

# ***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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International Energy Agency***

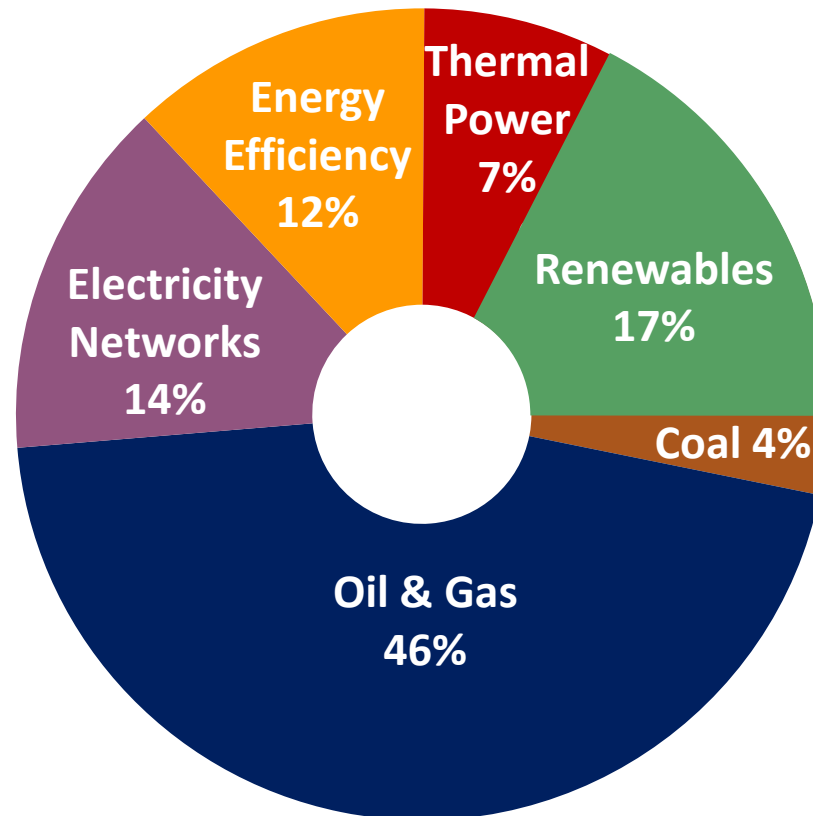
**October 2016**

- **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

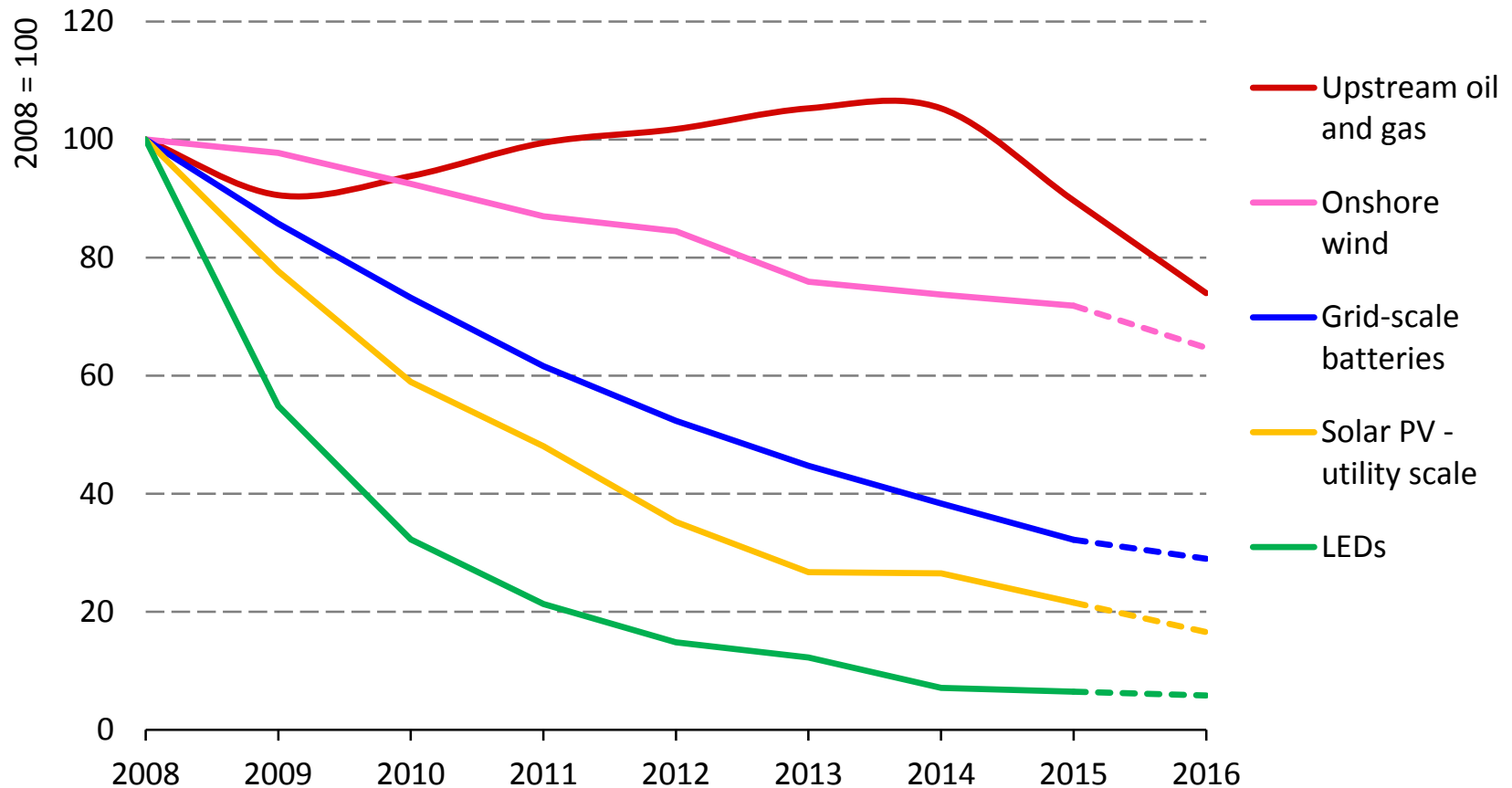
USD 1.8 trillion



***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



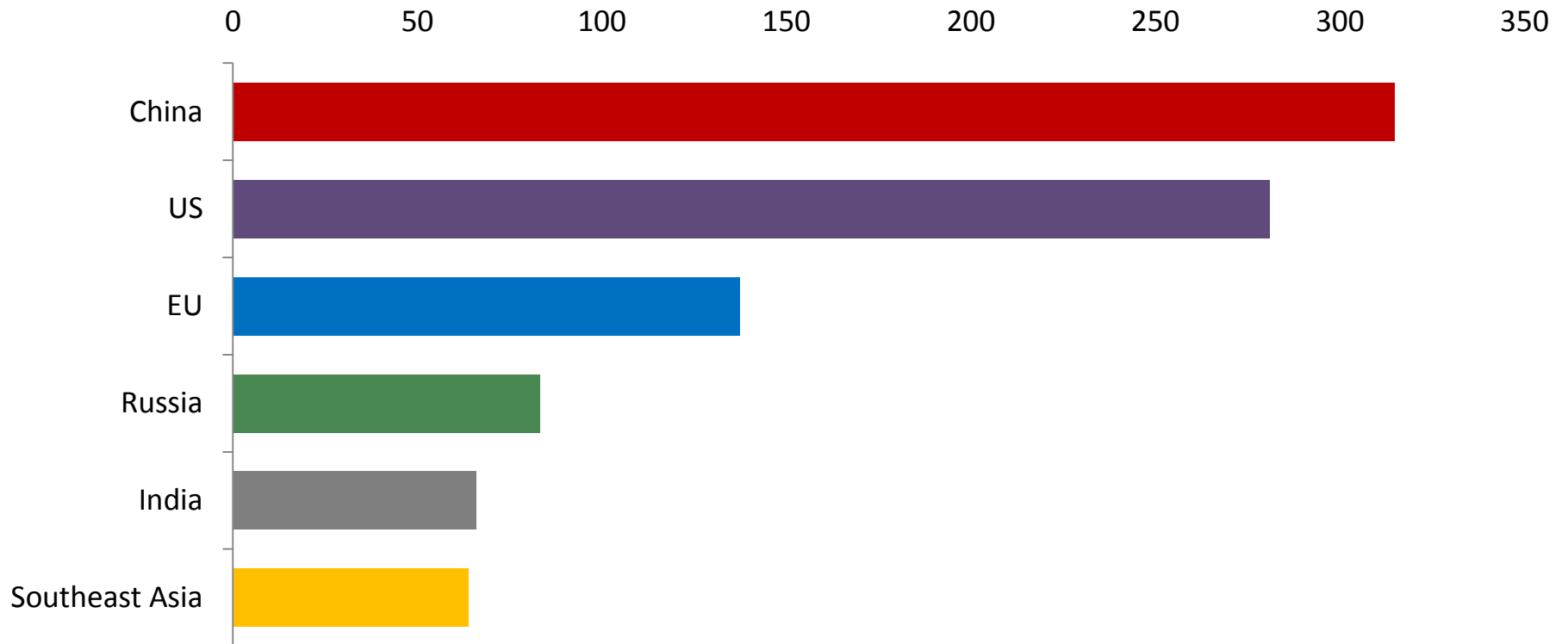
***But some other technologies, such as nuclear power, carbon capture and storage and energy-efficient building renovations risk falling behind in the future***

# 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

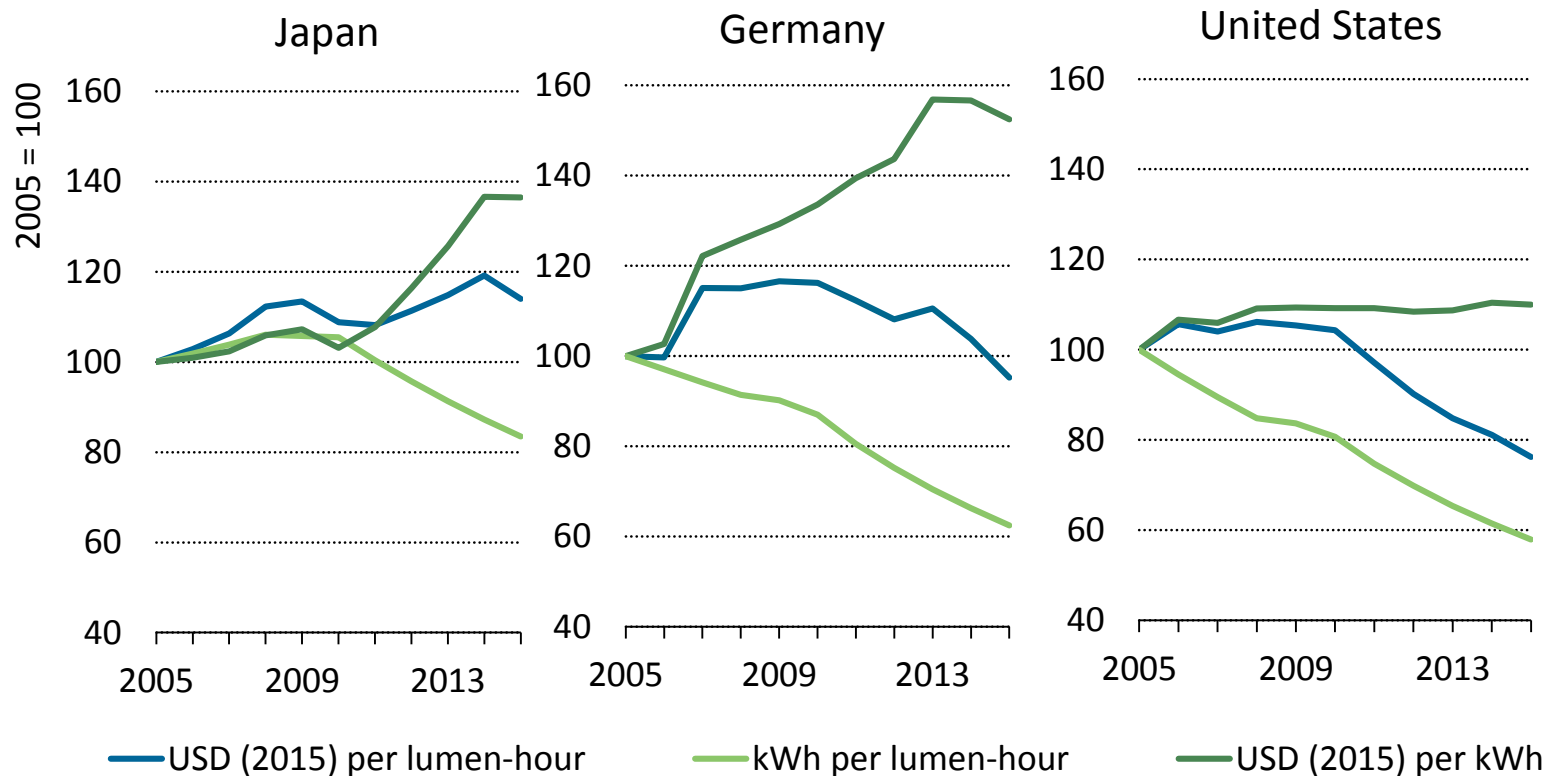


***Boosted by record power sector spending, China regains its position as top investment market, while the US declines due to sharply lower oil and gas investment***

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

World Energy Investment 2016

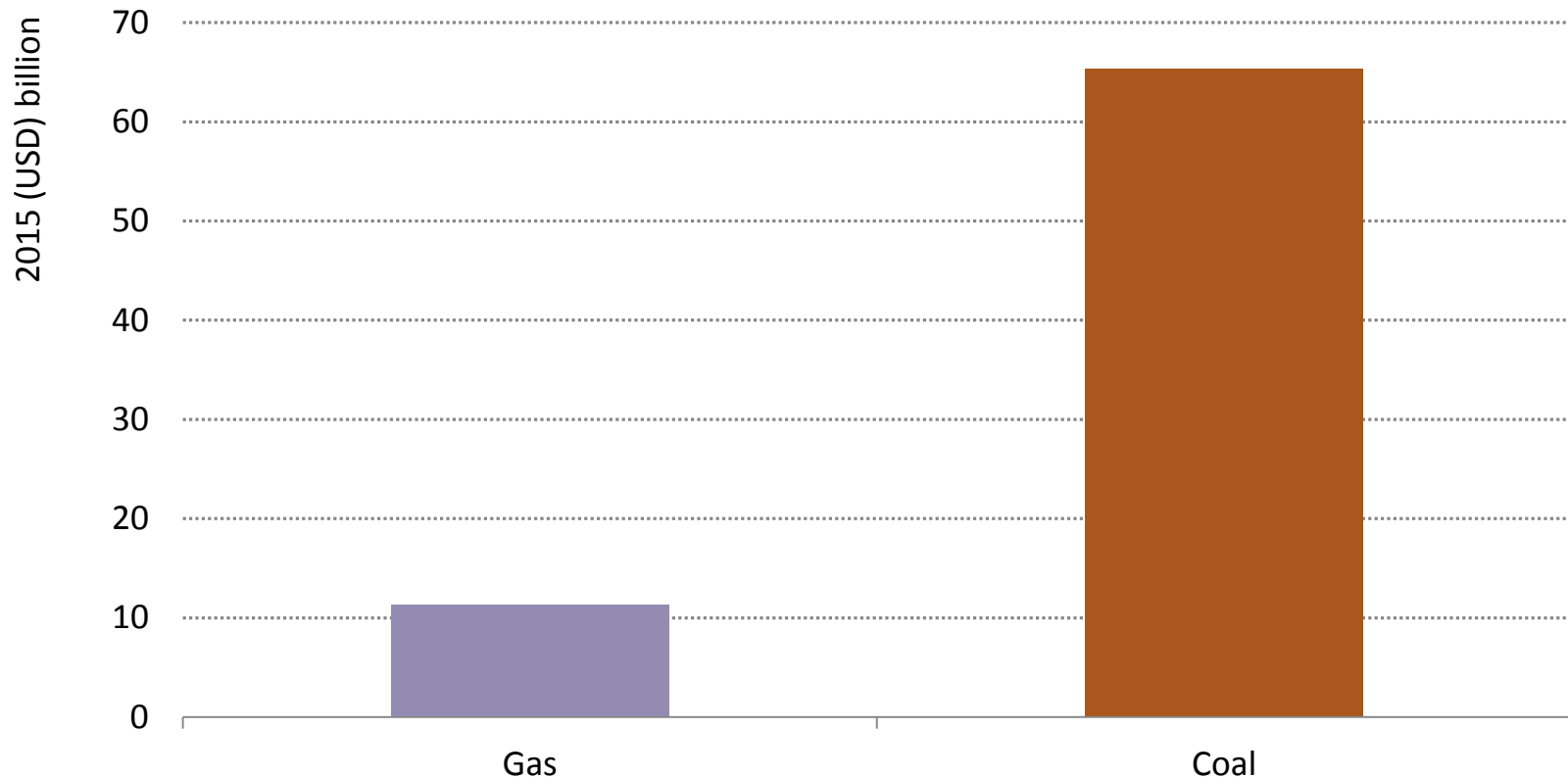
## Lighting efficiency and cost, and electricity prices in selected countries



***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)



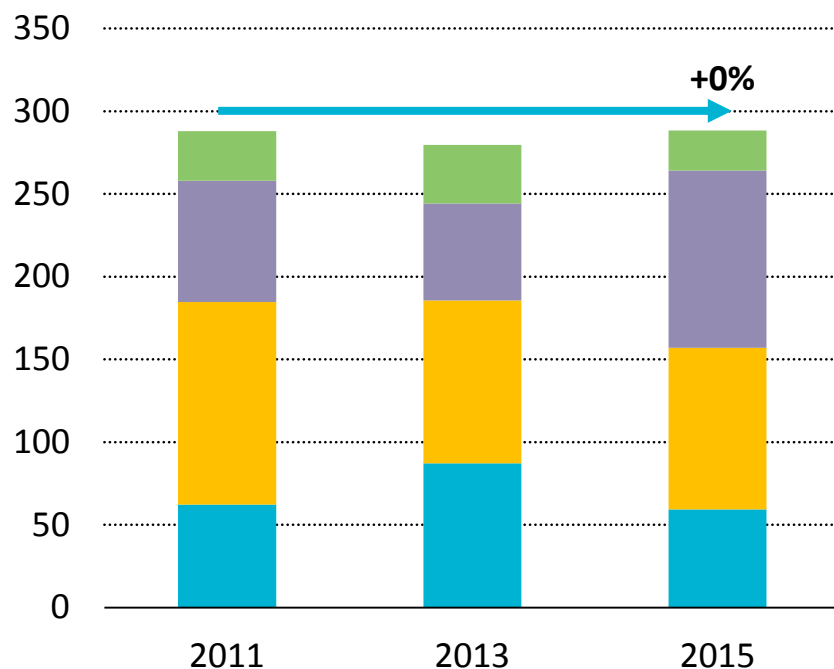
***Asian markets comprised 85% of global coal power investment, while N. America and Middle East, with robust infrastructure, favoured gas for new fossil fuel power***

# Renewables investment buys much more electricity

World Energy Investment 2016

## Global renewable power investment

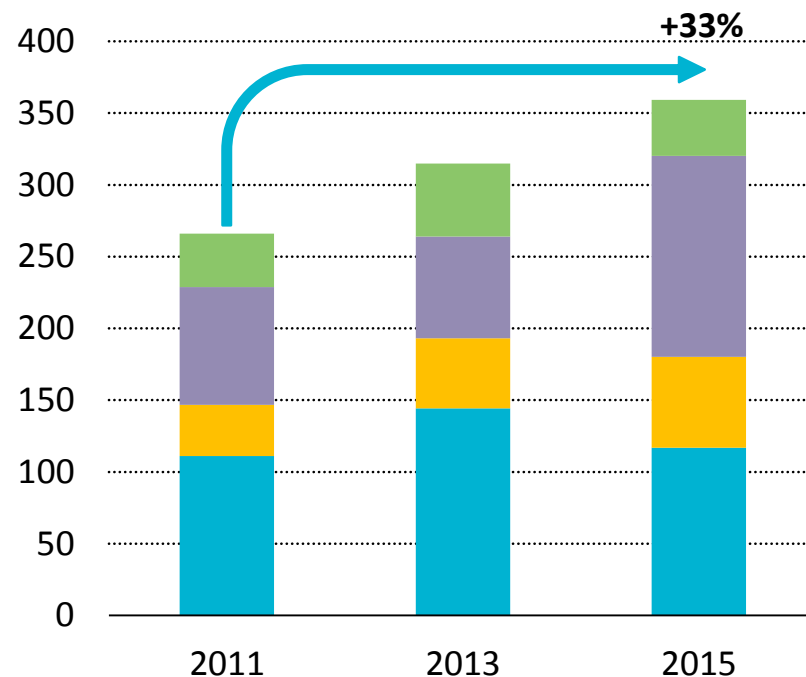
USD (2015) billion



■ Hydropower ■ Solar PV ■ Wind ■ Other renewables

## Expected generation from investment

TWh



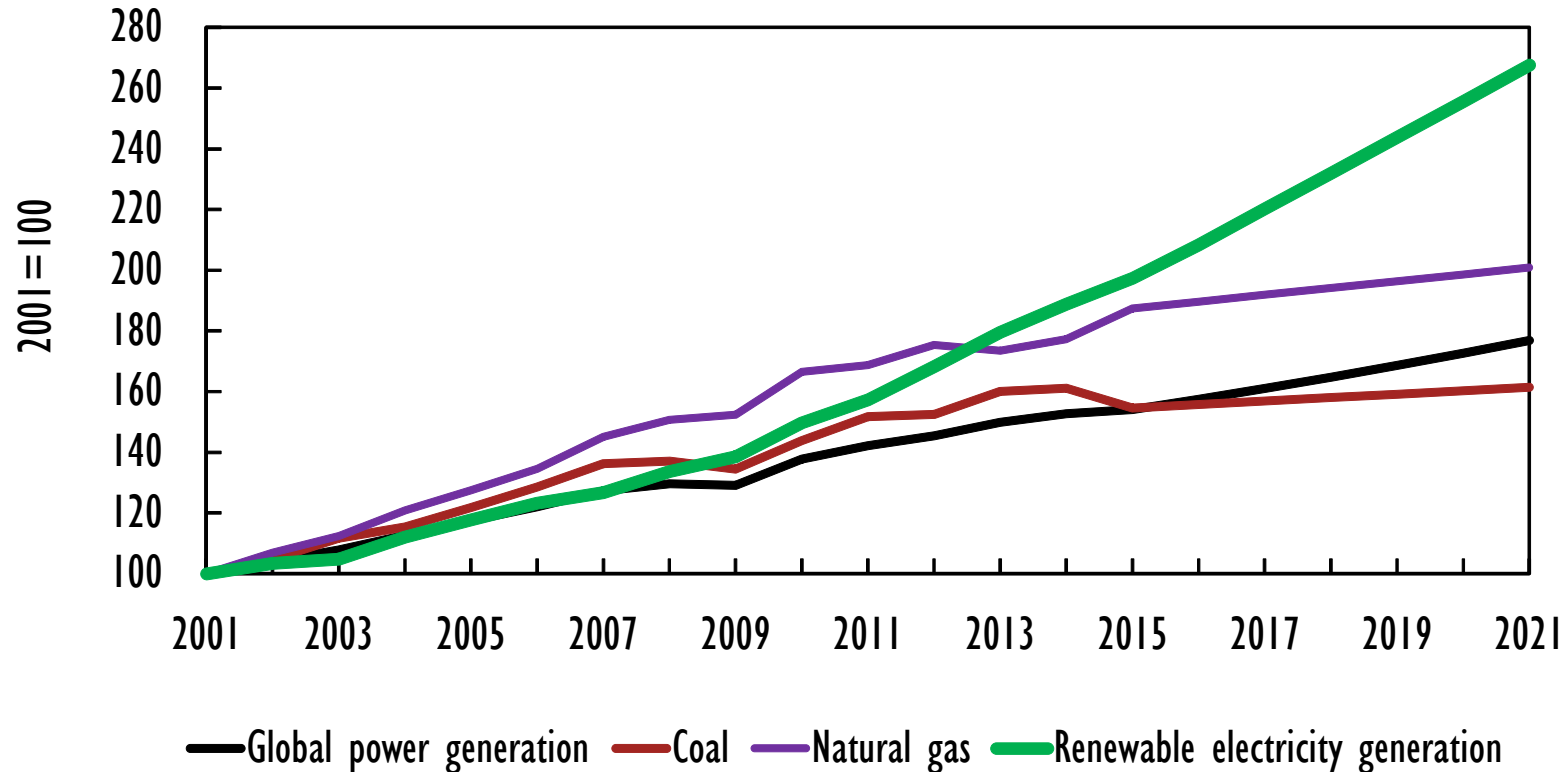
***Investment in renewables will generate annually more than 2015 global electricity growth. Wind leads, surging 35% in 2015 on economics and record offshore growth***

# Renewables to remain fastest growing source of electricity generation

RENEWABLE  
ENERGY

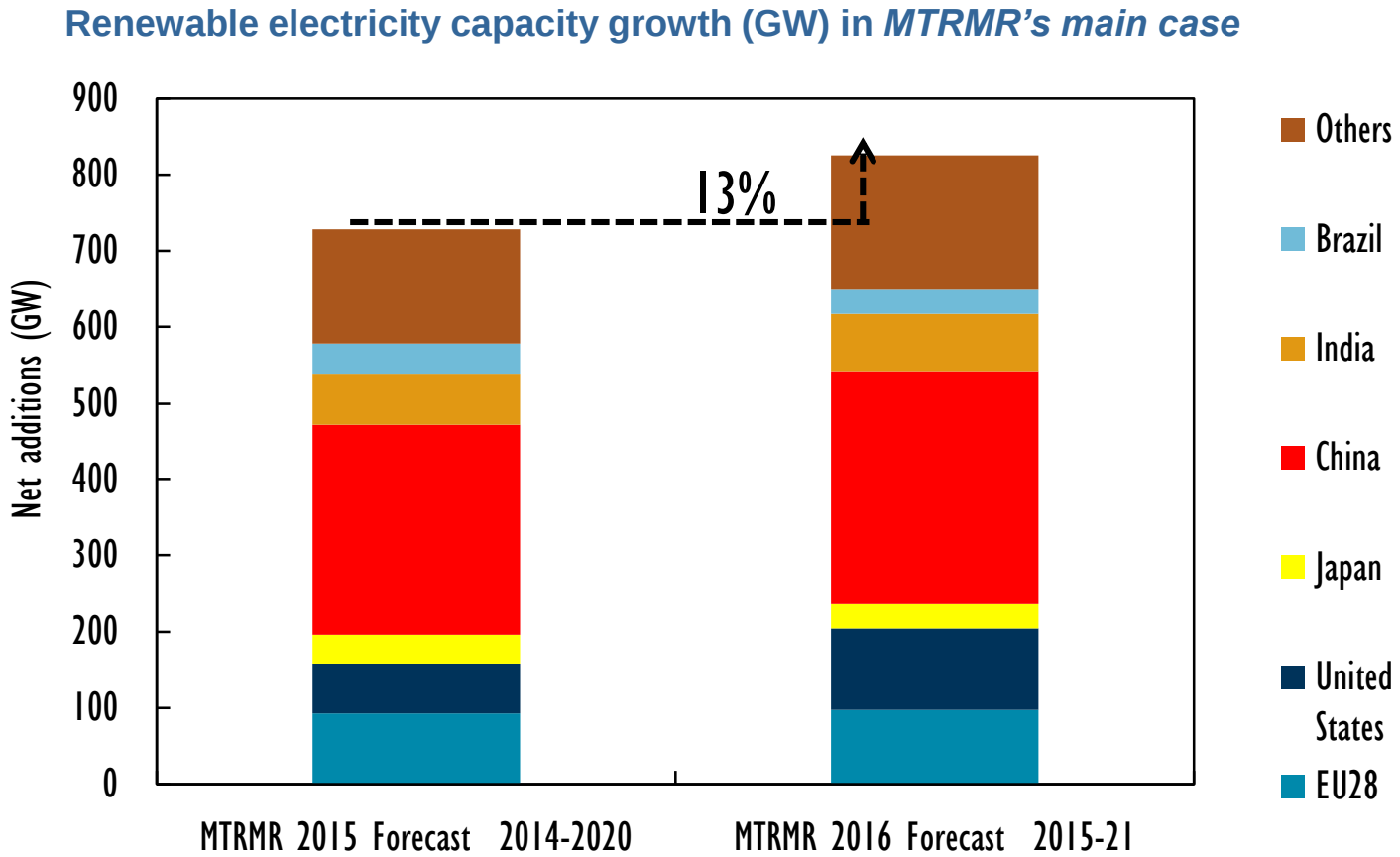
Medium-Term  
Market Report  
2016

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%**

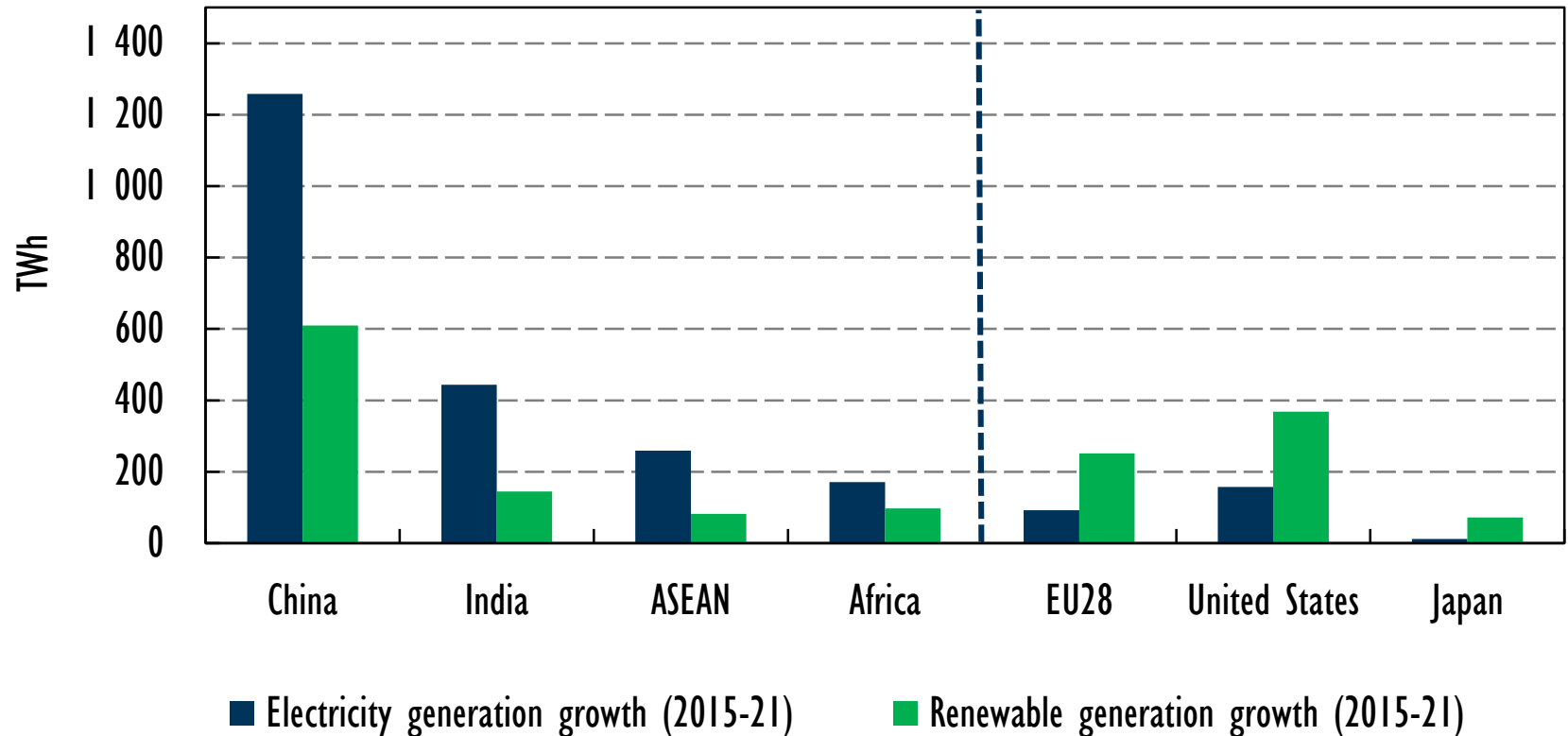
# New policies underpin a more bullish forecast for renewables



**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.

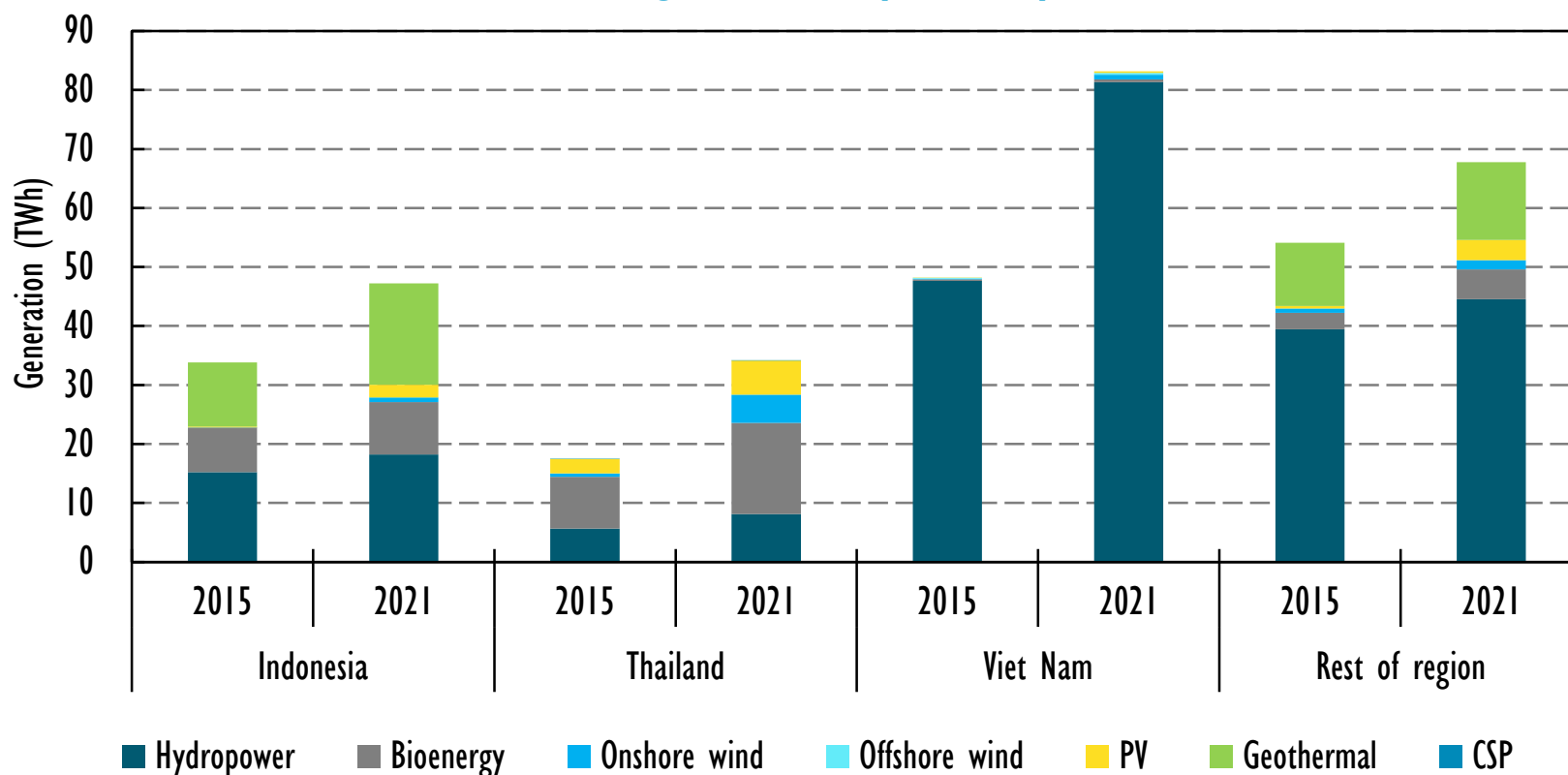
**The increase in generation from renewables in 2015-2021 represents 60% of the global increase in electricity output, but prospects vary across regionally**

# Renewables help diversify Southeast Asia electricity mix

RENEWABLE  
ENERGY

Medium-Term  
Market Report  
2016

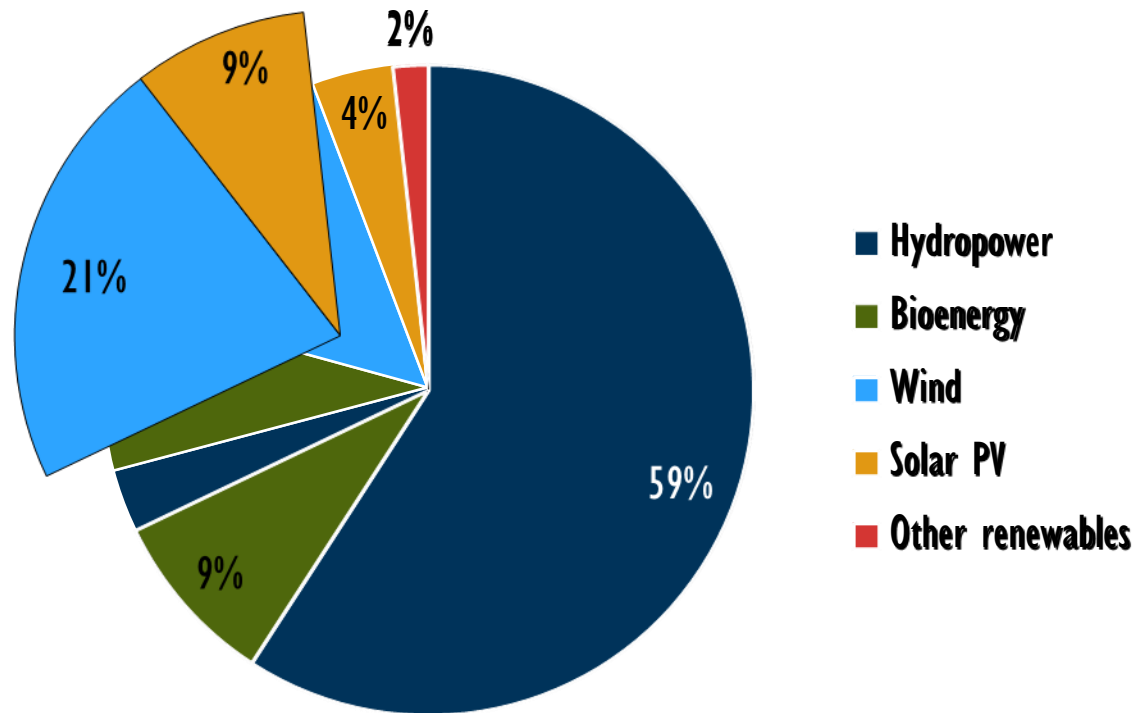
## ASEAN renewable generation growth and share of renewables in total generation (2015-21)



- 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

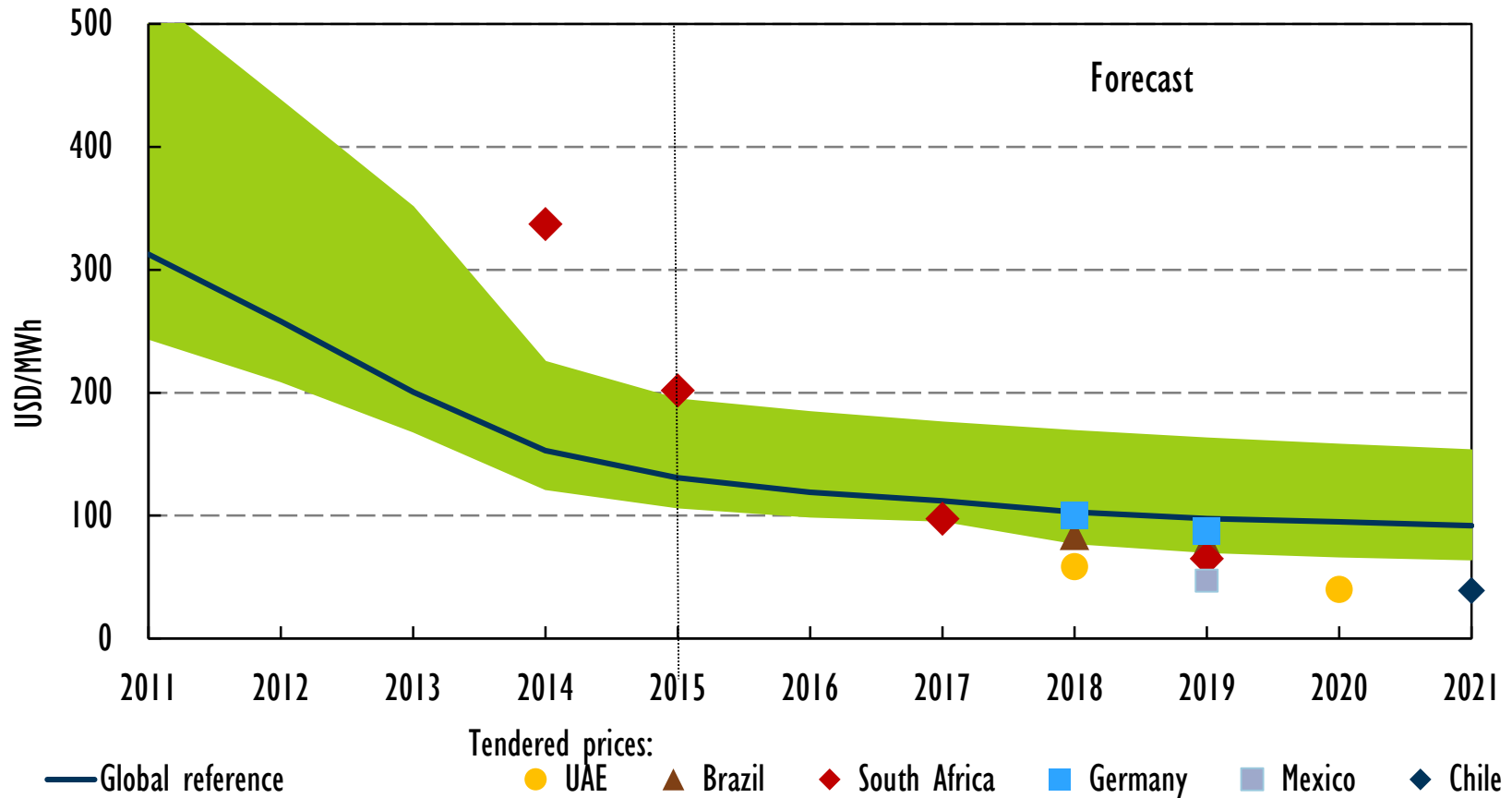
Renewable electricity generation by source 2025



**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

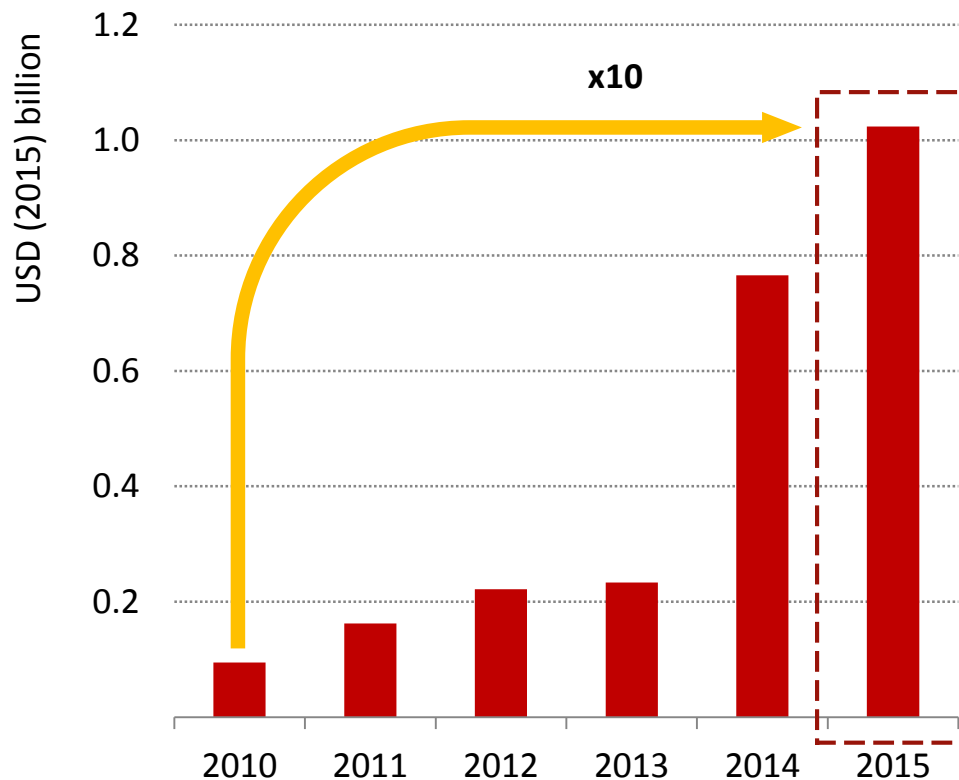
Utility-scale solar PV generation cost and contract prices



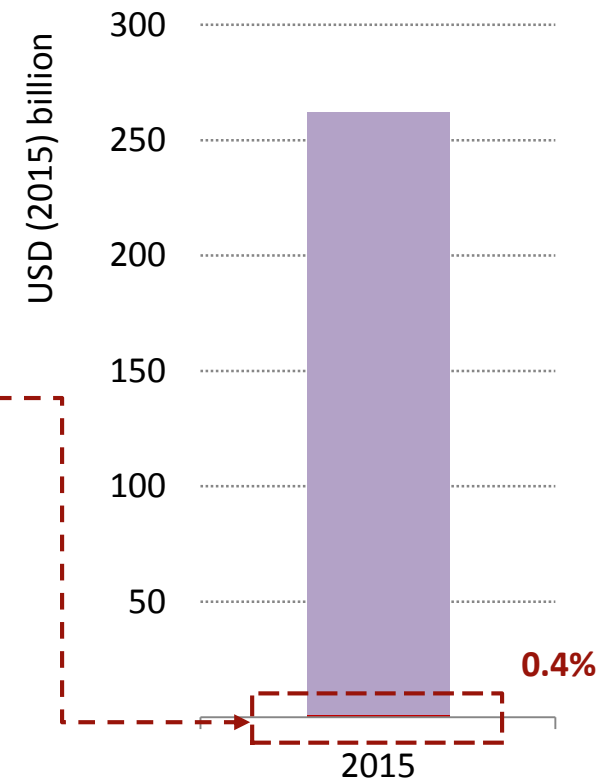
**Utility-scale solar PV generation costs to fall by another quarter over 2015-21;  
competitive tenders may result in even faster cost reductions**

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

## Global grid-scale battery storage investment



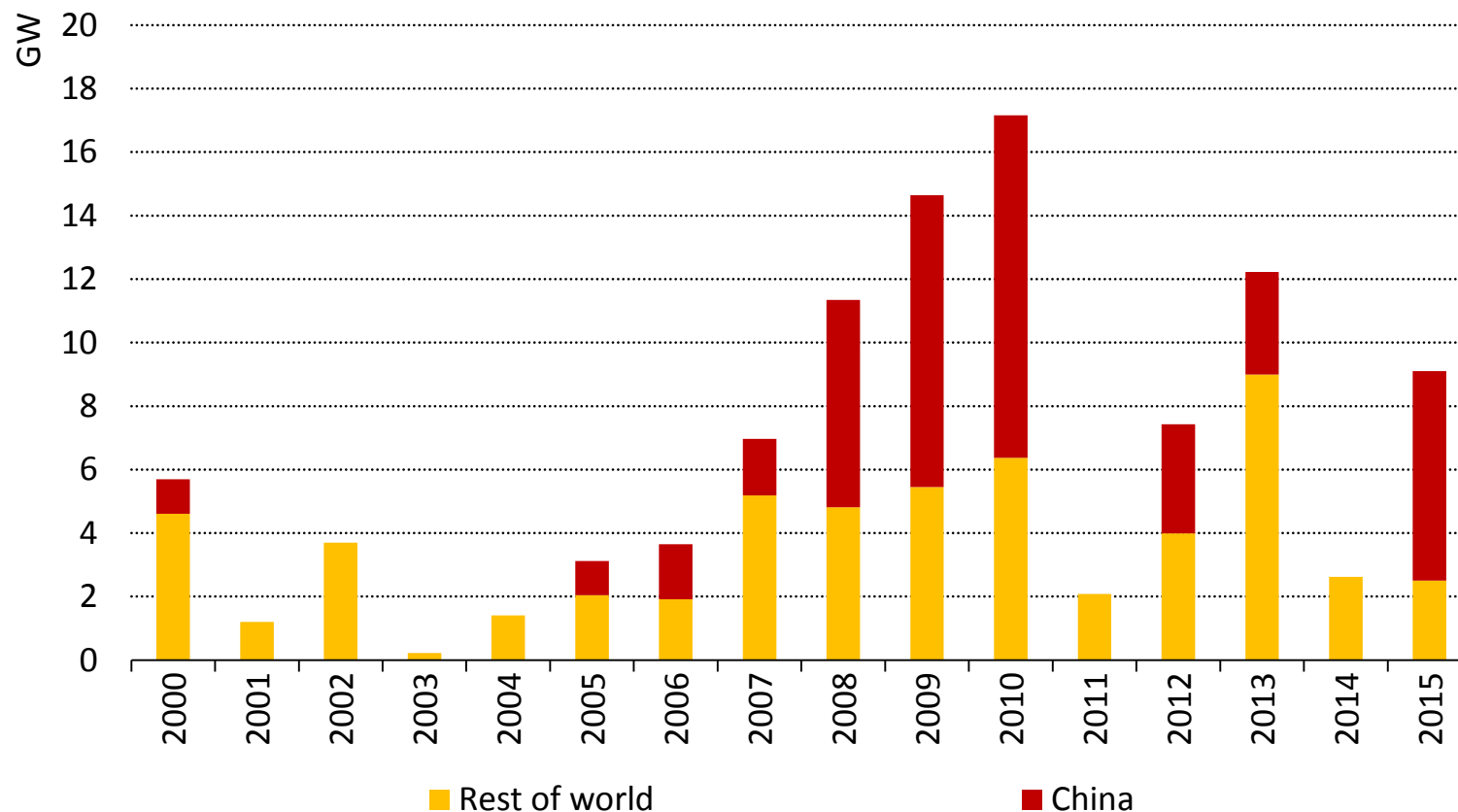
## Total networks investment



***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

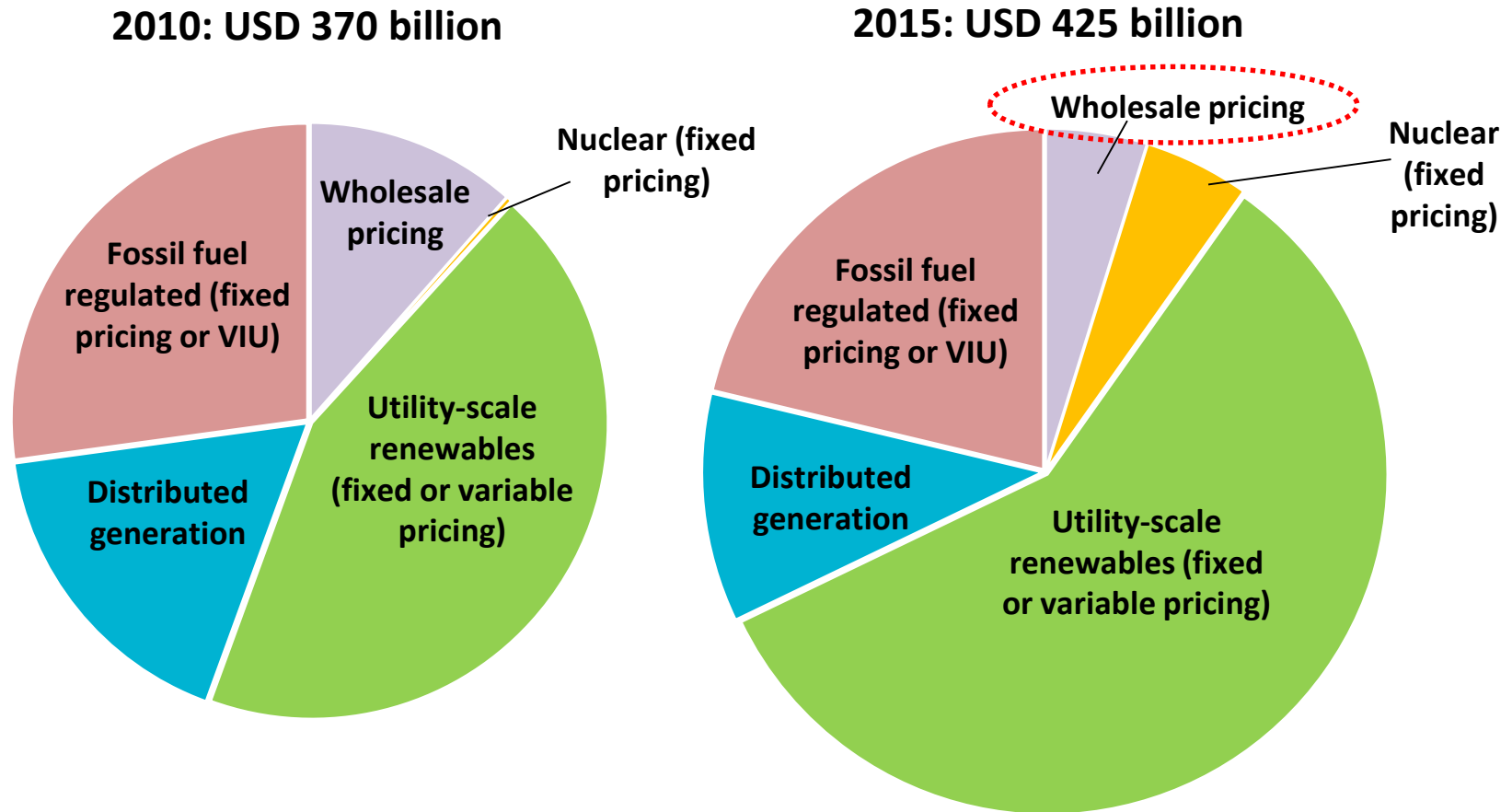
## Nuclear construction starts, 2000-2015



***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

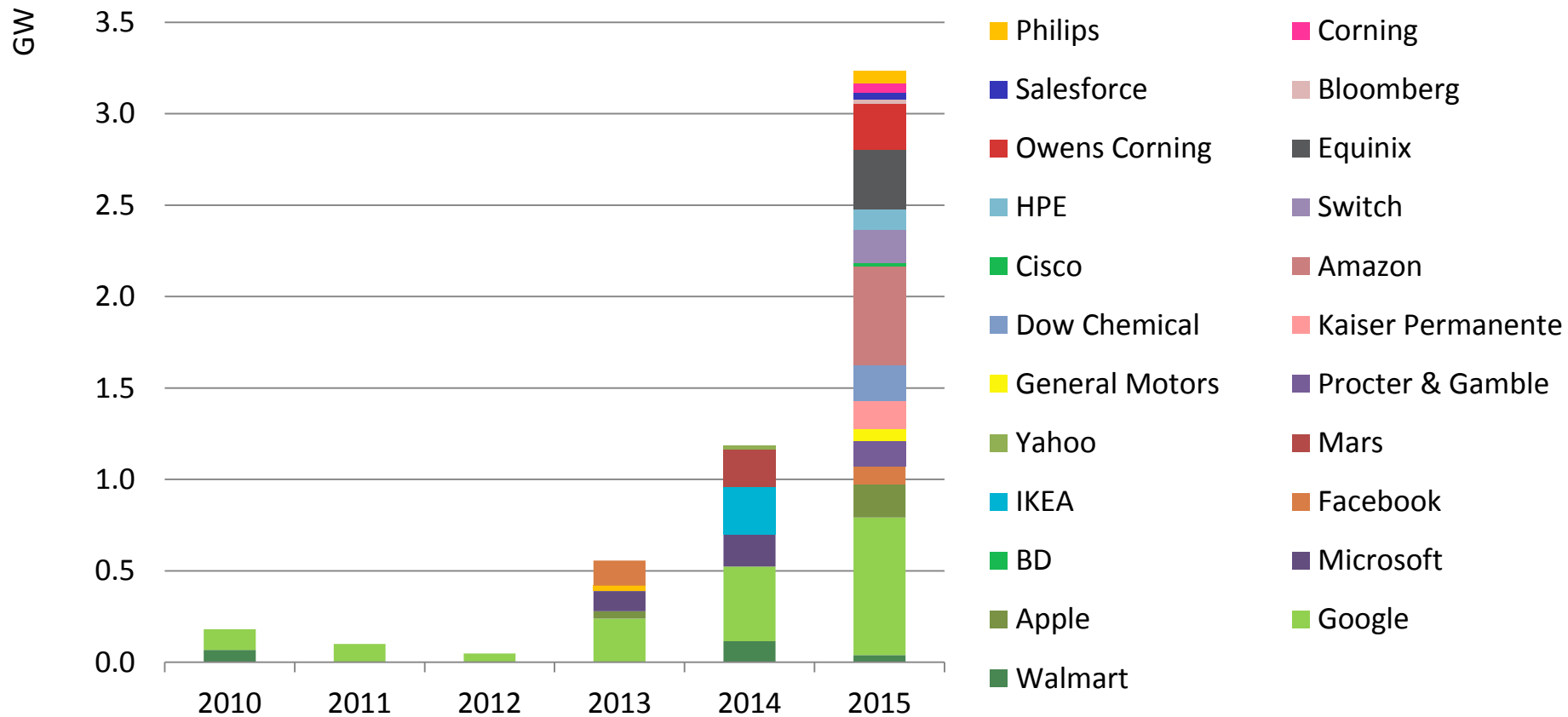


***95% of generation investments rely on contracts or price regulation, with a narrower role for wholesale pricing, as regulators pursue adequacy and low carbon aims***

# New business models expanding the sources of investment for clean energy

World Energy Investment 2016

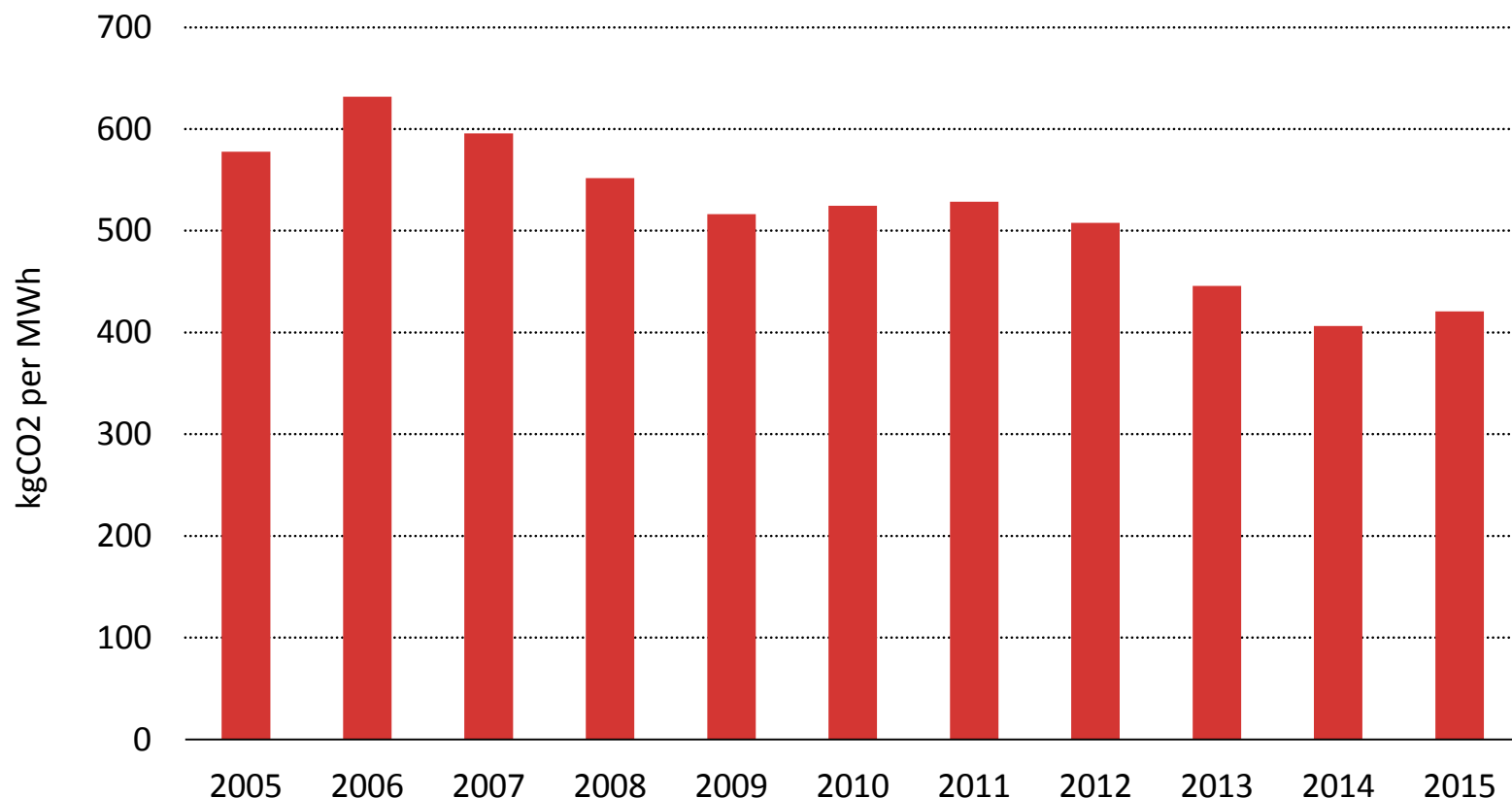
## Contracting of utility-scale renewables by non-energy companies in North America



***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

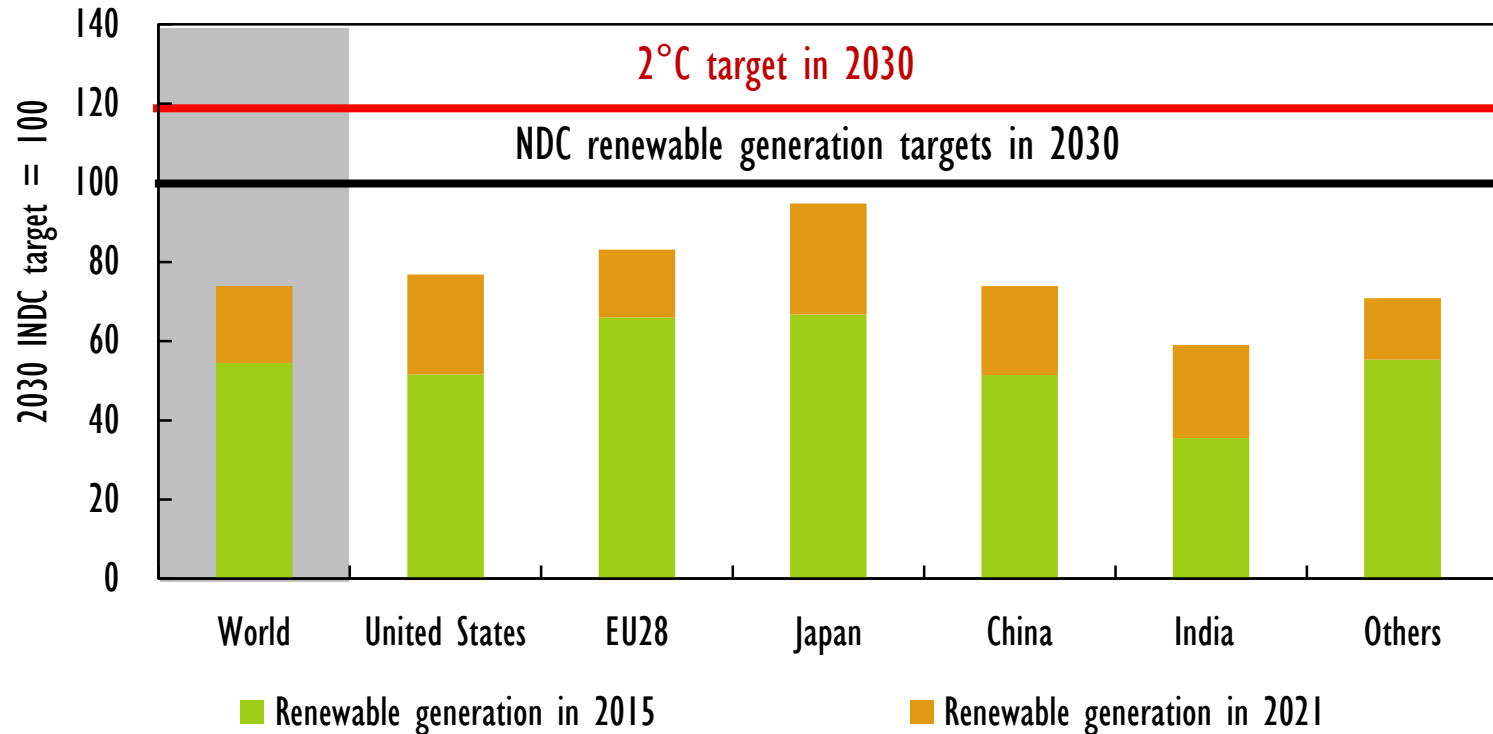
## Global average CO<sub>2</sub> emissions per MWh from new power generation capacity



***At 420kg CO<sub>2</sub>/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

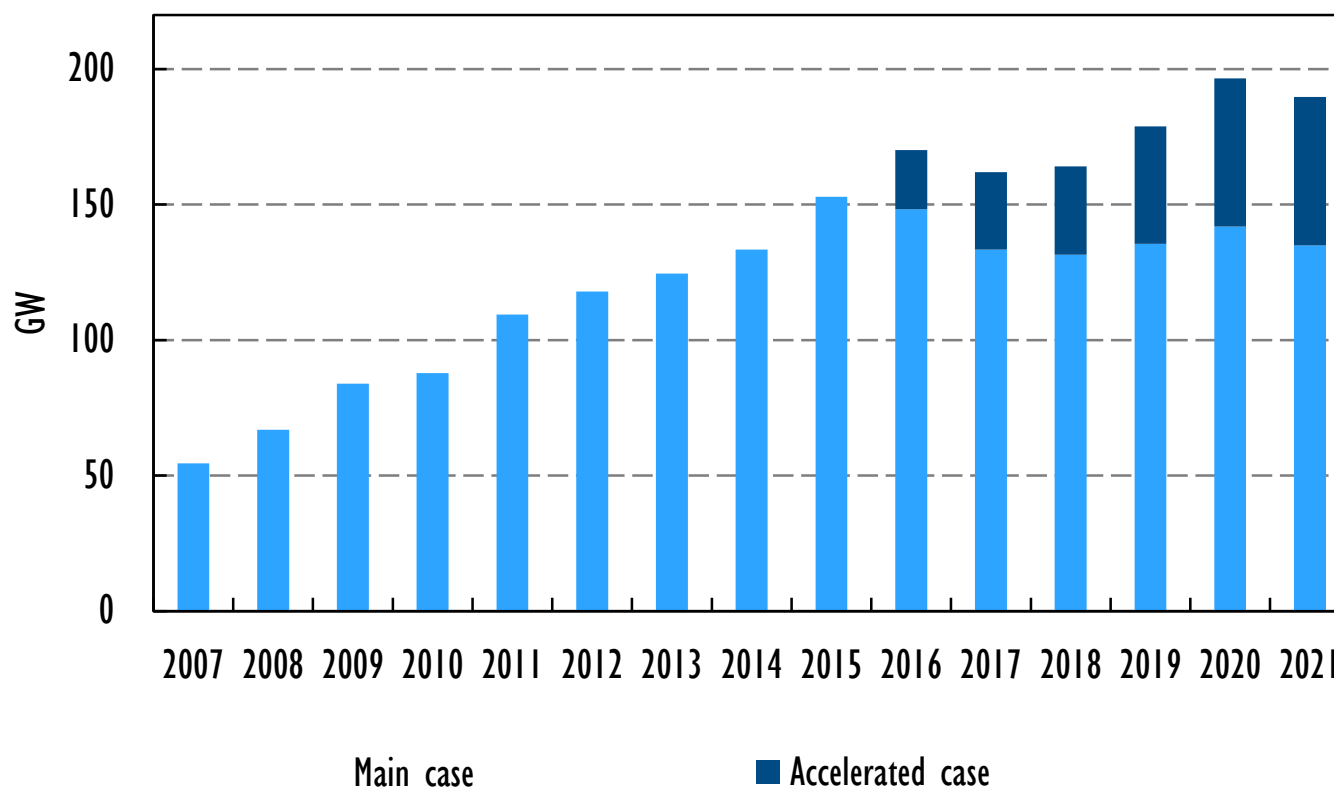
Renewable electricity generation indexed to NDC targets



**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