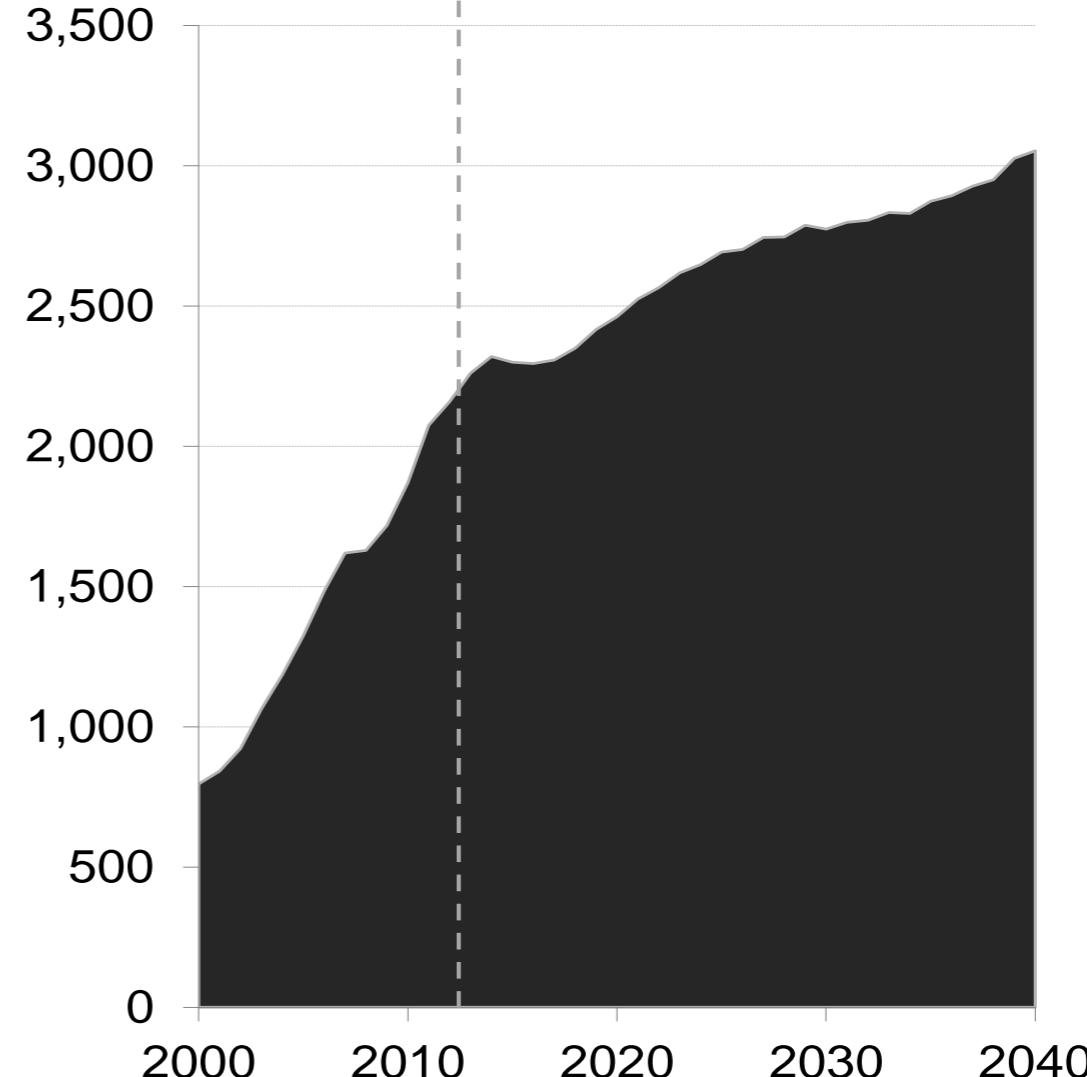
THERMAL COAL CONSUMED IN POWER GENERATION (MT/YR)

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WORLD EXCLUDING ASIA



ASIA



Note: Assumes coal quality of 6,000kcal/tonne

Source: Bloomberg New Energy Finance, IEA

PRESIDENT TRUMP

Bloomberg
NEW ENERGY FINANCE



Image: Bloomberg

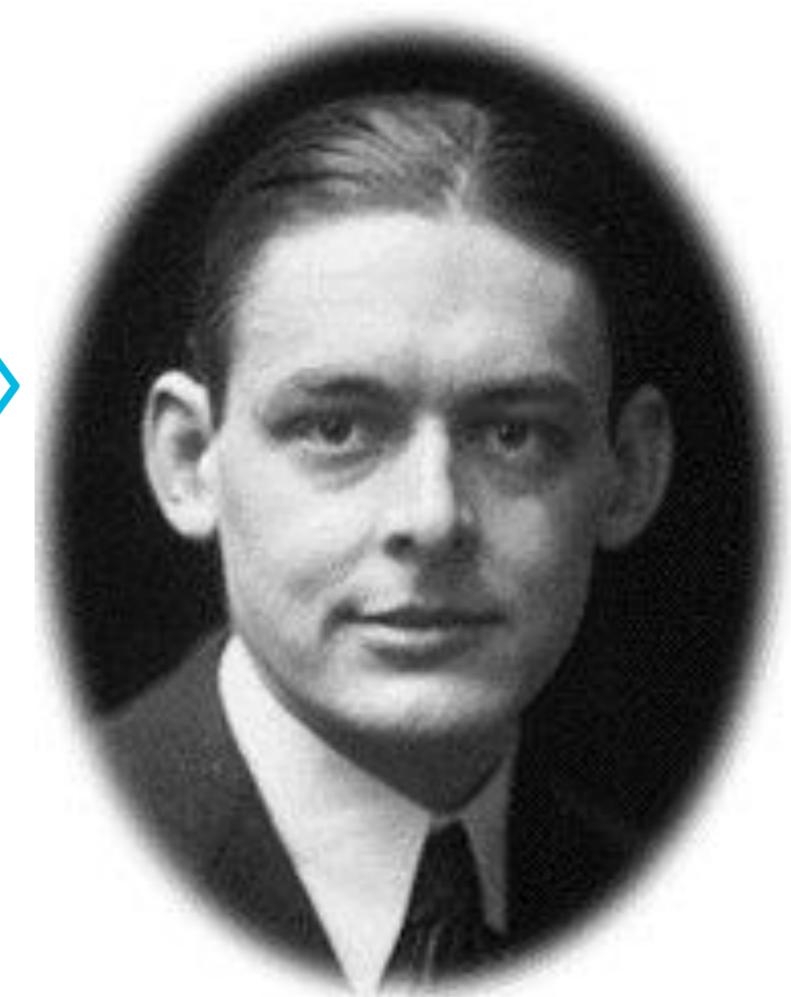
PESSIMISM

“

This is the way the world ends.
This is the way the world ends.
Not with a bang but a whimper.

”

TS Eliot
The Hollow Men, 1925



PESSIMISM

“

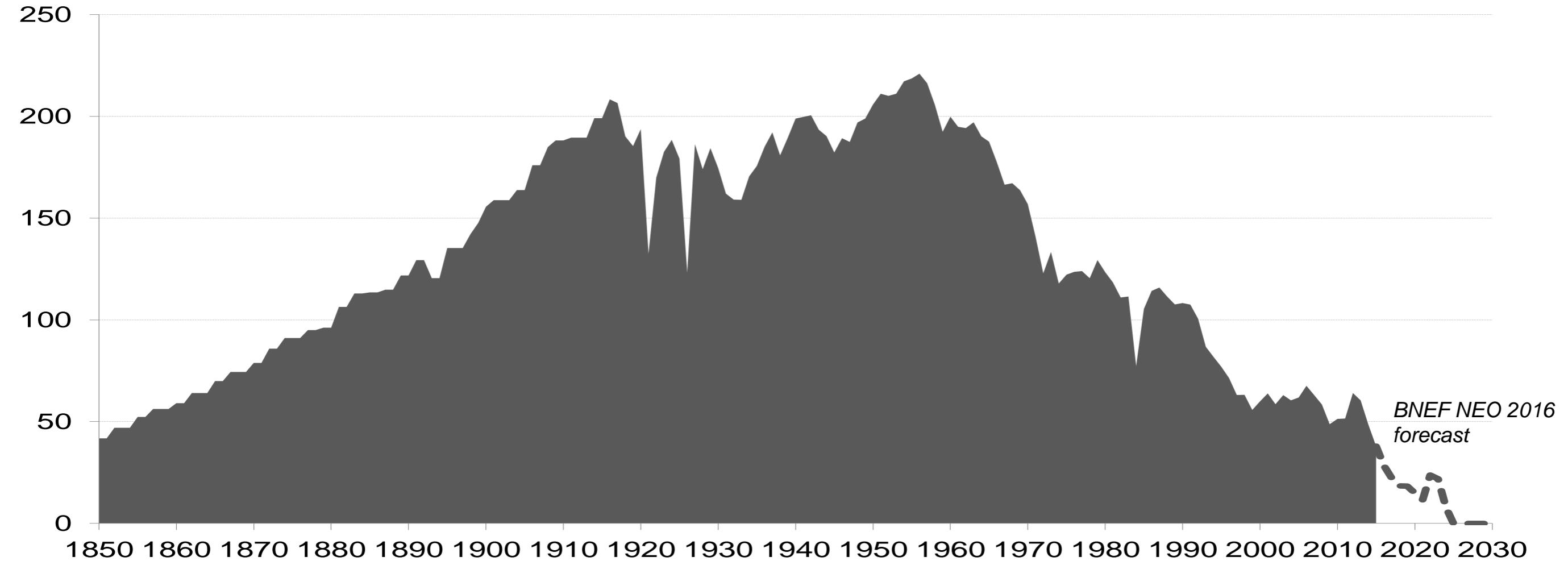
Go ahead and play
the blues then, if it
makes you happy

”

*Homer Simpson
Philosopher*



UK COAL CONSUMPTION 1850-2030 (MT/YR)



Source: BEIS, Prof. David Rutledge, Bloomberg New Energy Finance

CHOICE

“

Our energy future is not fate, but choice

”

Amory Lovins
Founder, Rocky Mountain Institute

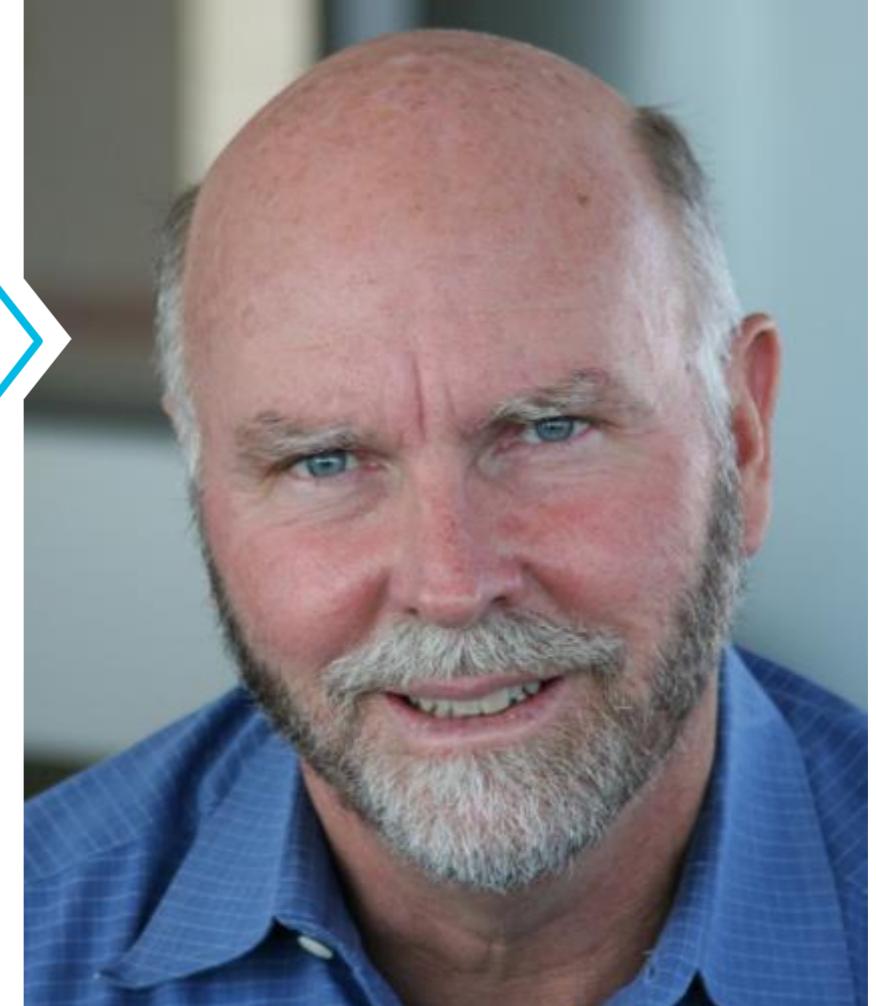


“

I'm not sure whether the optimists or the pessimists are right, but I do know this: it is the optimists who will get something done.

”

Craig Venter



Thanks!

MARKETS

Renewable Energy
Energy Smart Technologies
Advanced Transport
Gas
Carbon and RECs

SERVICES

Americas Service
Asia Pacific Service
EMEA Service
Applied Research
Events and Workshops

Unique analysis, tools and data for decision-makers driving change in the energy system

sales.bnef@bloomberg.net

Michael Liebreich
Twitter: @Mliebreich

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Guillaume Fouché
gfouche@Bloomberg.net

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