

Clean Energy Investment and Market Trends for the Low Carbon Transition:

IEA World Energy Investment 2016 and Medium-term Renewable Energy Market Report 2016

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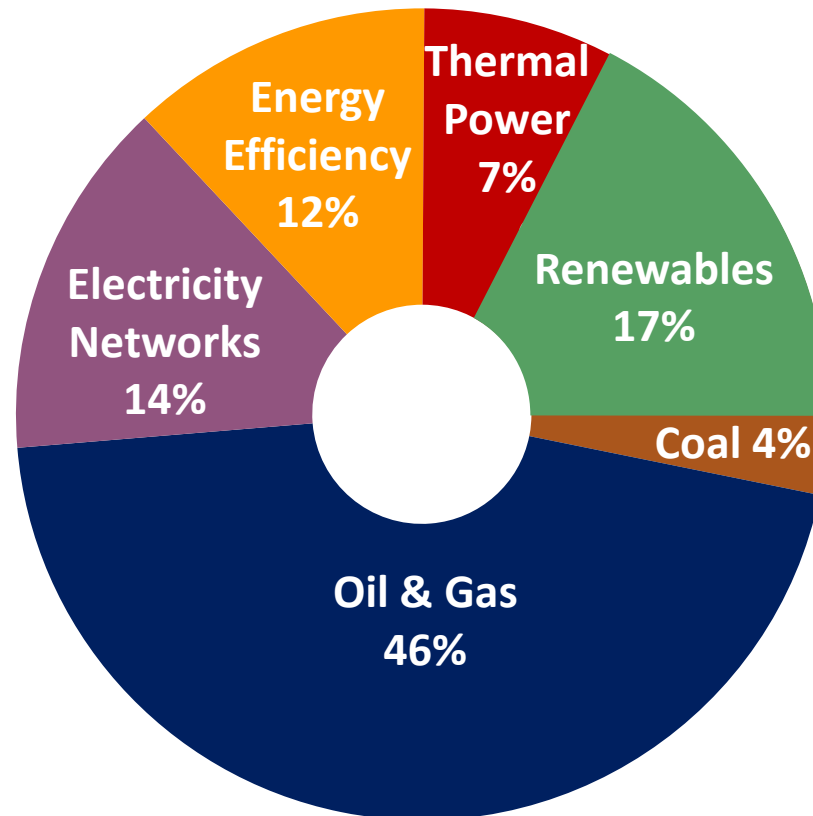
October 2016

- **Investors face new challenges and opportunities in the energy sector**
 - *Macroeconomic uncertainty and structural change affects demand patterns*
 - *COP21 Paris Agreement gives momentum to clean energy*
 - *The energy sector faces accelerated technological change*
 - *Lower energy prices and increasing inter-fuel competition reshape investment*
 - *New business models and investors are transforming the electricity sector*
- **Global energy investment declined in 2015, mainly due to lower oil and gas spending**
- **Share of renewables in investment boosted by technology progress, strong policy support and growth in good resource markets**
 - *A record amount of new renewable power capacity was installed in 2015*
 - *Total renewable capacity has now overtaken coal*
- **Renewables momentum hinges on policy makers heightening their commitments and providing investors more clarity & certainty**

Investment flows signal a reorientation of the global energy system

Global Energy Investment, 2015

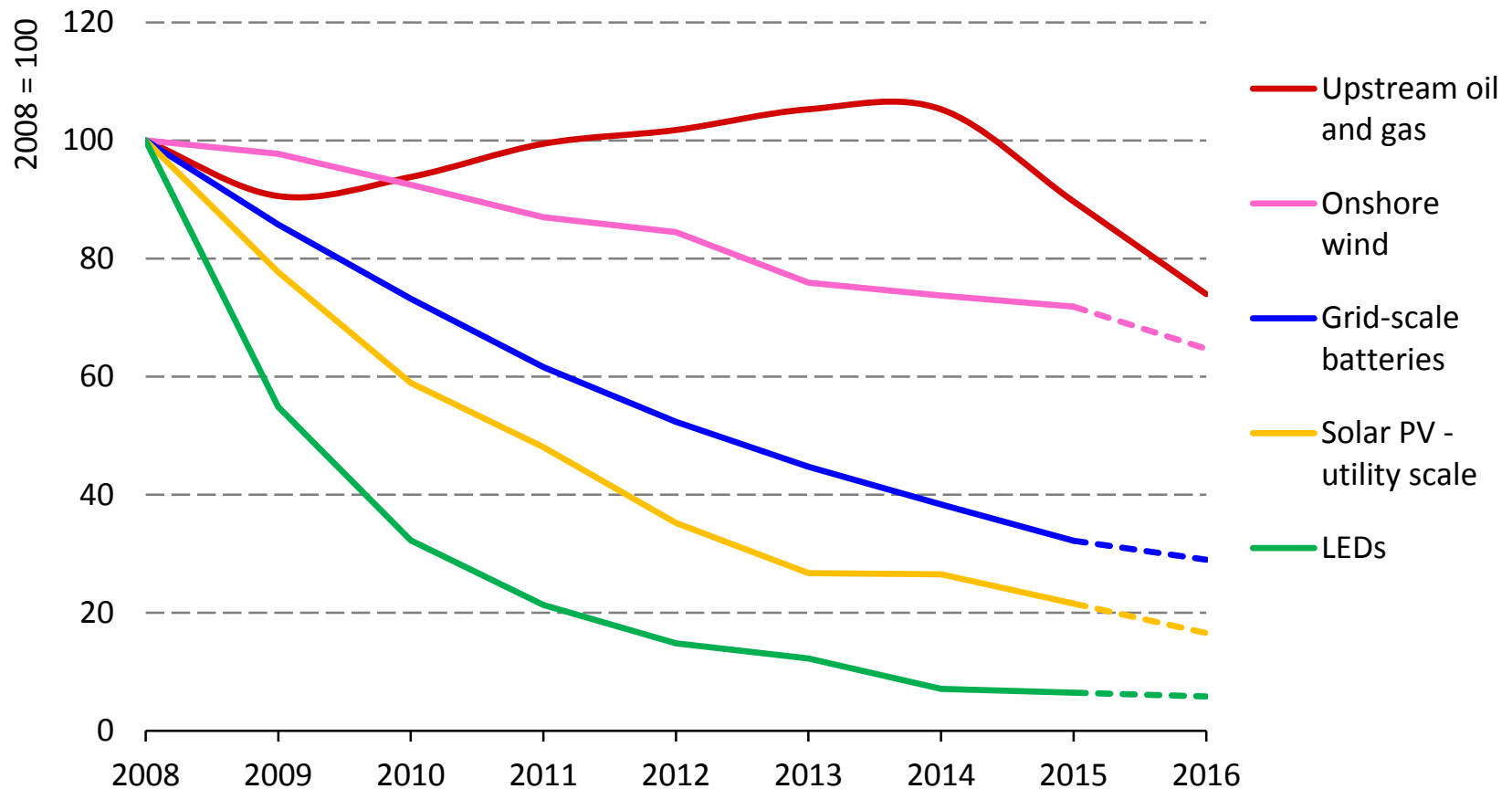
USD 1.8 trillion



An 8% reduction in 2015 global energy investment results from a \$200 billion decline in fossil fuels, while the share of renewables, networks and efficiency expands

Massive cost deflation is reshaping competition between fuels and technologies

Capital cost developments across the energy spectrum



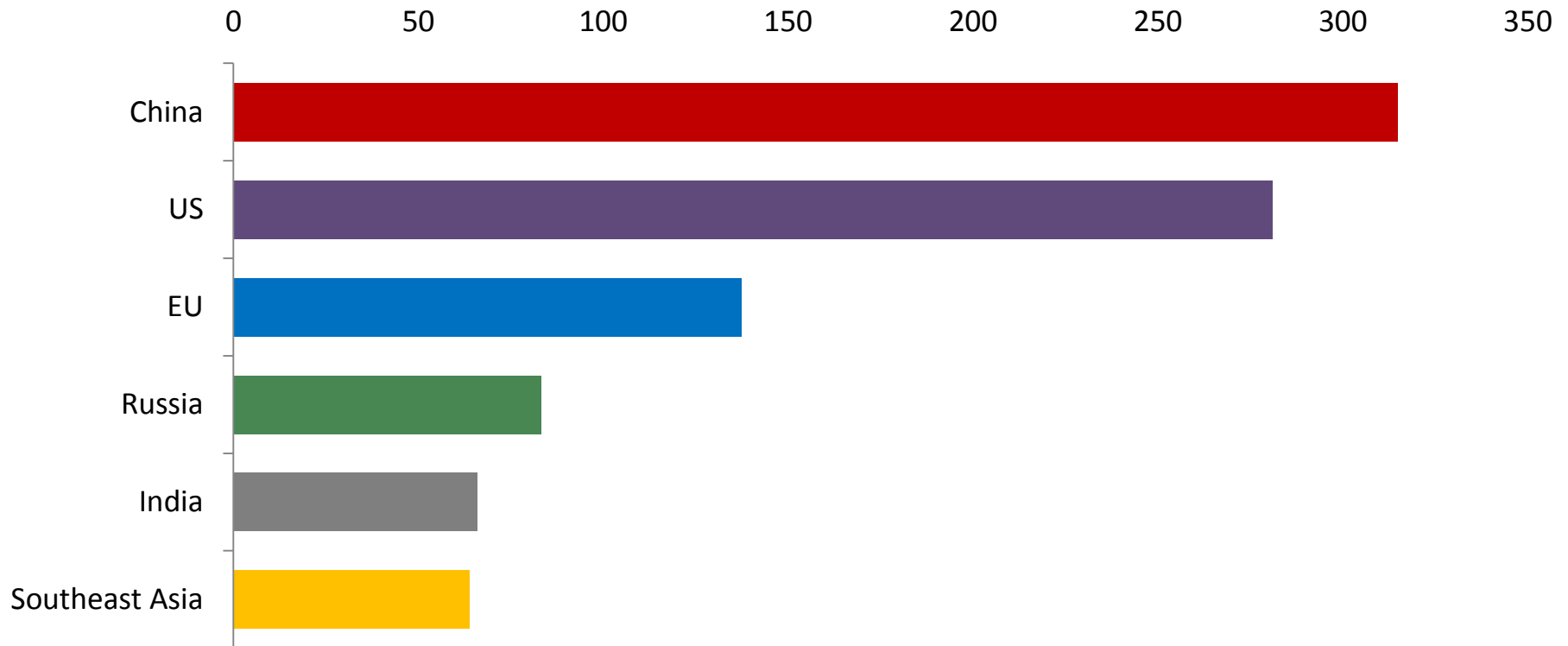
But some other technologies, such as nuclear power, carbon capture and storage and energy-efficient building renovations risk falling behind in the future

Southeast Asia: among the world's largest markets for global energy supply investment

World Energy Investment 2016

Energy supply investment in 2015, selected markets

USD (2015) billion

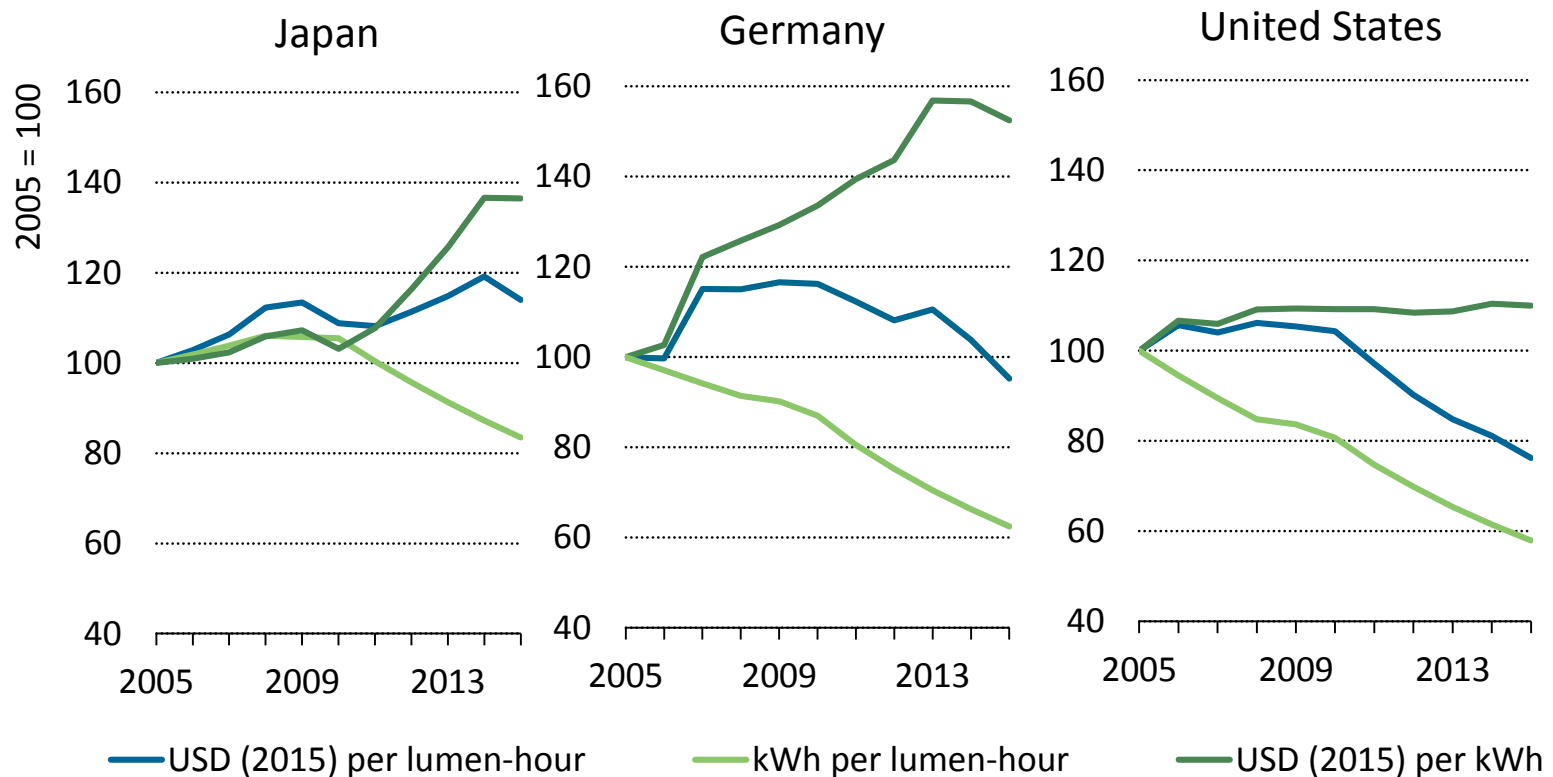


Boosted by record power sector spending, China regains its position as top investment market, while the US declines due to sharply lower oil and gas investment

Energy efficiency investment rose 6%, with buildings the largest and fastest-growing share

World Energy Investment 2016

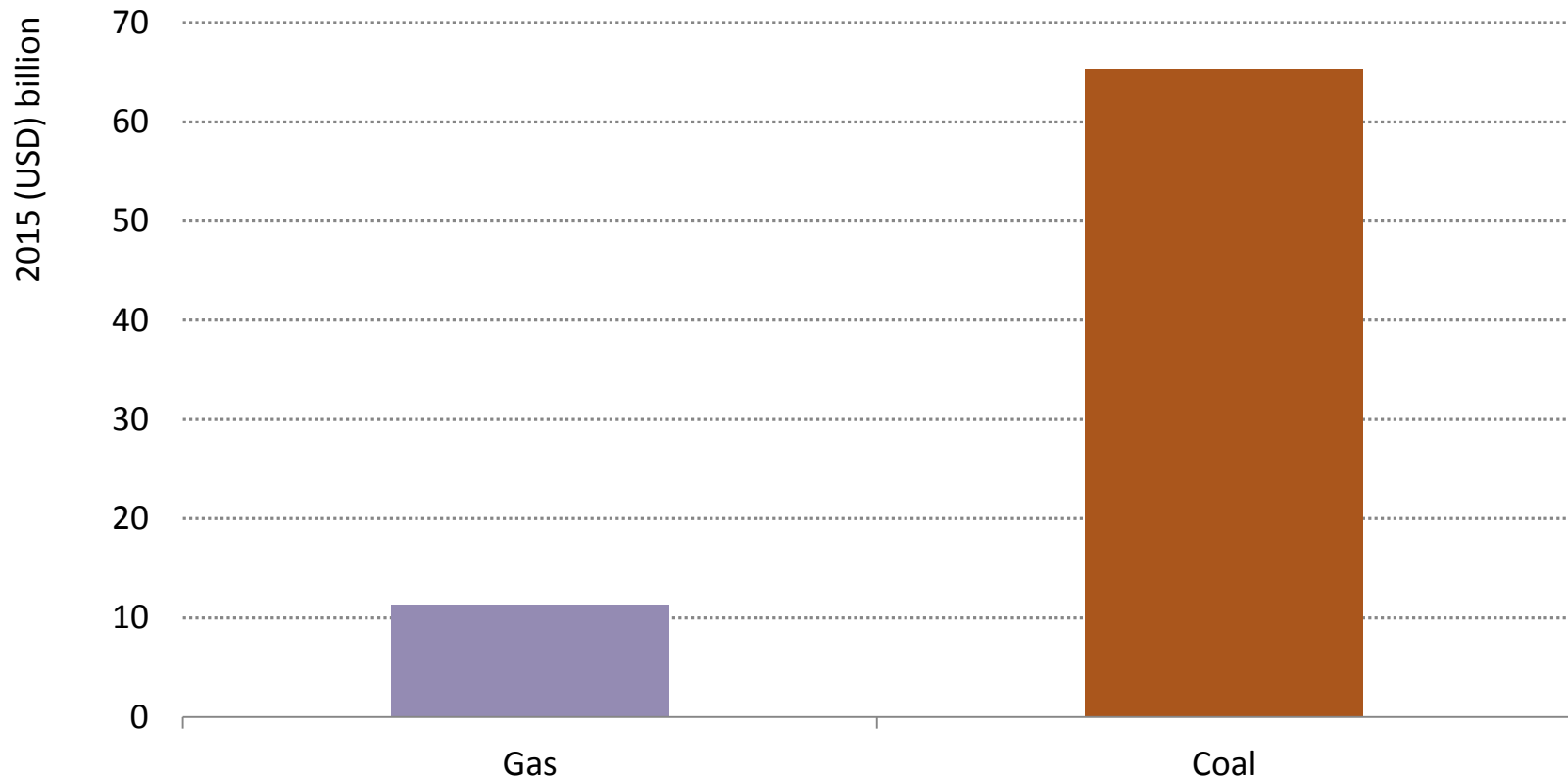
Lighting efficiency and cost, and electricity prices in selected countries



More efficient bulbs keep cost of lighting in check, even with rising electricity prices, and contribute to stagnation of demand growth in a number of OECD countries

Infrastructure costs favour coal power over gas in Asian energy importers

Coal and gas-fired power investment in Asian markets (2015)



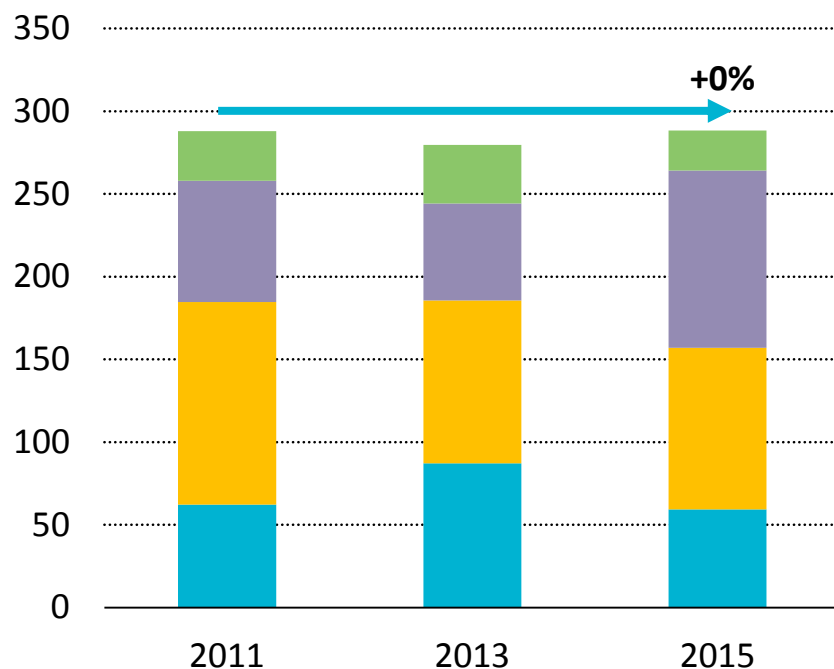
Asian markets comprised 85% of global coal power investment, while N. America and Middle East, with robust infrastructure, favoured gas for new fossil fuel power

Renewables investment buys much more electricity

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Global renewable power investment

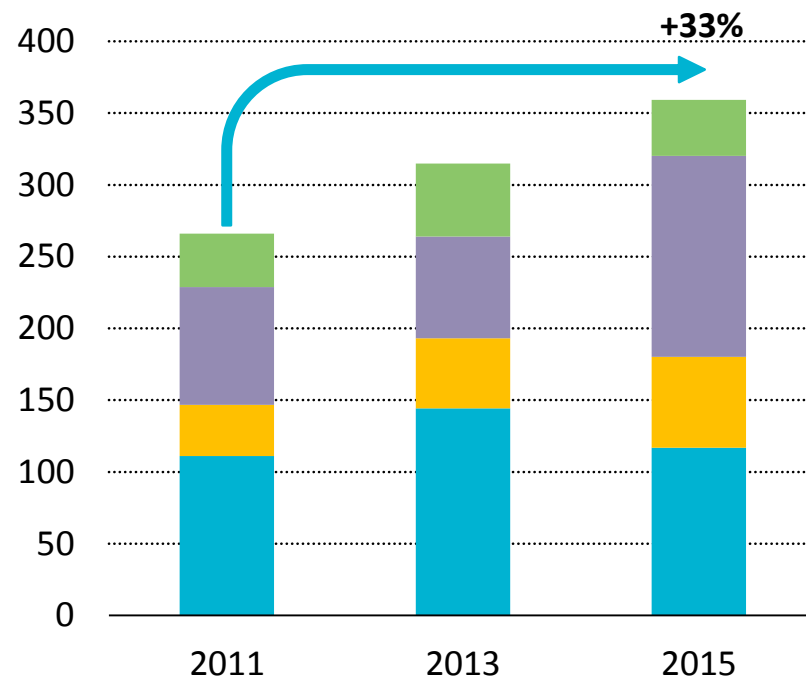
USD (2015) billion



■ Hydropower ■ Solar PV ■ Wind ■ Other renewables

Expected generation from investment

TWh



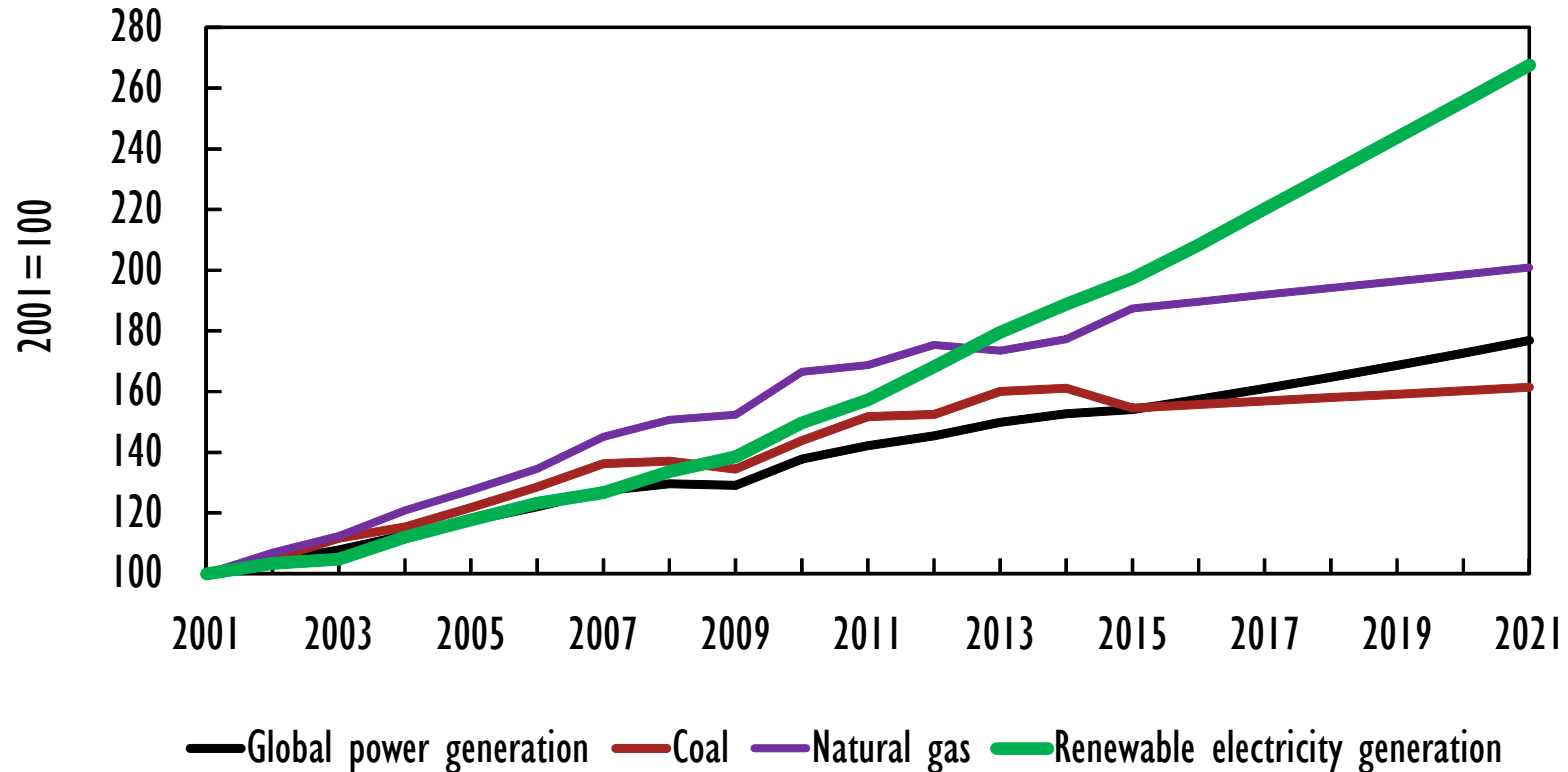
Investment in renewables will generate annually more than 2015 global electricity growth. Wind leads, surging 35% in 2015 on economics and record offshore growth

Renewables to remain fastest growing source of electricity generation

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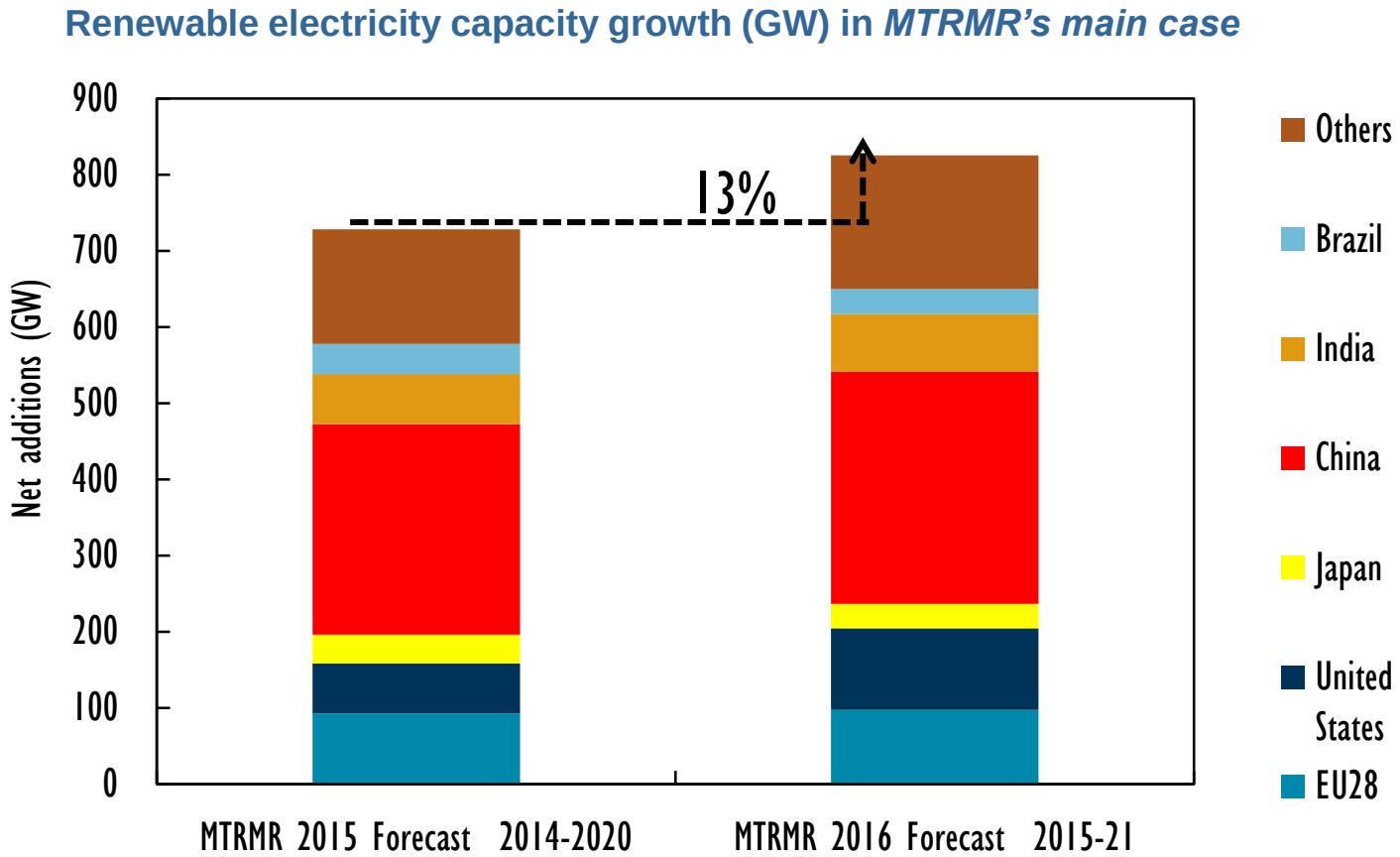
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Indexed electricity generation by fuel (2001-21)



Generation from renewables to rise by almost two-fifths over 2015-2021, pushing their share of total electricity generation from 23% to 28%

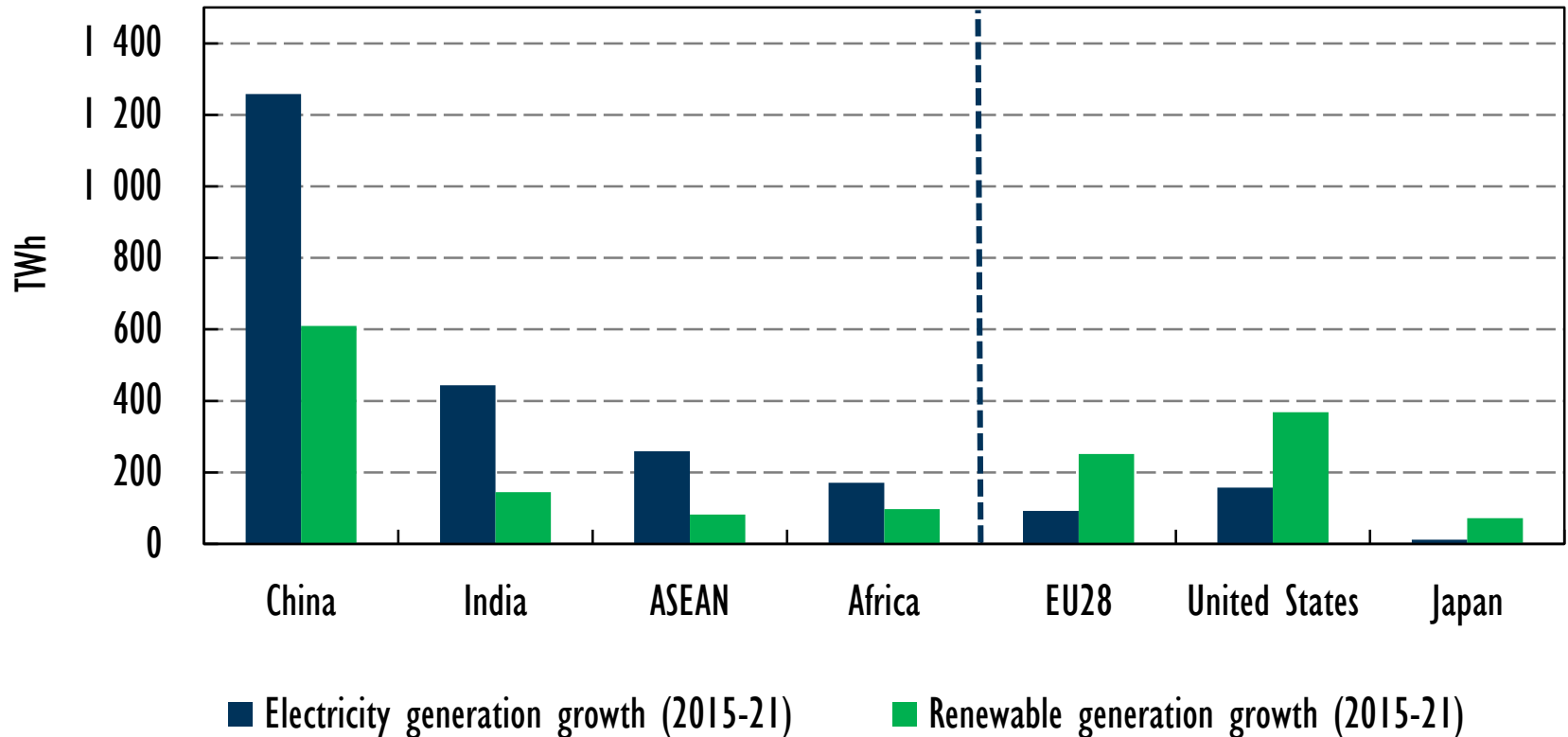
New policies underpin a more bullish forecast for renewables



China remains key growth market for renewable capacity, while the United States surpasses the EU for the first time

A two-speed world for renewable electricity

Electricity and renewable generation growth by country/region



Source: Total electricity generation from World Energy Outlook 2016, forthcoming.

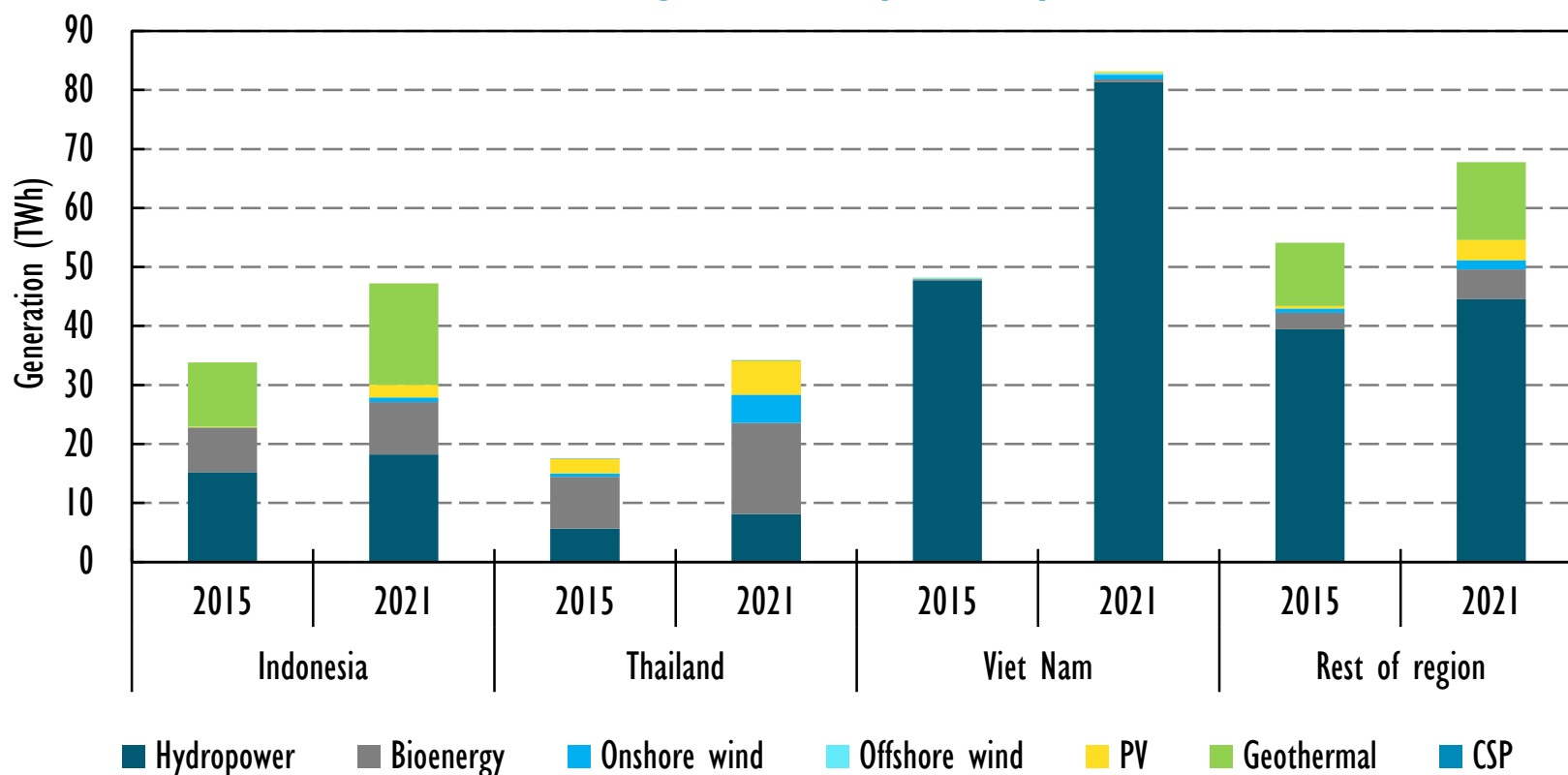
The increase in generation from renewables in 2015-2021 represents 60% of the global increase in electricity output, but prospects vary across regionally

Renewables help diversify Southeast Asia electricity mix

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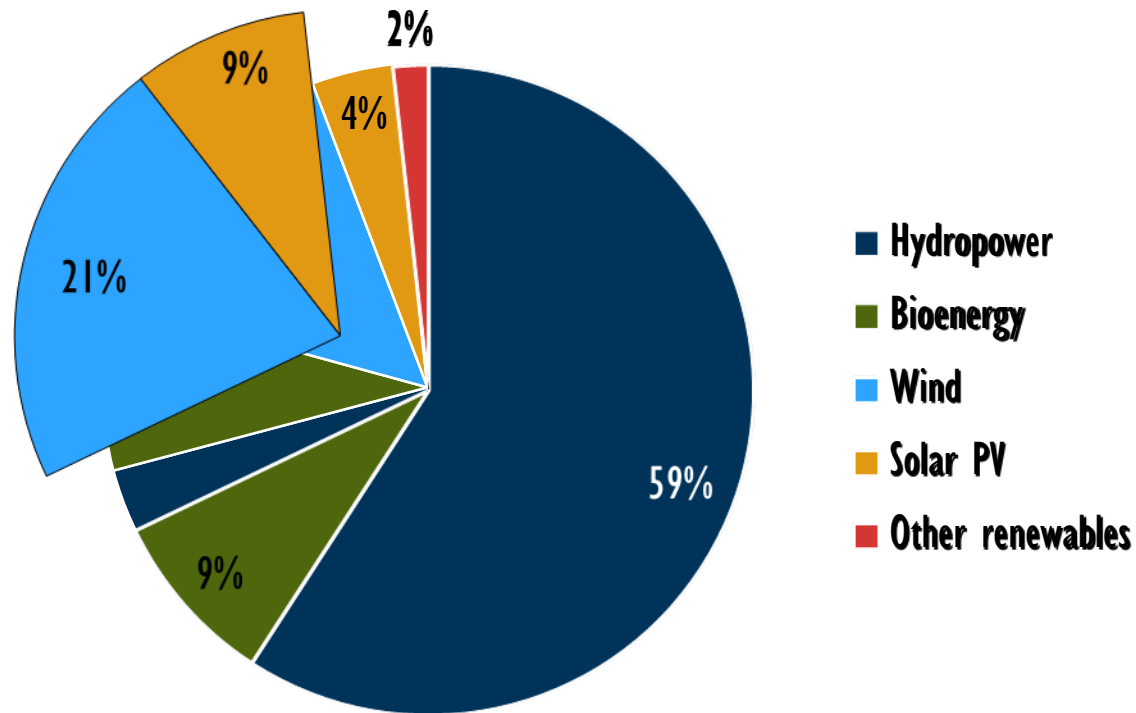
ASEAN renewable generation growth and share of renewables in total generation (2015-21)



- Fossil fuels continue to dominate generation as ASEAN witnesses strong demand growth (5% CAAGR)
- Hydro generation growth slows in most countries (except Viet Nam) while diversification needs help non-hydro renewables to pick up gradually

Wind and solar PV compensate for slower hydropower growth

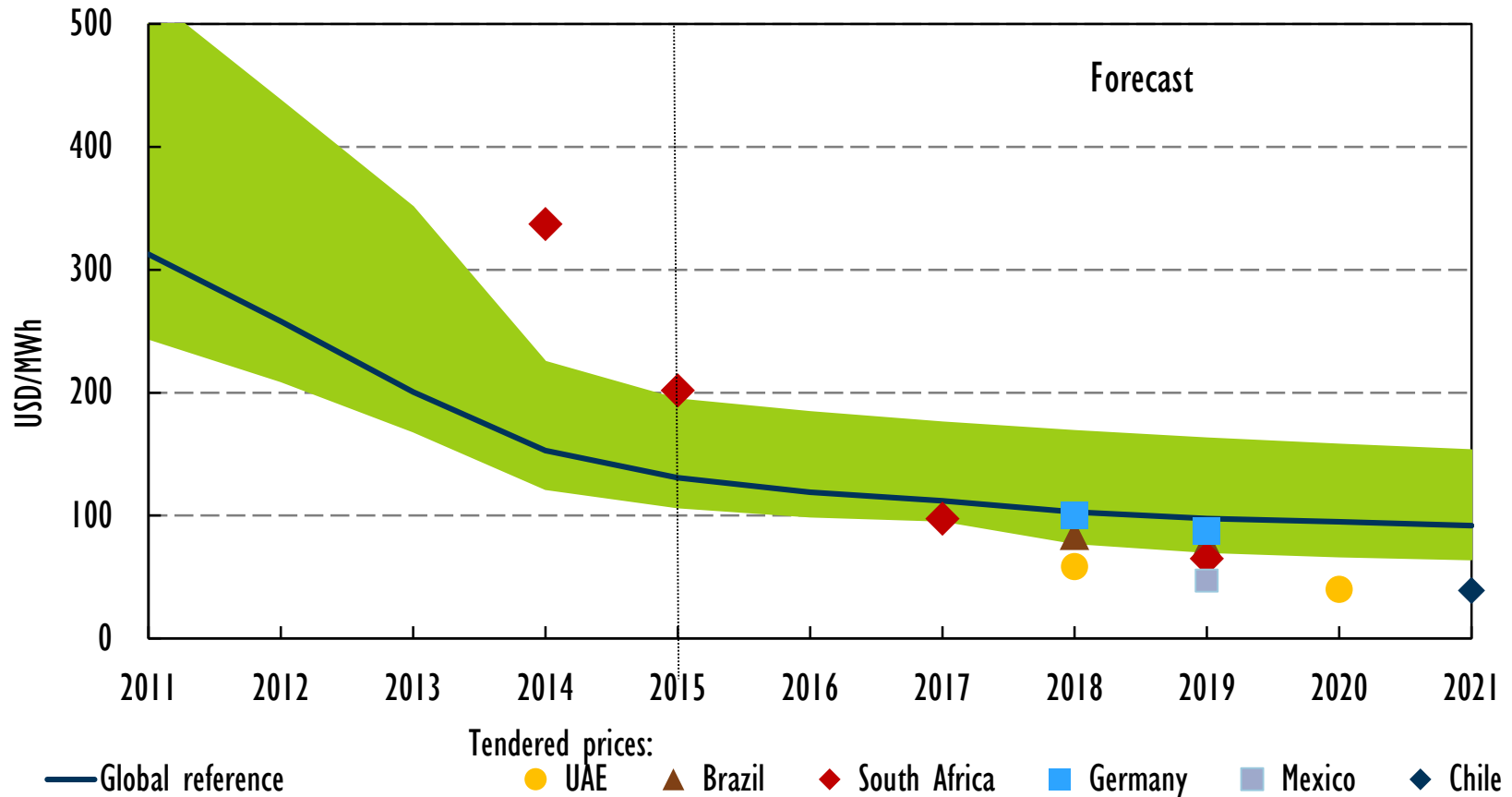
Renewable electricity generation by source 2025



Solar PV & wind account for almost 2/3 of rise in renewables generation; total renewable electricity overpasses 7600 TWh by 2021, equivalent to EU+US today

Solar PV costs continue to decline with increasing competition

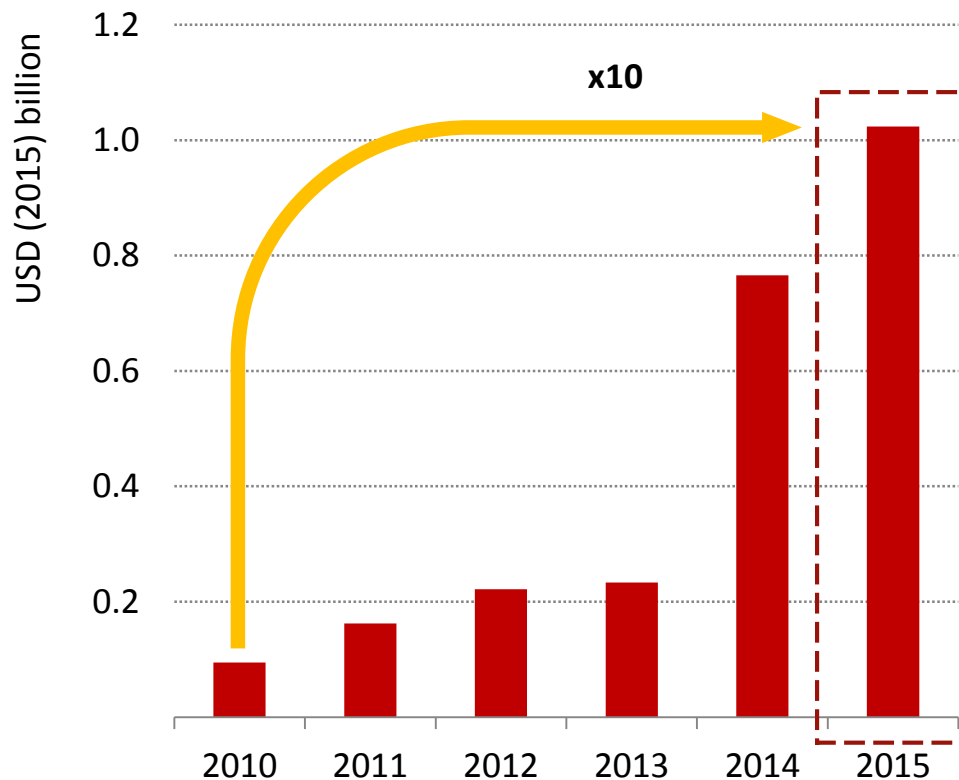
Utility-scale solar PV generation cost and contract prices



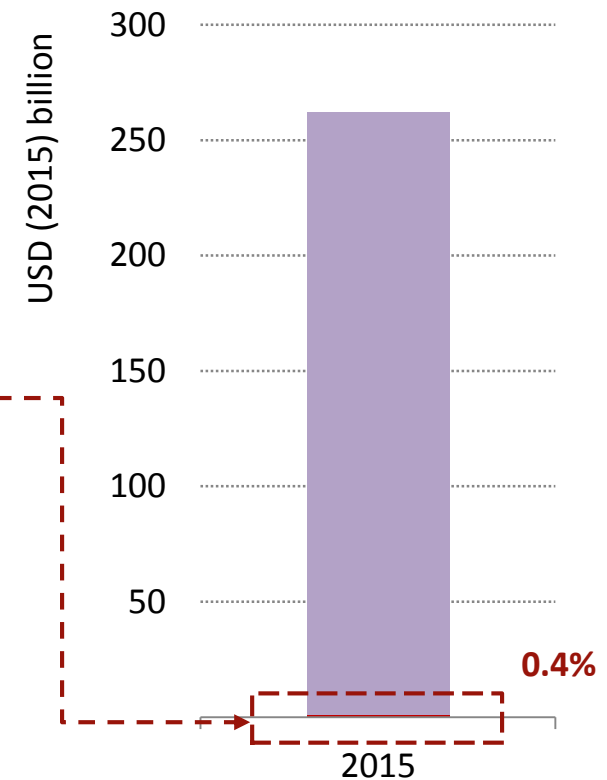
**Utility-scale solar PV generation costs to fall by another quarter over 2015-21;
competitive tenders may result in even faster cost reductions**

In electricity networks, batteries accelerate though grids comprise most investment growth

Global grid-scale battery storage investment



Total networks investment

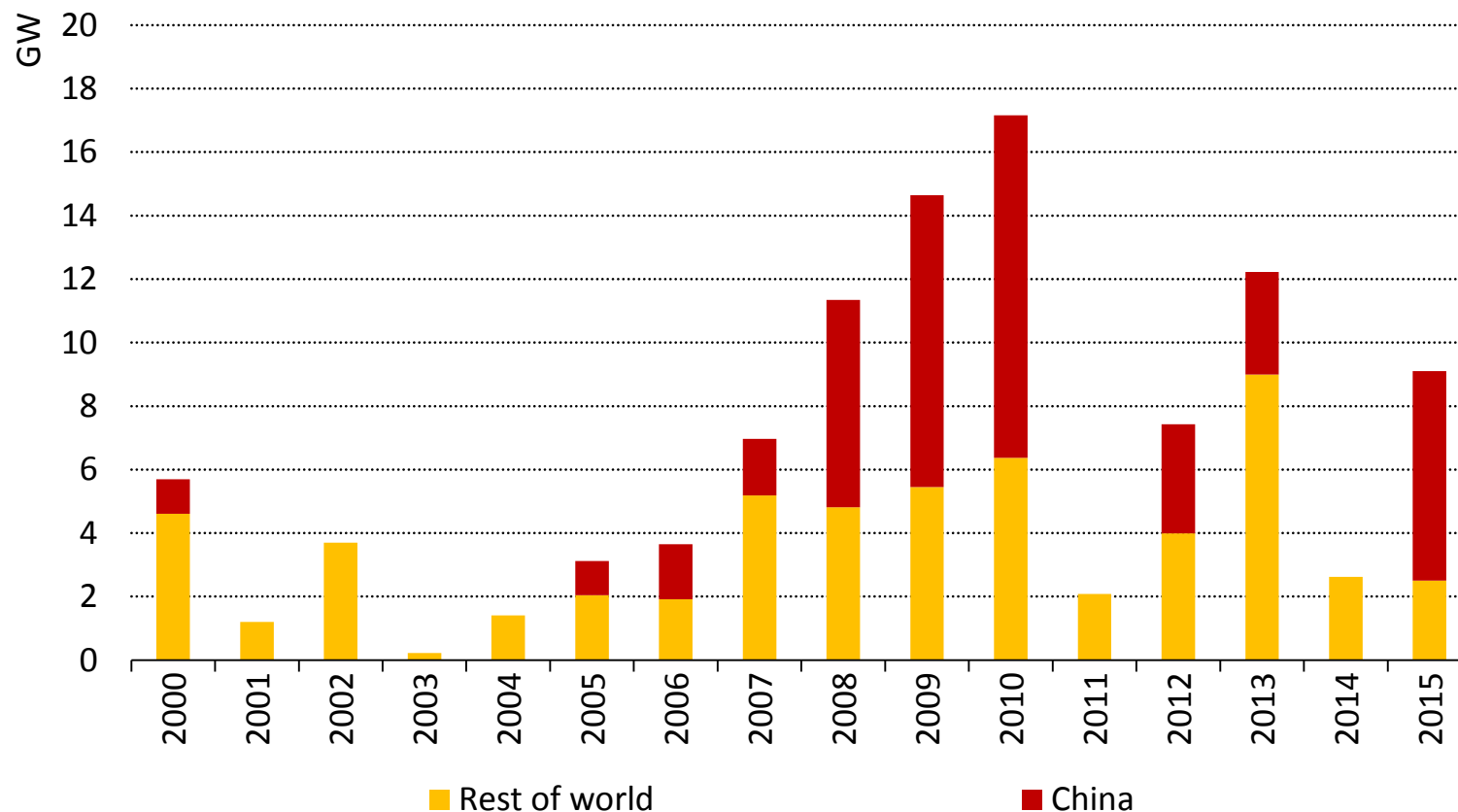


Grid-scale battery storage spending has expanded tenfold since 2010. Their value lies most in complementing grids that constitute the bulk of investment

Global nuclear investment remains robust due to China

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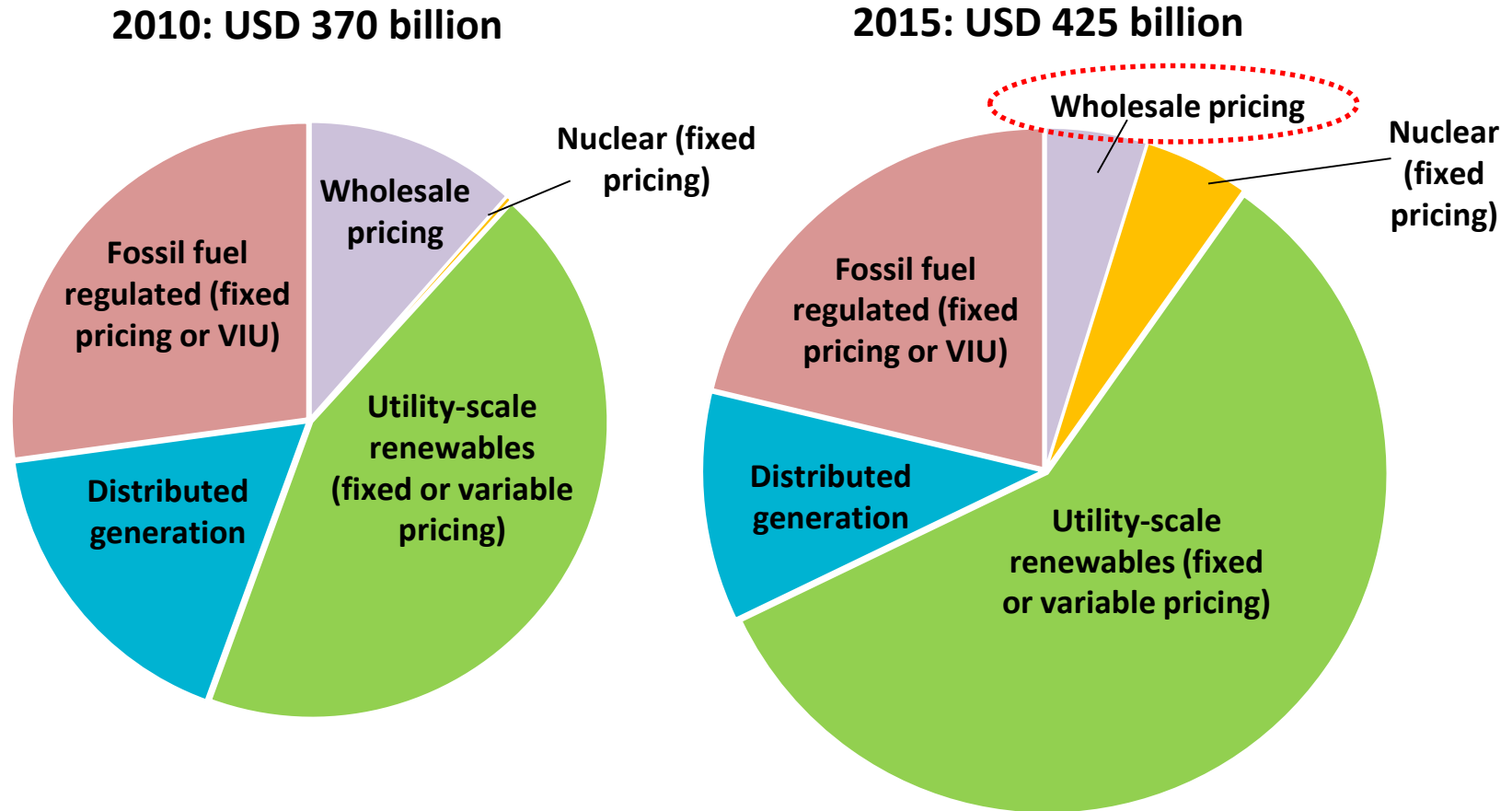
Nuclear construction starts, 2000-2015



Economics and public concerns remain a challenge to significant nuclear expansion

Governments increasingly in the driving seat of electricity security

Global power generation investment by main business model

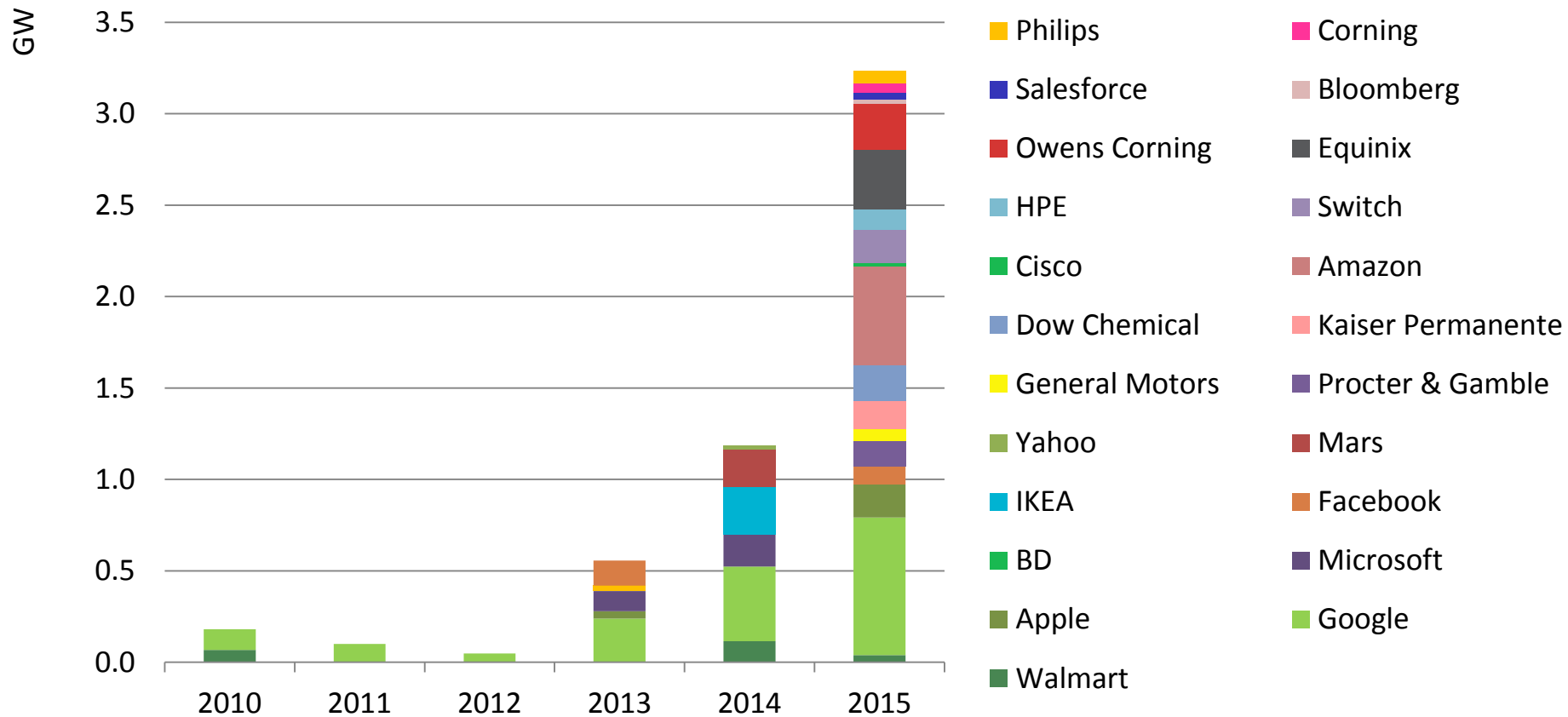


95% of generation investments rely on contracts or price regulation, with a narrower role for wholesale pricing, as regulators pursue adequacy and low carbon aims

New business models expanding the sources of investment for clean energy

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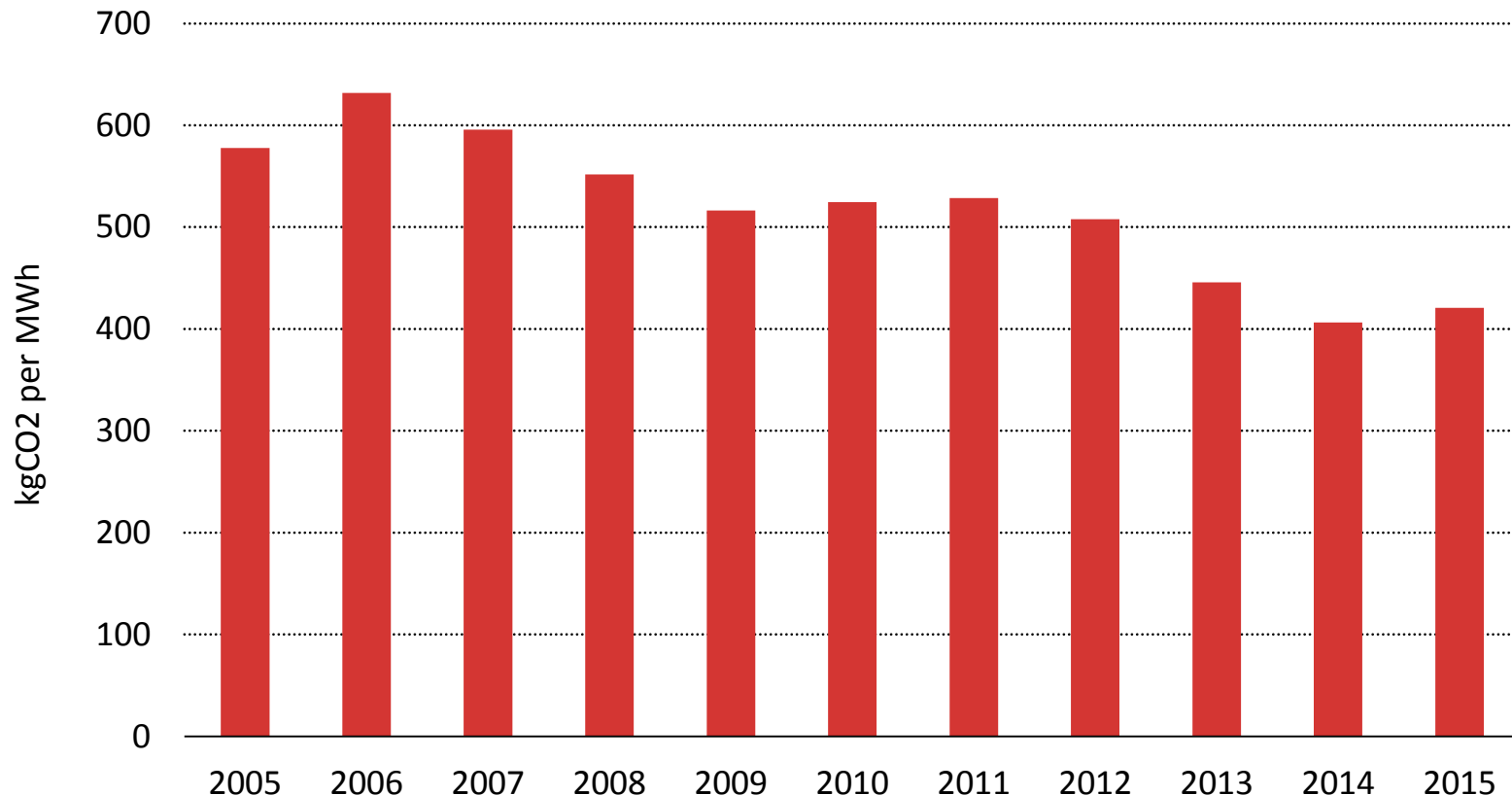
Contracting of utility-scale renewables by non-energy companies in North America



Consumer-led spending – e.g. distributed solar PV and corporate buying – comprised over USD 50 billion of renewable investment, led by United States, Europe and Japan

Carbon intensity of new power capacity down 20% since 2010

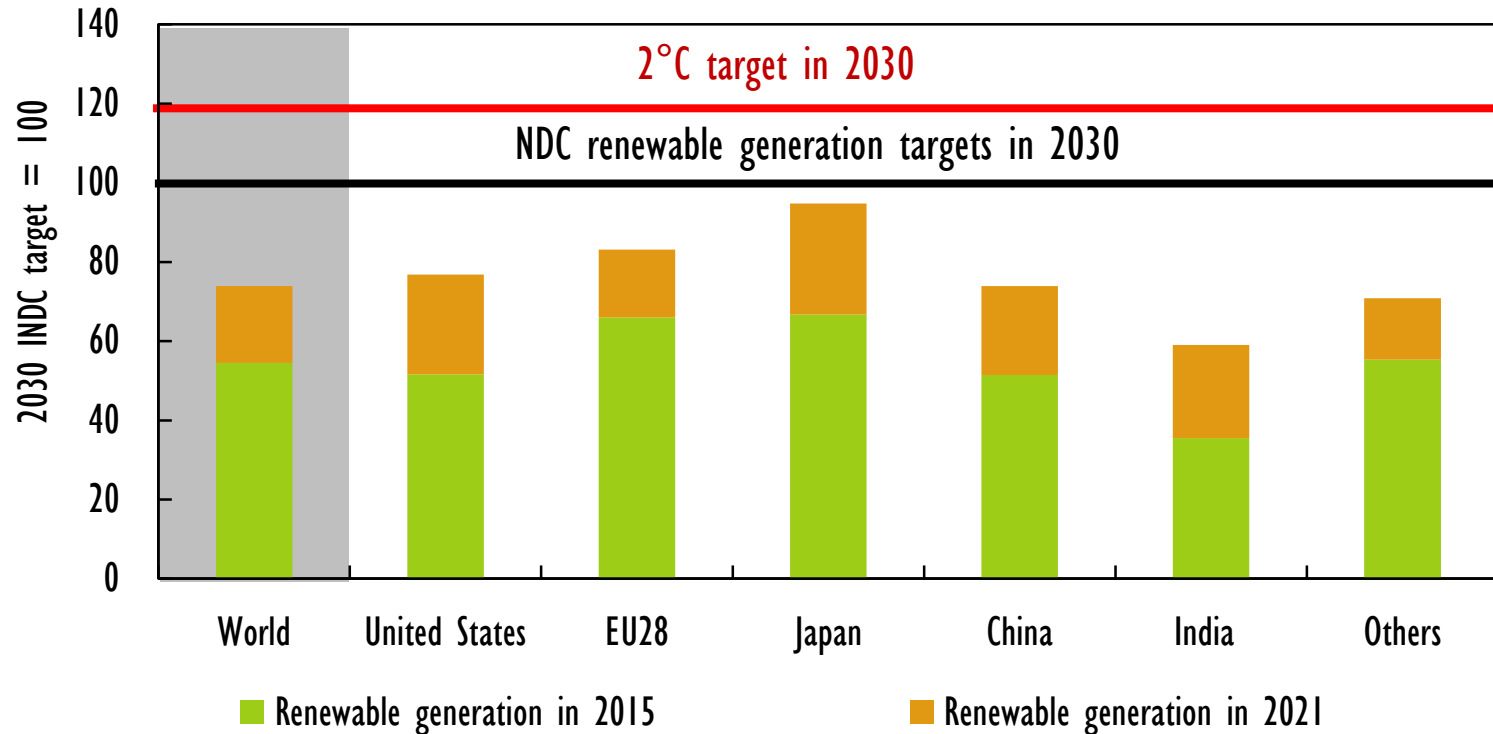
Global average CO₂ emissions per MWh from new power generation capacity



At 420kg CO₂/MWh, generation investments slowly reduce emissions intensity of existing power fleet (530kg/MWh), but remain well above 100kg/MWh to meet 2DS

But renewable power forecast falls short of 2°C target

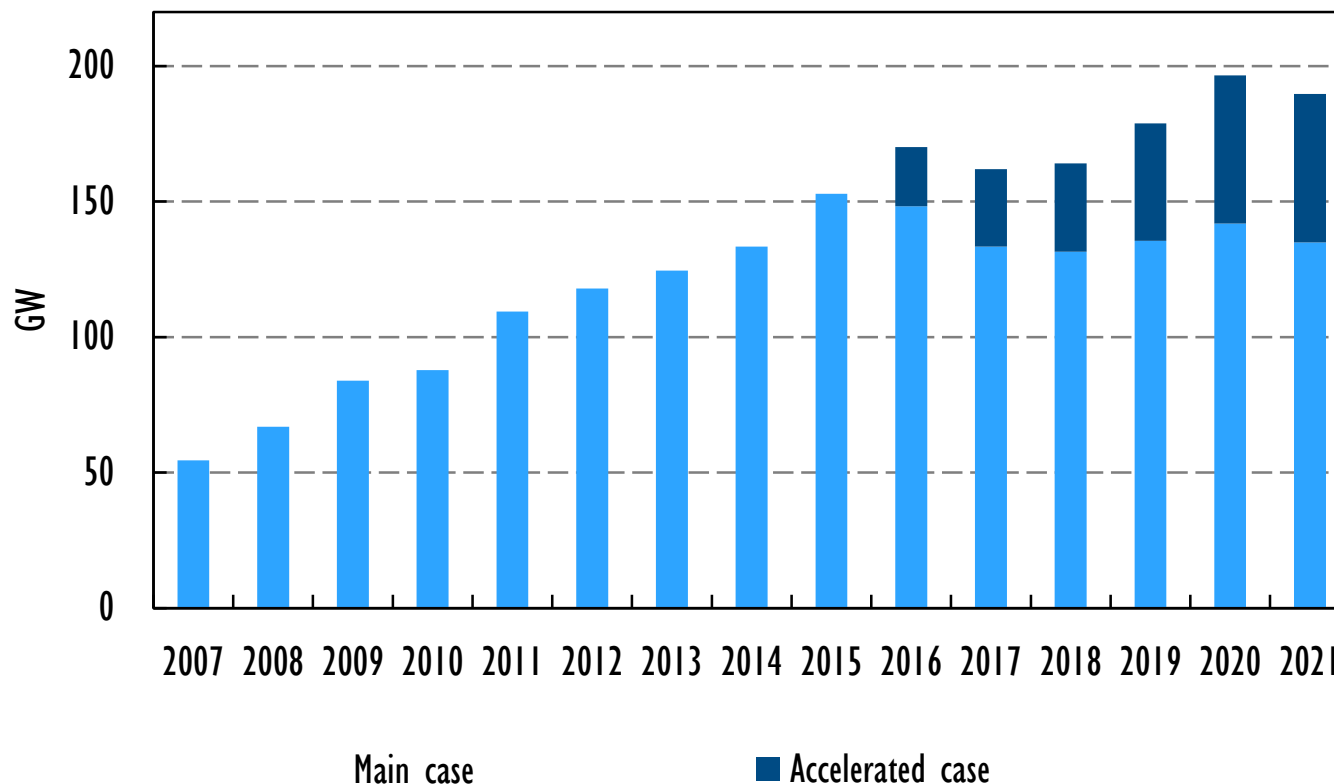
Renewable electricity generation indexed to NDC targets



Renewables are set to grow rapidly and are in line to reach NDC pledges by 2030, but this is only a first step towards a sustainable world energy system

More ambitious policies could enhance the outlook in line with 2°C target

Renewable electricity capacity additions in MTRMR 2016 Accelerated Case vs. Main Case



Renewables are in line with NDC pledges by 2030 but reducing policy uncertainty and overcoming financing & grid integration challenges remain key to achieve 2°C target

- Massive cost deflation across the entire energy spectrum is reshaping competition between fuels and technologies
- Renewables account for more than two-thirds of power generation investment. Wind (onshore) & solar PV are the only technologies on track for a 2°C scenario
- Competition in Asia between renewables & coal/gas will be critical to meeting global targets for low carbon transition
- New business models are transforming electricity, but policies drive most investment; governments play a key role in supply security
- Attracting investment in renewables hinges on appropriate market rules & regulations, particularly in markets with slow electricity demand growth
- IEA will continue to measure and assess investment trends and support energy transition with its policy, technology and system integration of renewables work