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Policies and financing for investment in the low carbon power transition: International experiences

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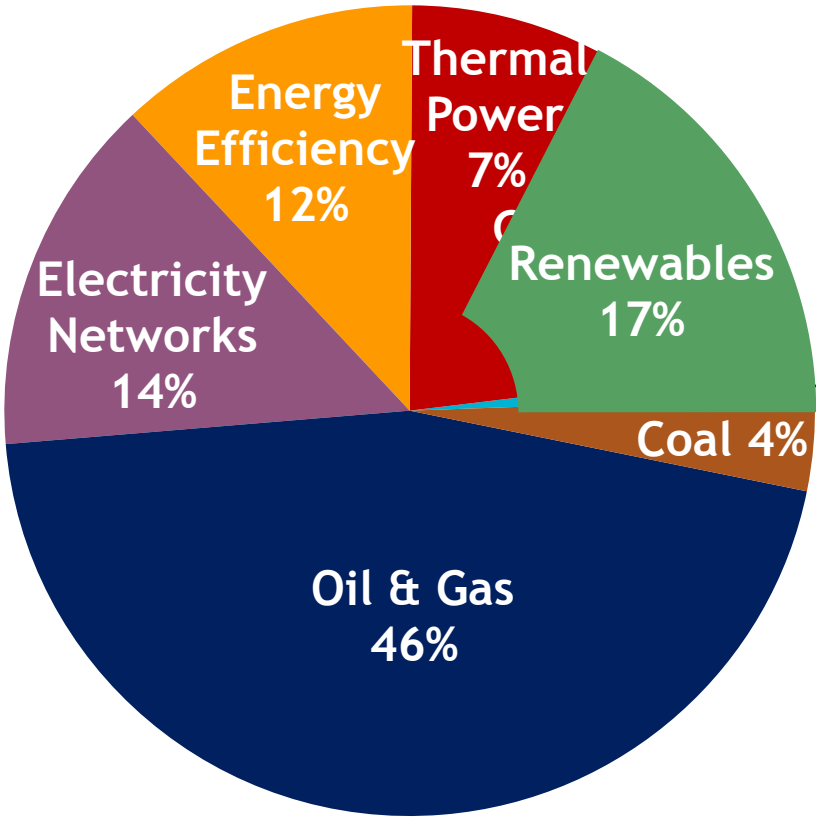
The market context

- **Investors and policy makers face new challenges and opportunities**
  - *Future energy demand growth and its evolving relationship with economic growth are major uncertainties for investment*
  - *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*
- **Investment flows signal move towards cleaner energy**
- **Still, the transition to a low carbon power system faces market specific challenges for financing generation, networks and flexibility**
- **In general, policy makers need to heighten their commitments, providing clarity and certainty to investors**

Investment flows signal a reorientation of the global energy system

Global Energy Investment, 2015

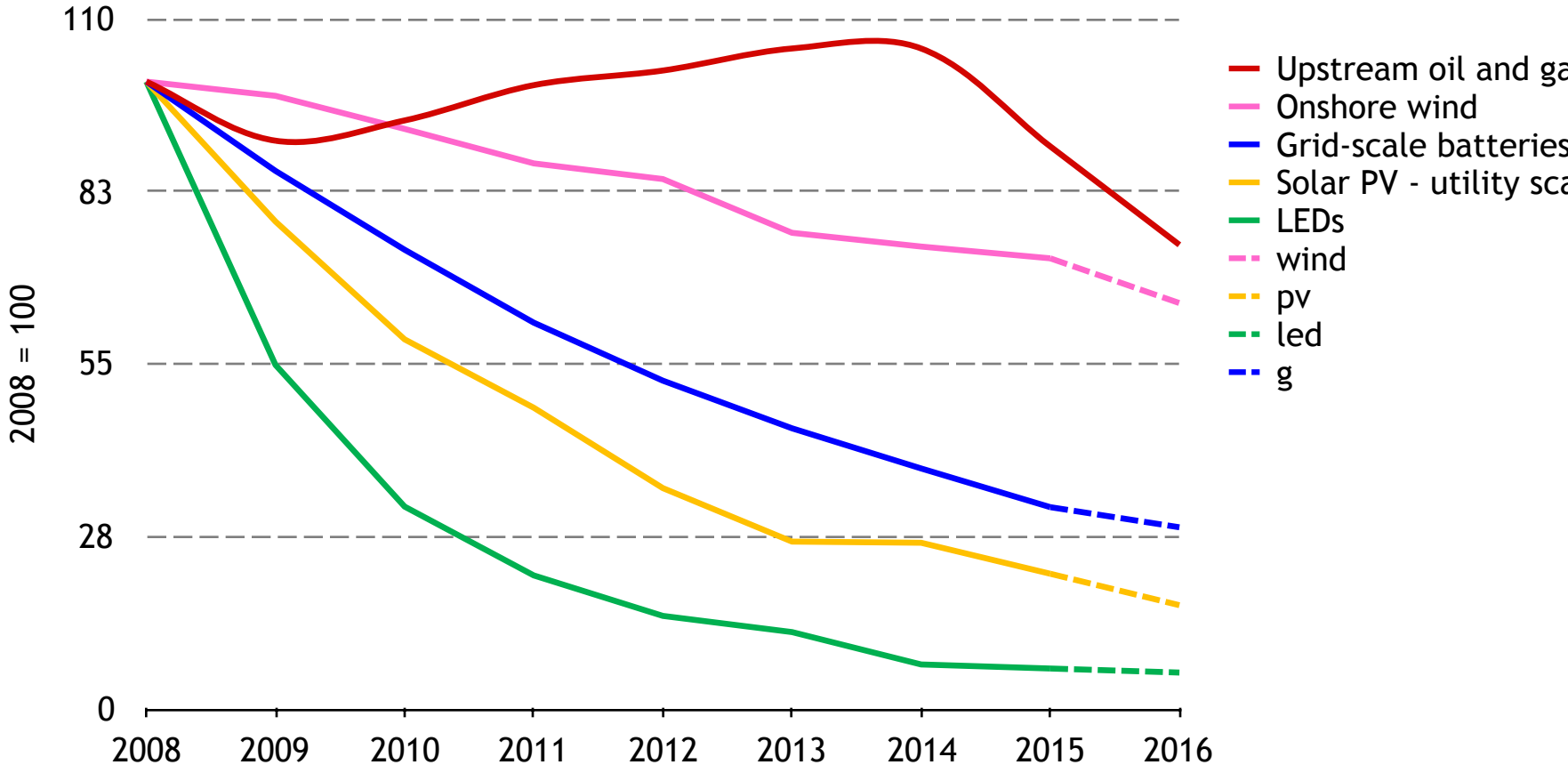
USD 1.8 trillion



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

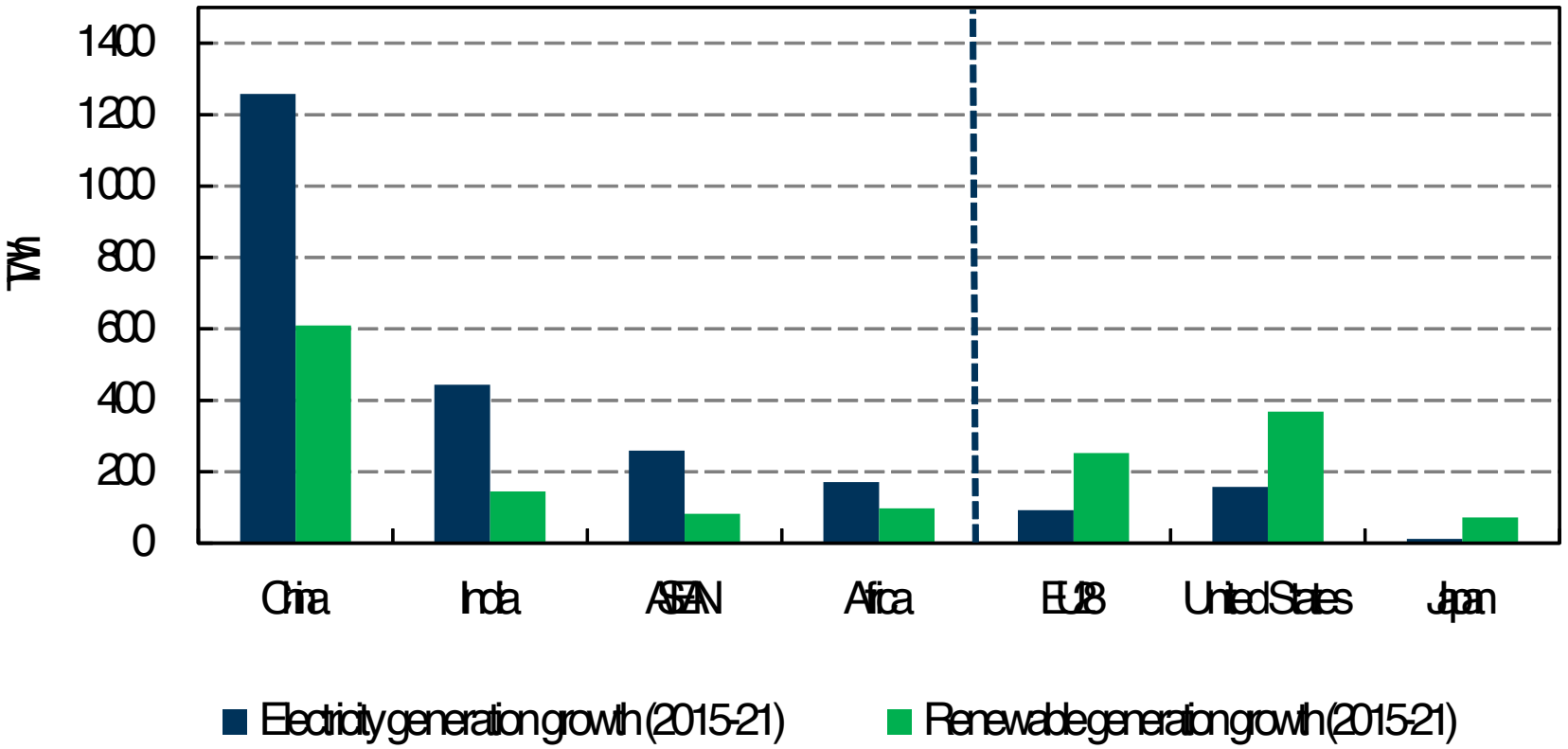


But some other technologies, such as nuclear power, carbon capture and storage and energy-efficient building renovations risk falling behind in the future

A two-speed world for demand and renewables growth

RENEWABLE ENERGY
Medium-Term Market Report 2016

Electricity and renewable generation growth by country/region (2015-21)

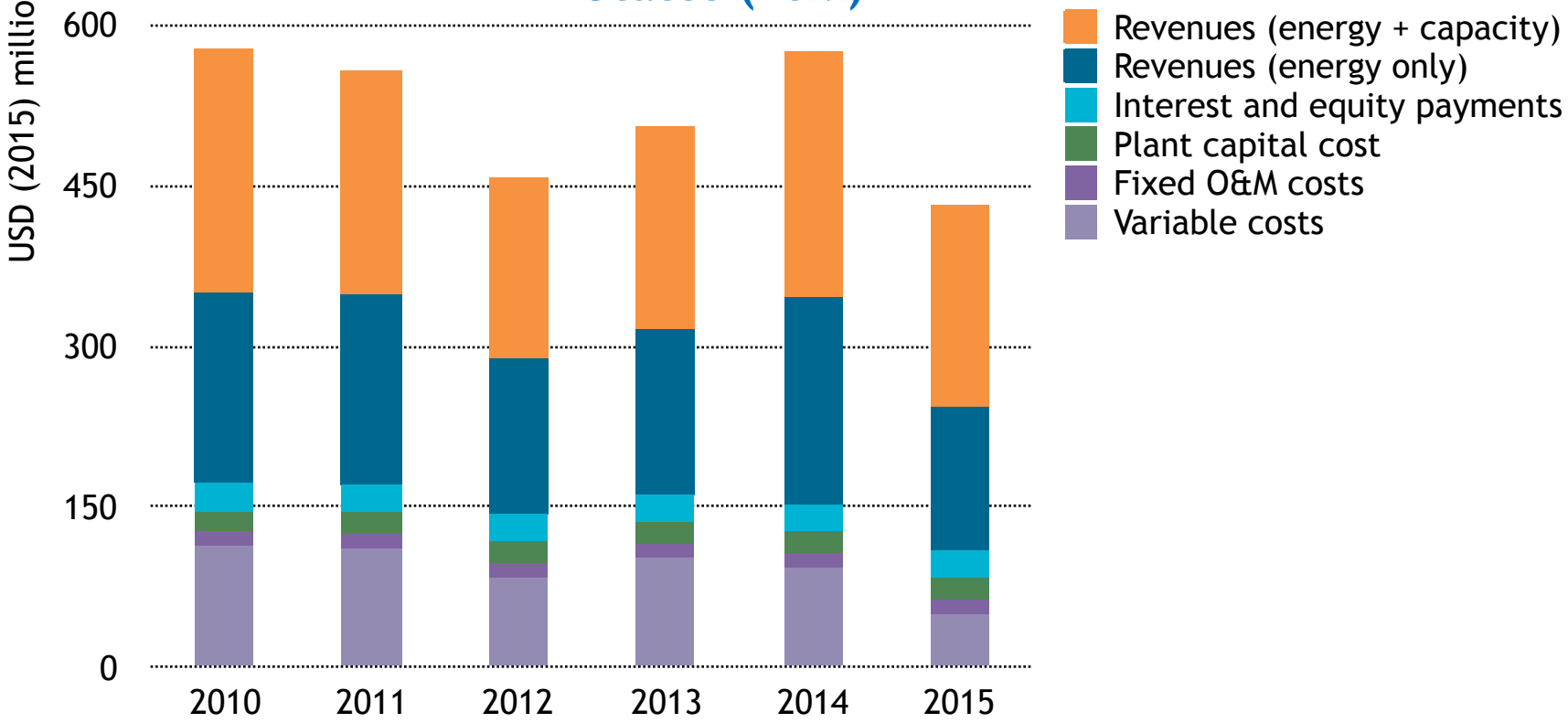


Source: Total electricity generation from World Energy Outlook 2016.

While renewables growth represents 60% of the global increase in electricity output, investment and integration challenges depend a lot on market context.

Investment uncertainties have risen for flexible thermal generation in competitive markets

Capital cost recovery for a new gas-fired power plant in United States (PJM)

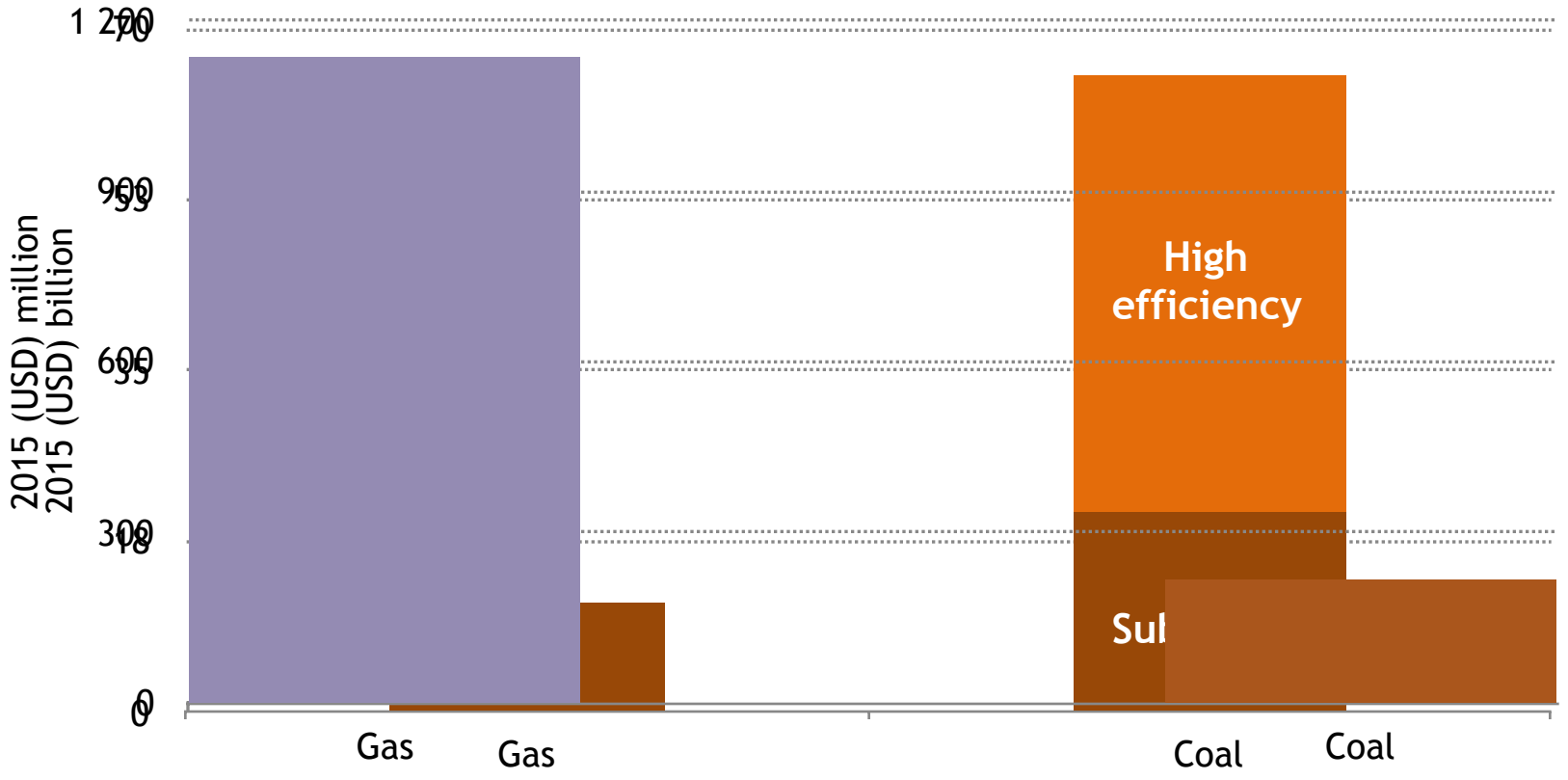


In Europe and some US regions, stagnant demand with rising renewables has increased risks for all generators of market revenues not covering full generation cost

Infrastructure costs favour coal power over gas in Asian energy importers

World Energy Investment 2016

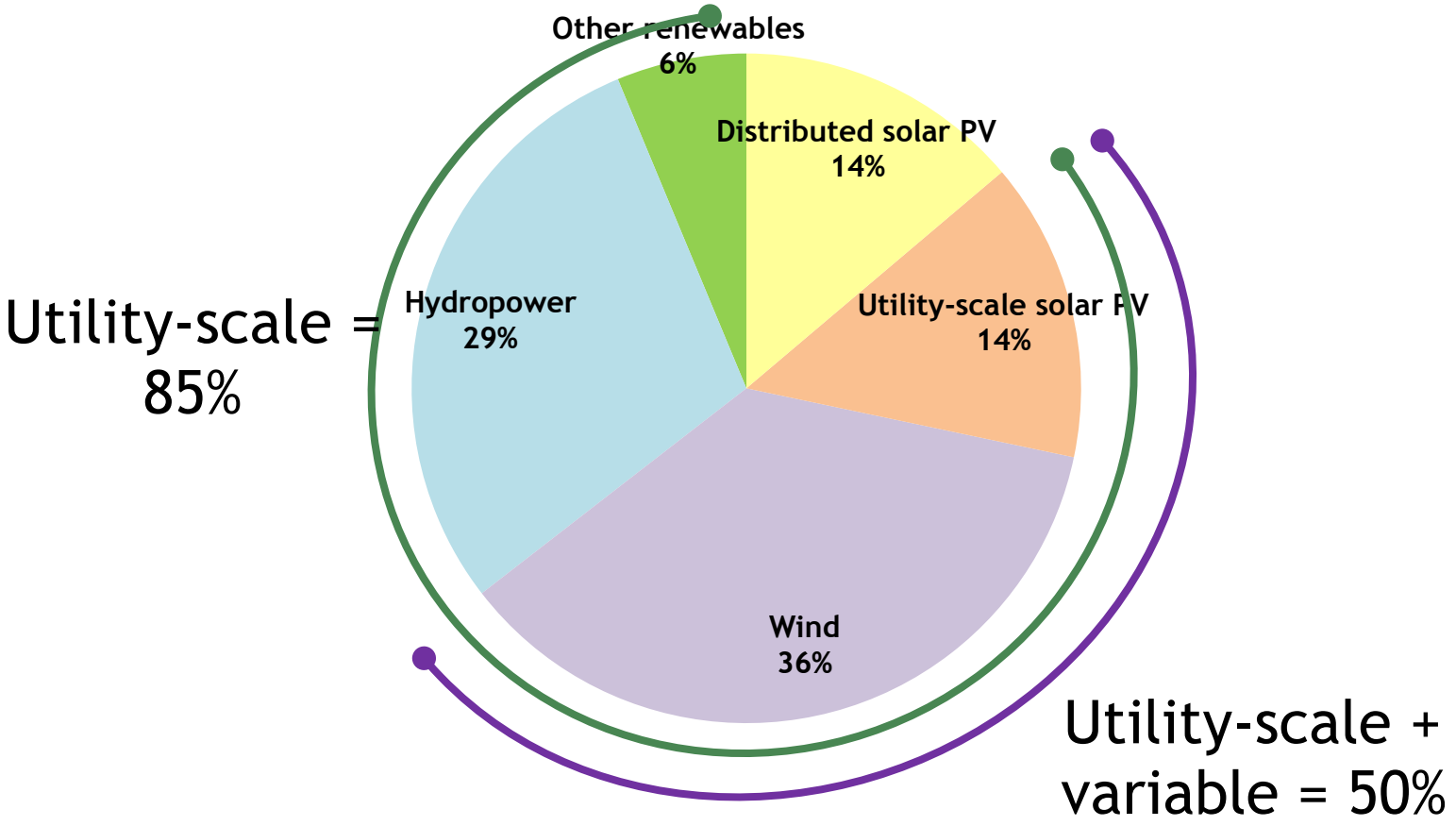
Coal and gas-fired power investment in Asian markets (2015)



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

The importance of the electricity network investment for integrating renewables

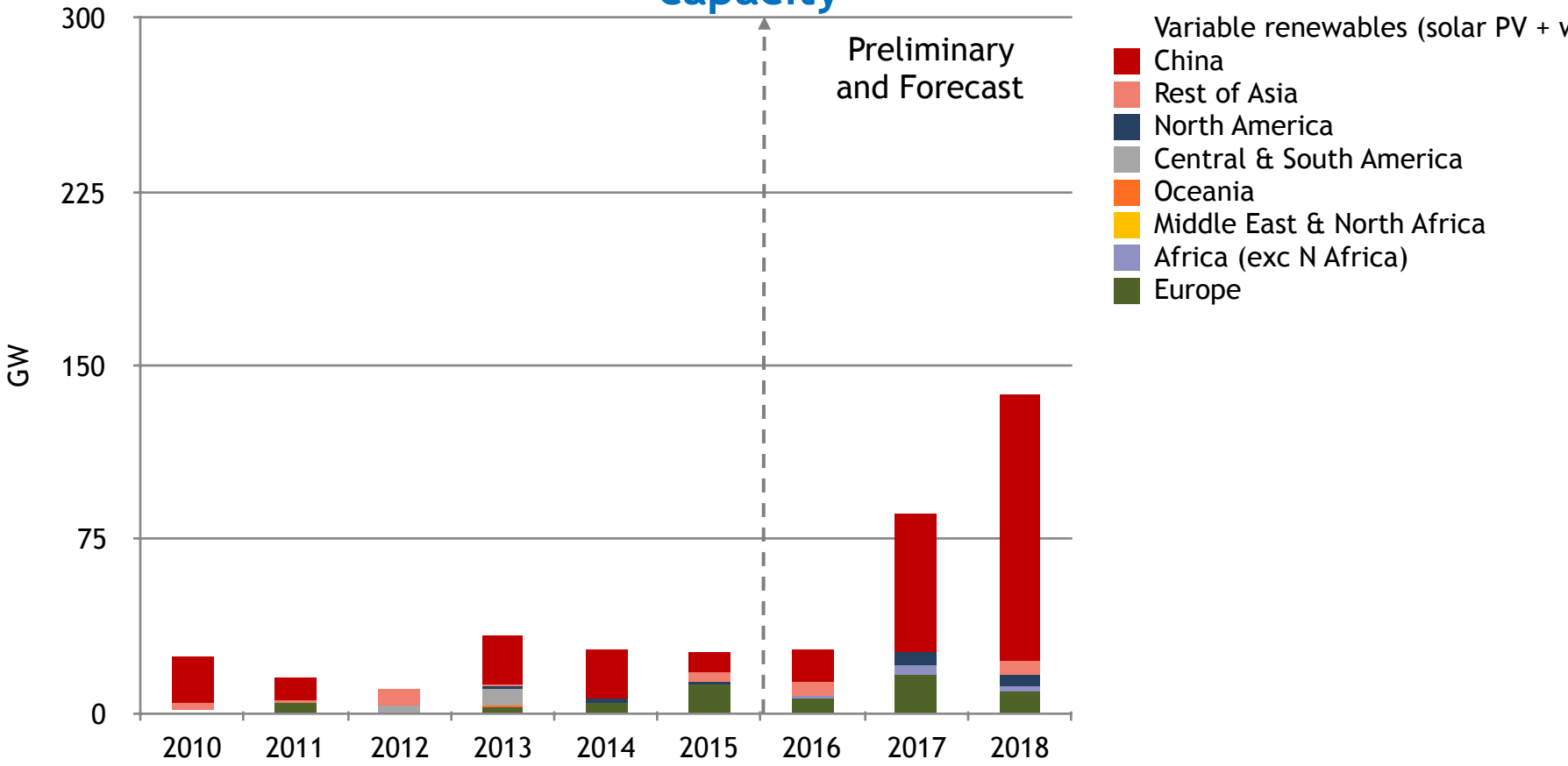
Global renewables deployment 2010-2015 (660 GW)



Distributed renewables can quickly scale to provide decentralised solutions, but over 85% of renewable additions the past five years interact with the centralised grid

Interconnections a crucial source of flexibility to integrate growing variable renewables

Transfer capacity additions vs variable renewable net additions to capacity

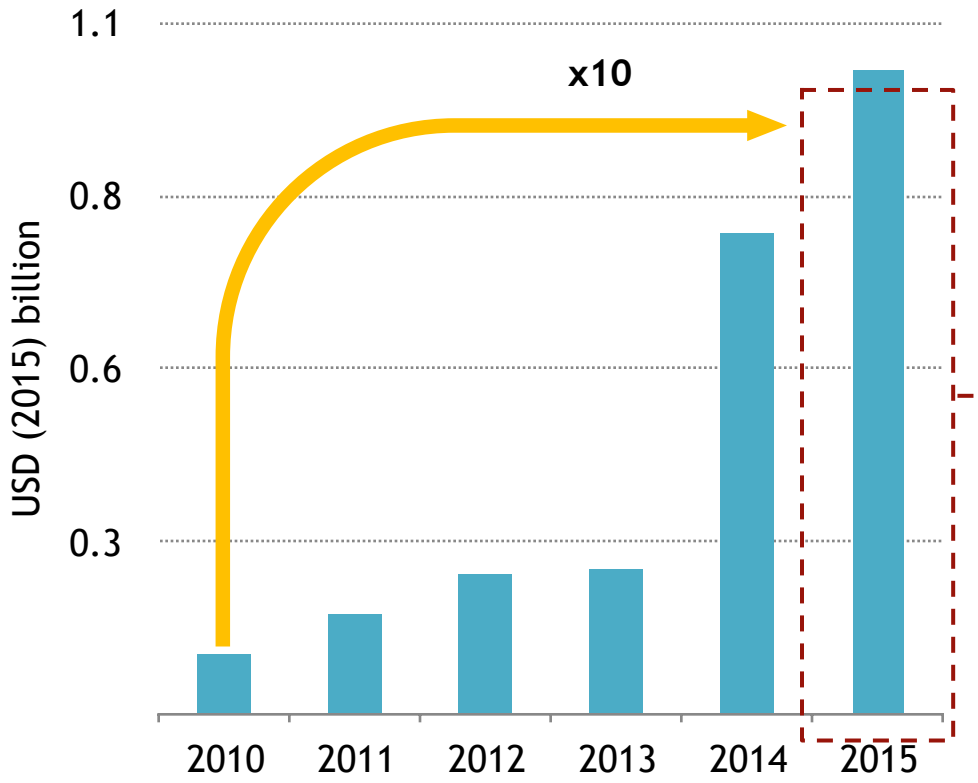


Note: Variable renewables capacity additions are from *Medium-Term Renewable Energy Market Report 2016*

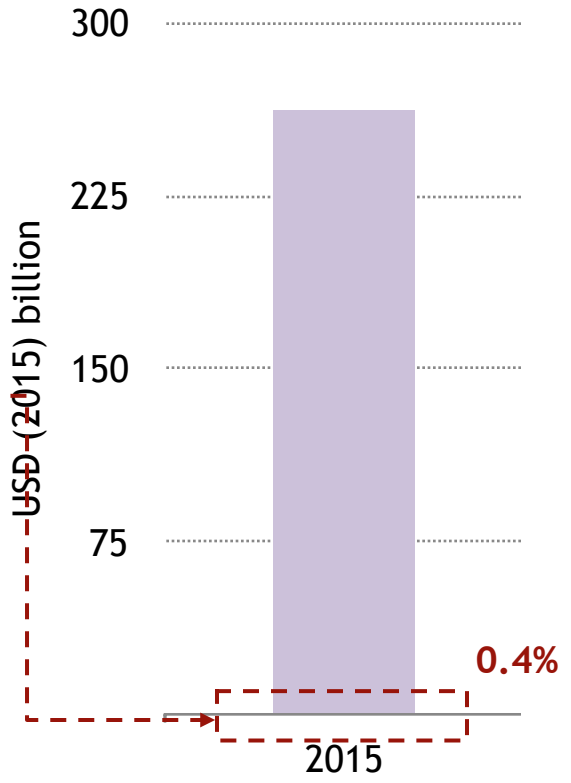
China accounts for 60% of additions since 2010 with programme for long-distance lines. Europe's deployment supported by targets and favourable

Strong interest in battery storage, though grids comprise most networks investment growth

Global grid-scale battery storage investment



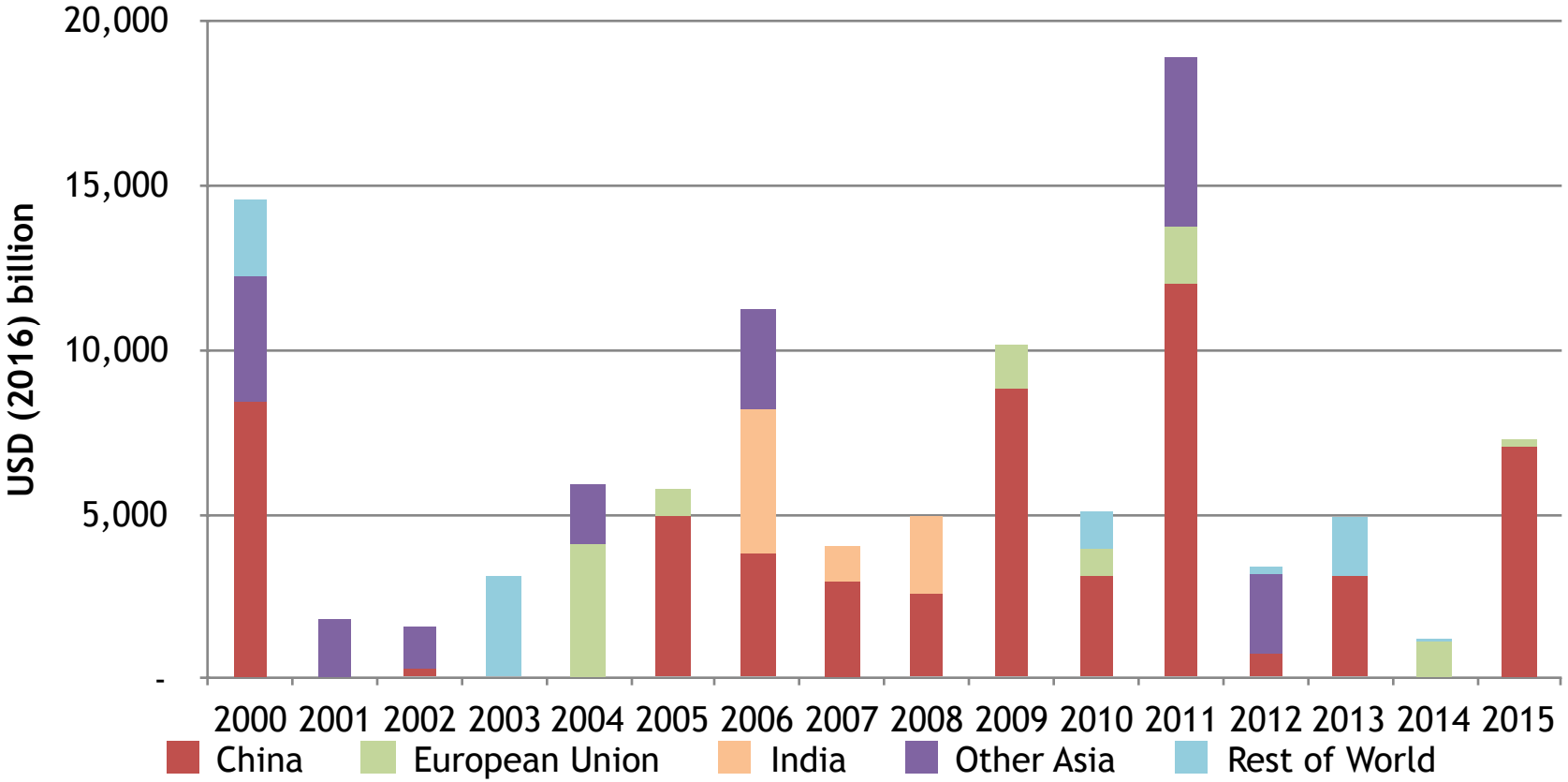
Total networks investment



Battery investments now mainly in demand shifting. Optimised network and policies would help monetise capacity, ancillary services, flexibility and avoided grid costs.

Pumped hydro remains the largest source of storage investment

Global pumped hydro storage plant investment

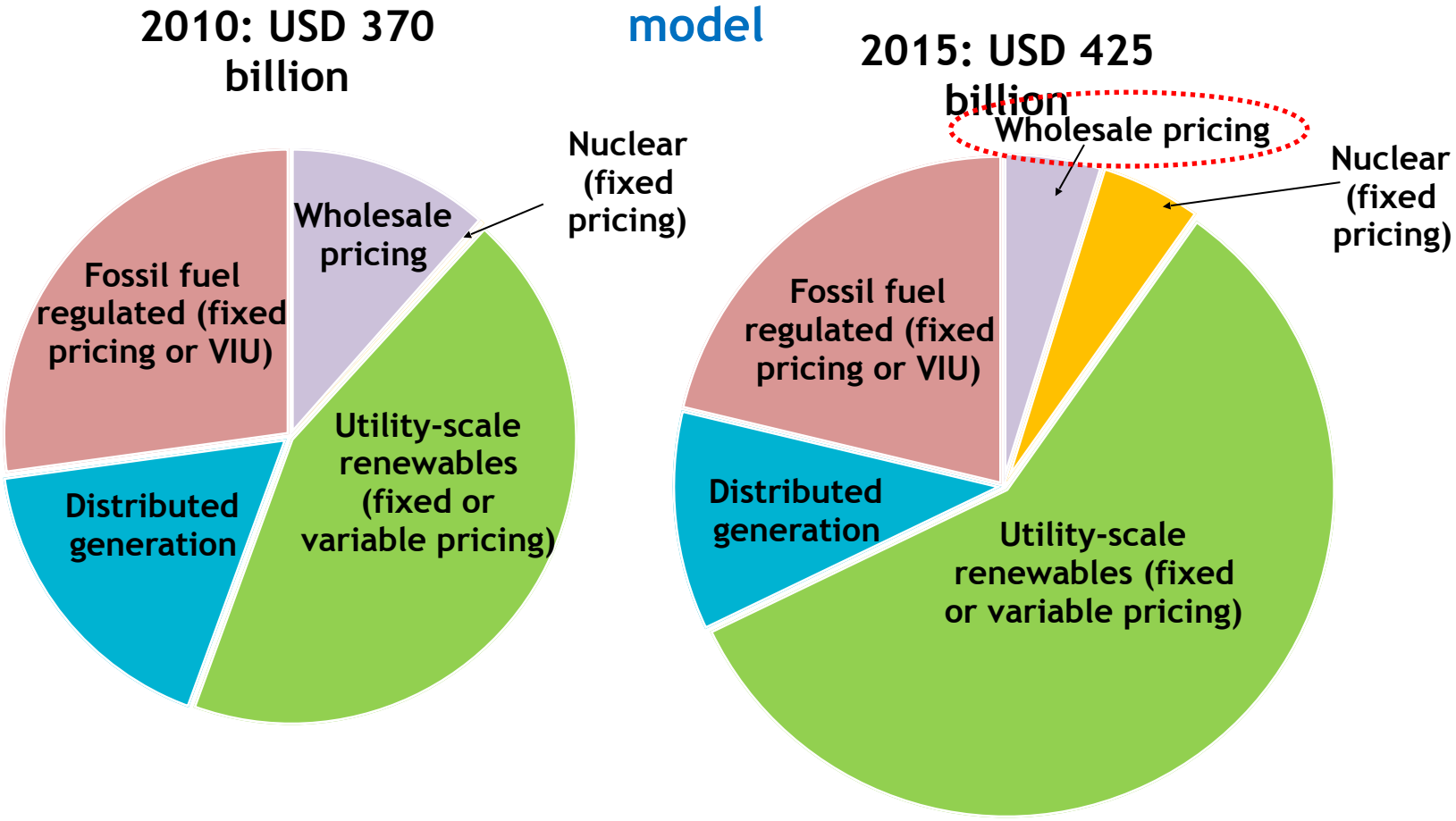


Note: Data may not fully account for all configurations, including mixed plants of hydropower and pumped storage.

Energy price arbitrage business models now less supportive in competitive markets. Investment increasingly requires dedicated tariffs and removal of regulatory barriers.

Policies are playing an increasing role in the pricing of electricity

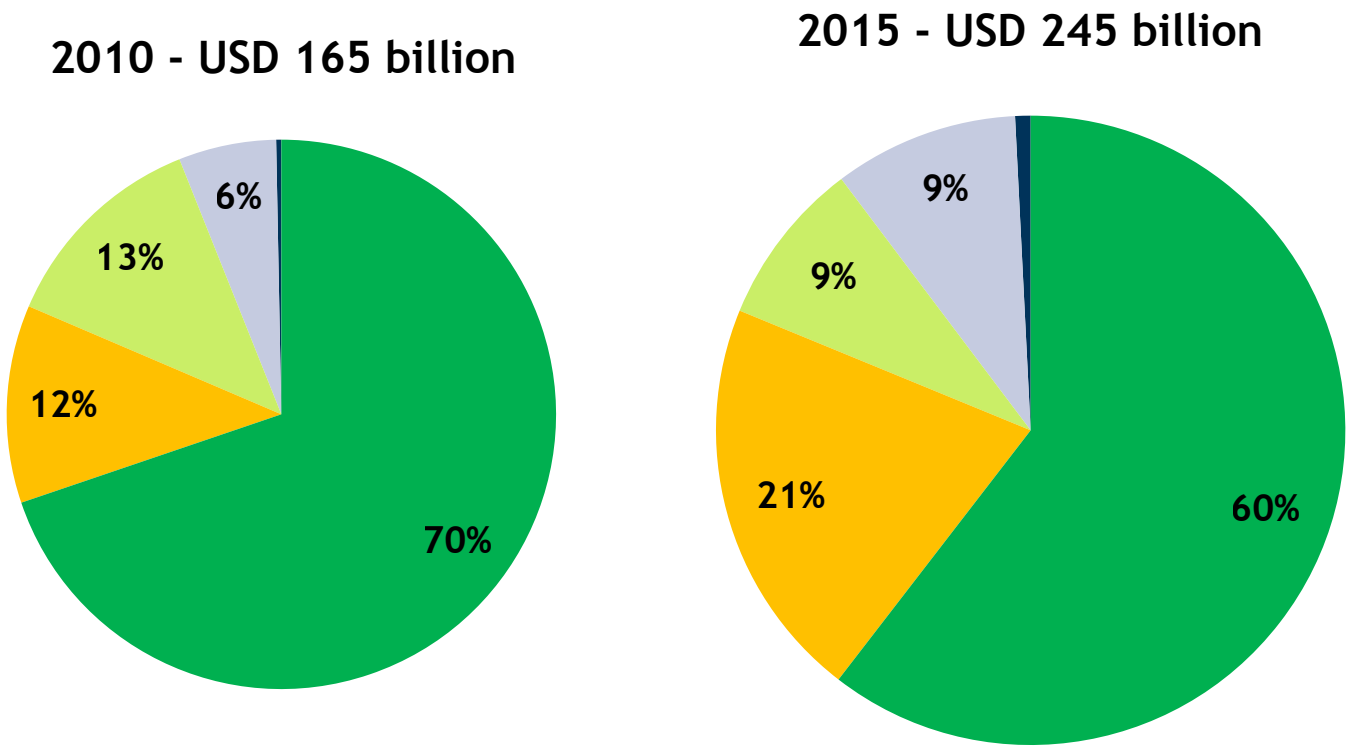
Global power generation investment by main business model



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

Policy drivers of renewable investment shifting to more competitive mechanisms

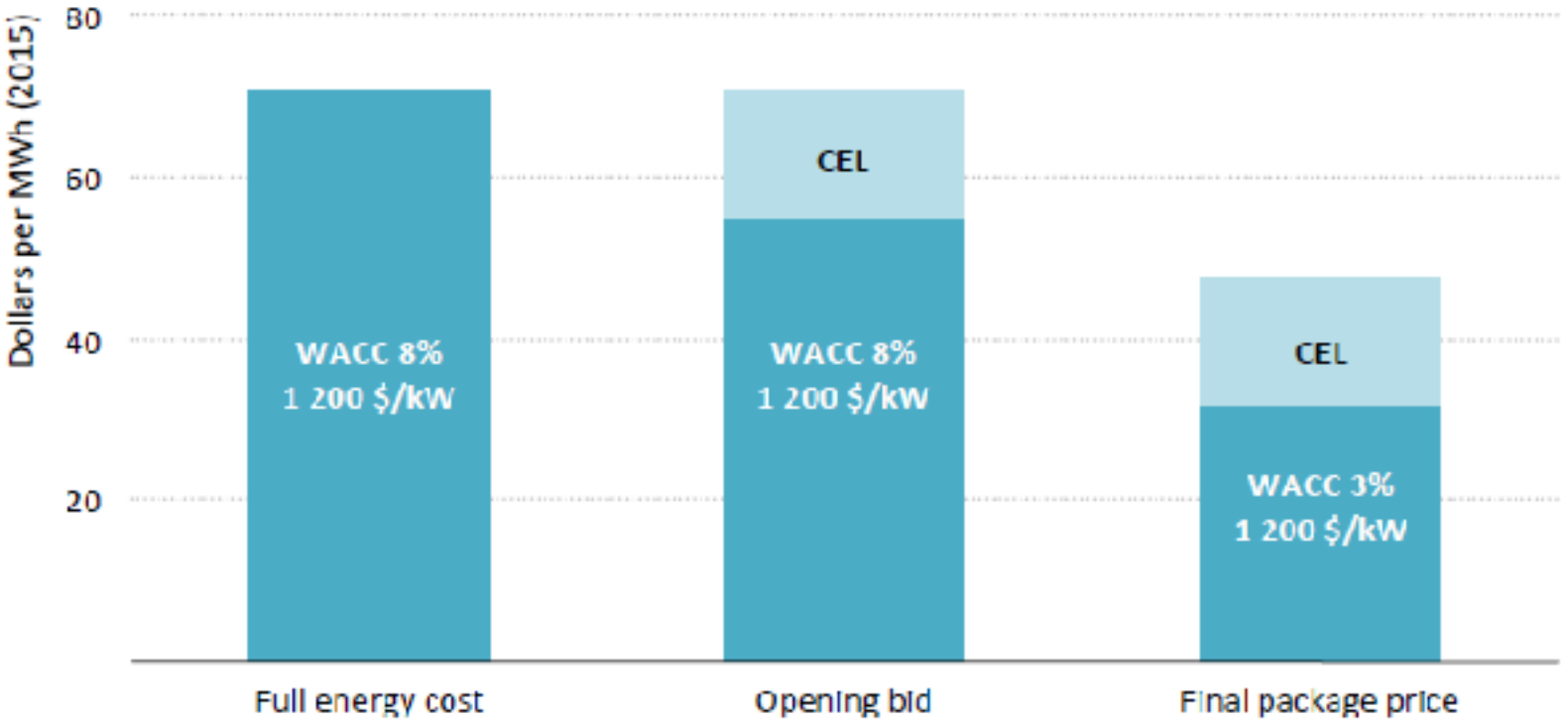
Utility-scale renewable investment by type of primary remuneration



One-fifth of large-scale renewable investment driven by long-term prices in auctions, but mixed models and more exposure to energy price risks playing increasing role

Policies for system friendly renewable investment in Mexico

Indicative cost and auction price for solar PV in Mexico

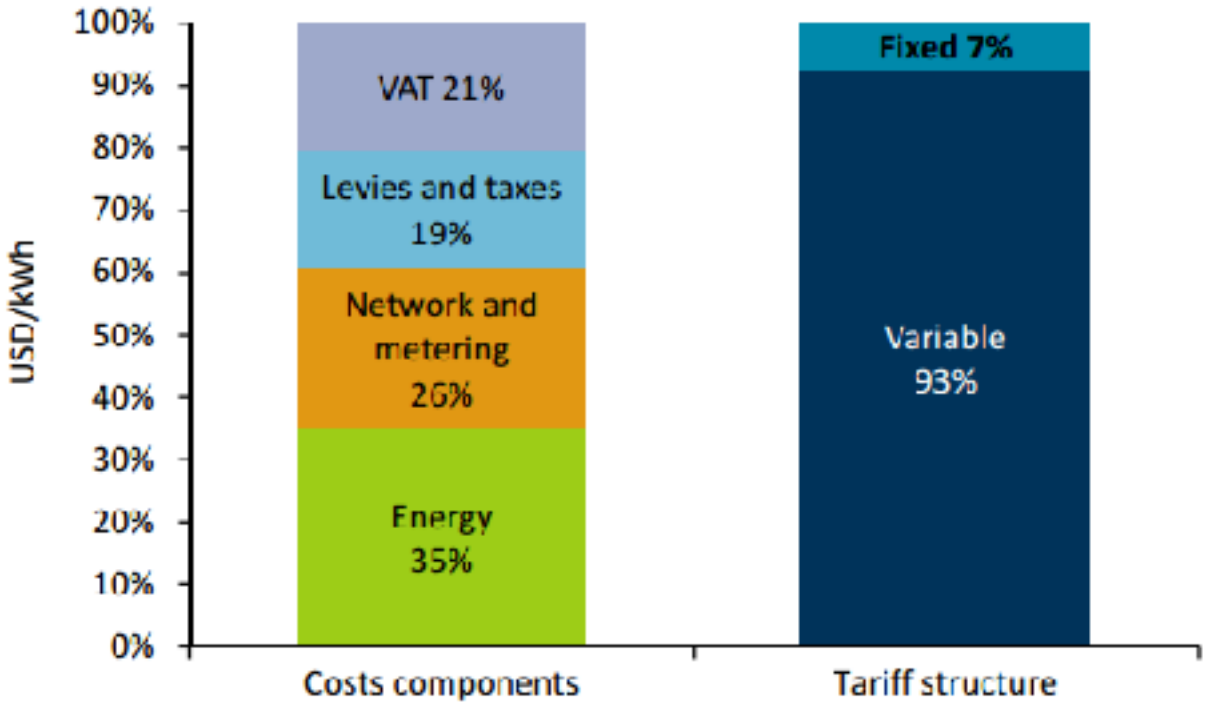


Notes: MWh = megawatt-hour; CEL = clean energy certificates; WACC = weighted average cost of capital; kW = kilowatt. These are indicative costs and prices for solar PV, showing how auctions can secure competitive bids and final prices.
Source: World Energy Outlook, 2016.

In addition to driving down costs, Mexico's auction system would enhance system value of variable renewables through accounting for location and time profile in awards.

Cost reflective power system crucial for financing the electricity network

Cost components and tariff structure of selected retail electricity prices

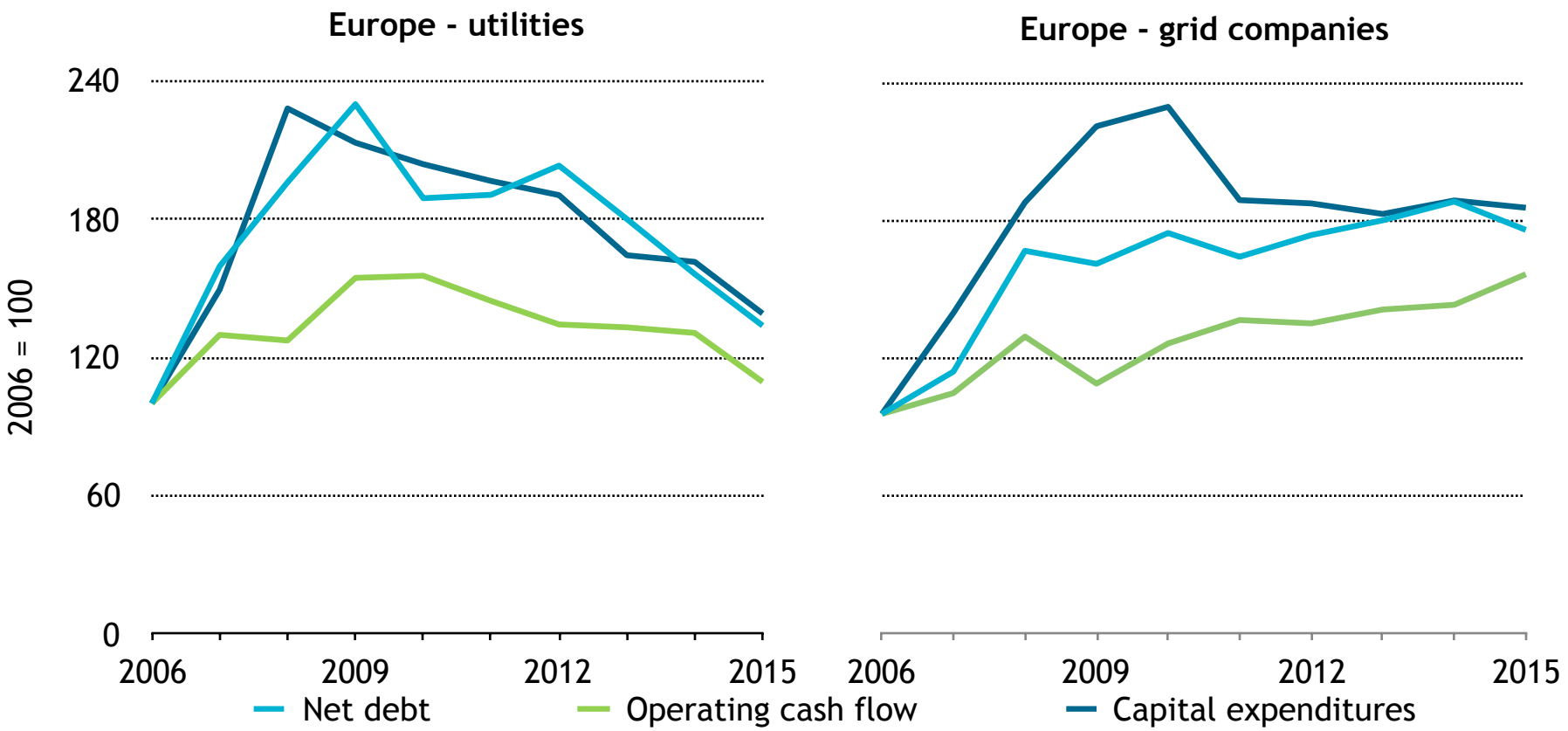


Source: Repowering Markets, 2016

Cost reflective and transparent tariff design should reflect the underlying system costs level and structure in order to induce efficient and sustained investment.

Financial health of utilities and grid companies remains a key to power sector transition

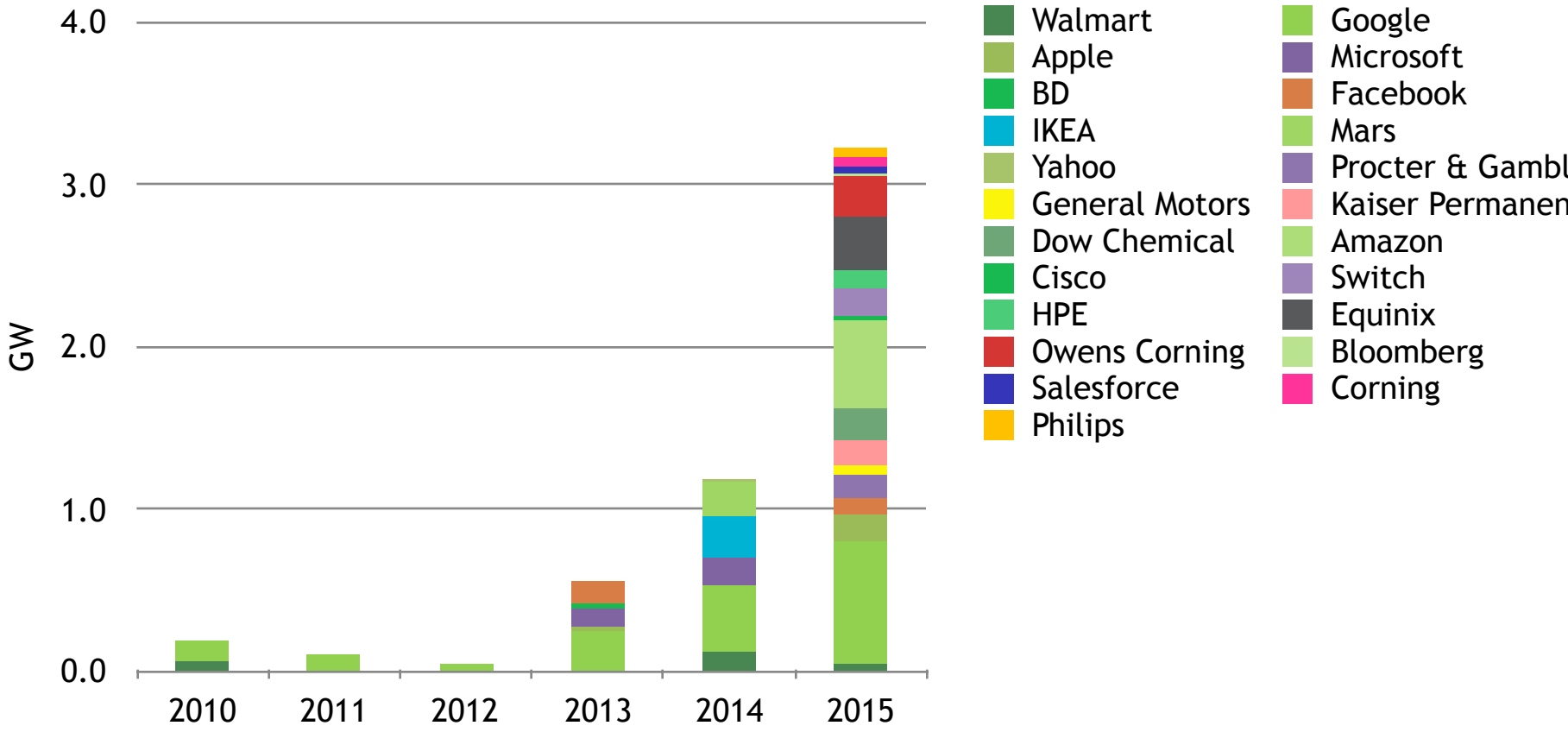
Financial indicators for listed European power companies



Utilities will play an important role as sources of finance, reliable off takers and investors in robust and flexible networks and infrastructure to ensure electricity security.

Corporations emerge as additional sources of credit worthy off take for renewables

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

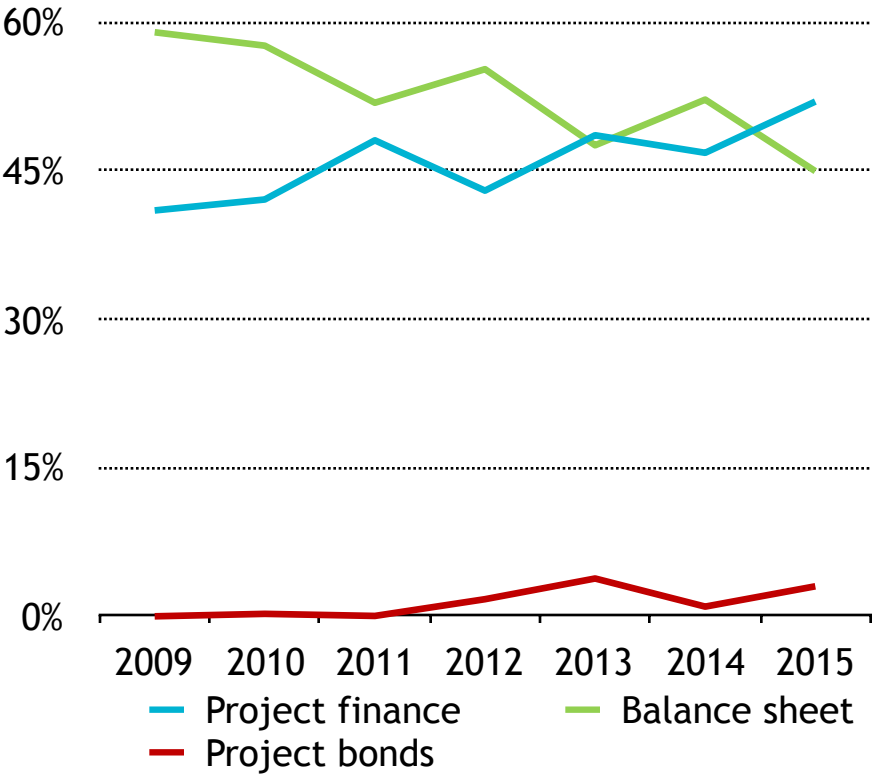


Technology companies have driven rapid growth, with increased momentum outside the US, but business model requires a robust centralised grid and system balancing.

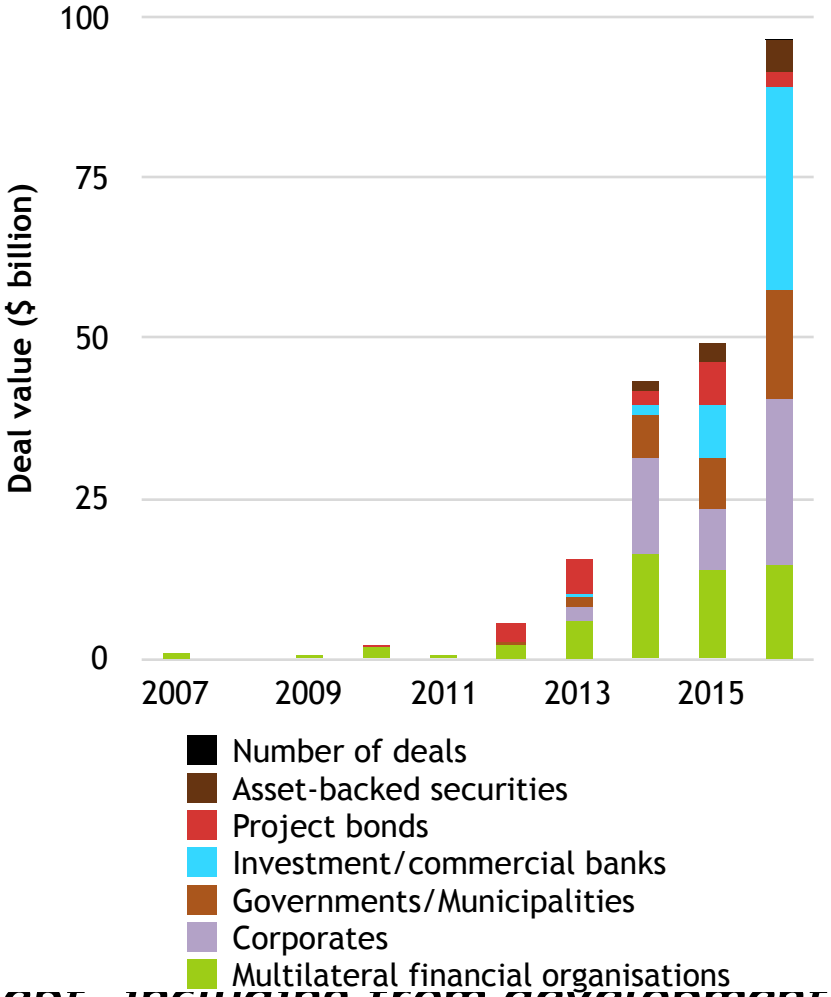
Diversified sources of finance playing a larger role

World Energy Investment 2016

Global sources of finance for new utility-scale renewable power



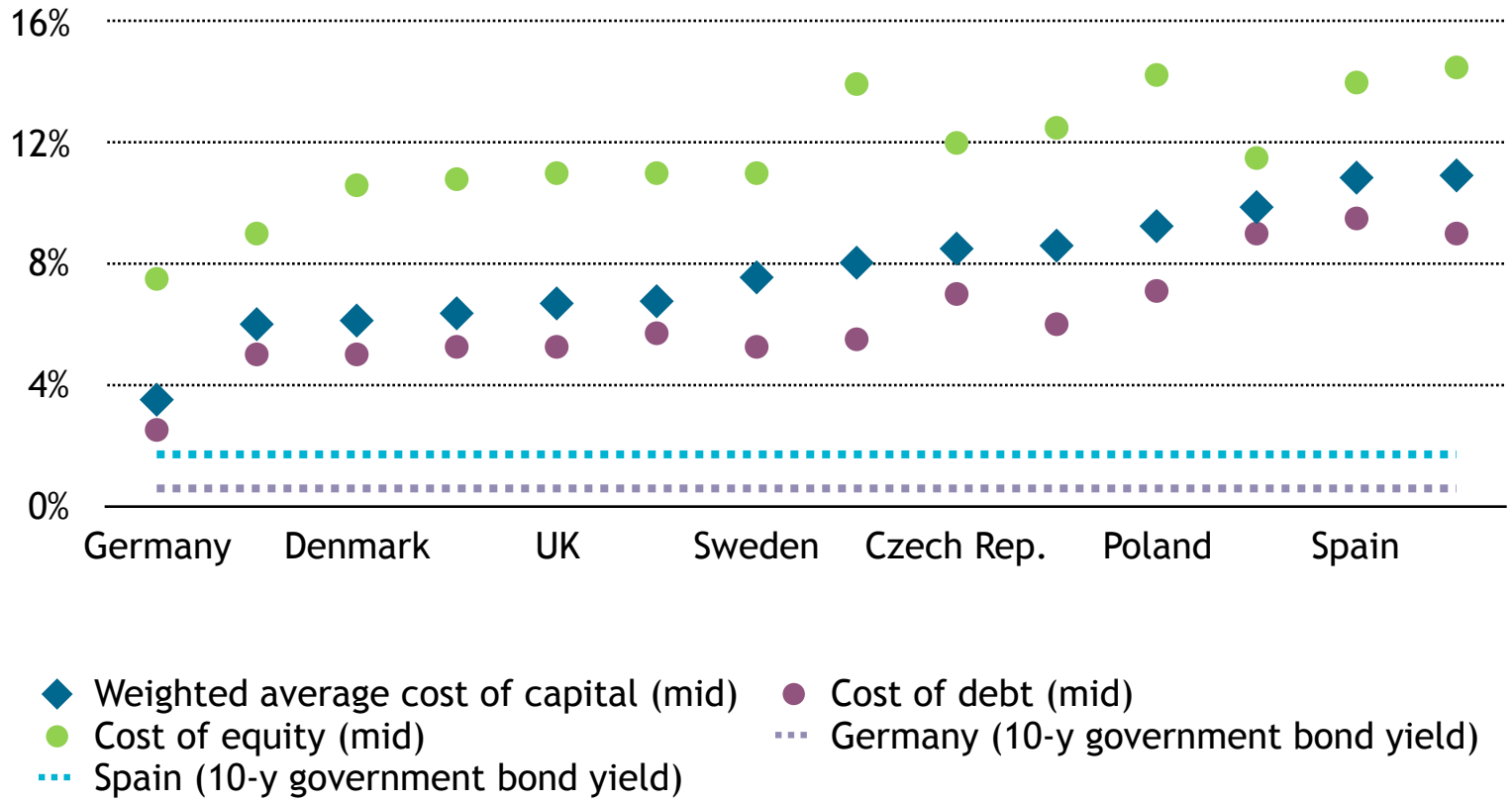
Global green bond issuance



Improved access to reduced cost debt, including from development institutions, will be a key to financing the transition.

Enabling environment can have a big impact on the cost of capital

Cost of capital estimates for onshore wind in Europe by country, 2015



Note: Midpoints are shown for reported equity and debt data. Weighted average cost of capital is calculated using country-specific debt/equity ratios and does not account for the tax-deductibility of interest on debt. Source: Cost of debt, cost of equity and debt/equity ratios adapted from DiaCore (2016), "The impact of risks in renewable energy investments and the role of smart policies". Bond yields from Bloomberg LP (2016) *Bloomberg Terminal*.

In addition to overall financing conditions, Europe cost of capital differences reflect policy design, progress in system integration and power market fundamentals

Enabling an electricity system of the future

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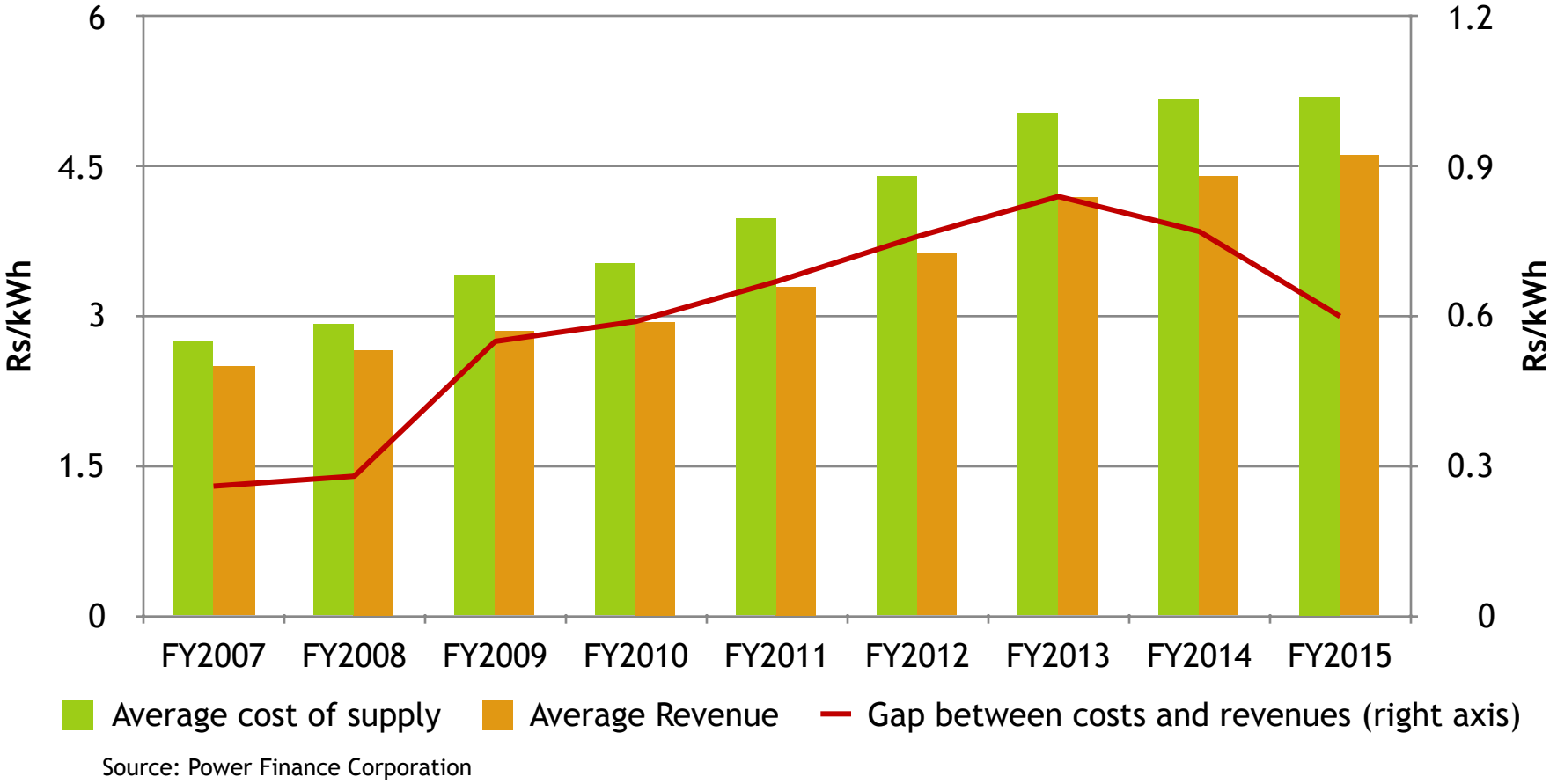
- Technology cost reductions have reshaped electricity business models, but best practices increasingly address the system value of low carbon generation.
- A robust electricity network will act as a key enabler supported by cost reflective tariffs - governments play a key role in investment for ensuring supply security.
- Reducing project risks and improving access to low cost debt financing will be important to spur greater private investment in generation and flexibility.
- An integrated policy approach is needed, covering market design, investment policies, CO_2 prices & system integration, including storage & demand response.
  - For markets with stable demand growth, measures include early retirement of surplus capacity incompatible with long-term goals and stronger interactions with heating and transport sectors and energy efficiency policies.
  - For emerging countries with rising demand, measures that facilitate financing and investment and the need for regulators to address system integration from the onset.

Backup

Cost reflective power system key to low carbon power transition

Average cost of supply, realized revenues and financial gap of Indian DISCOMs



Source: Power Finance Corporation

Distribution companies have been challenged to procure power to be sold at loss, with reduced off-take and delayed payments. Policy reforms are starting to ease the situation.

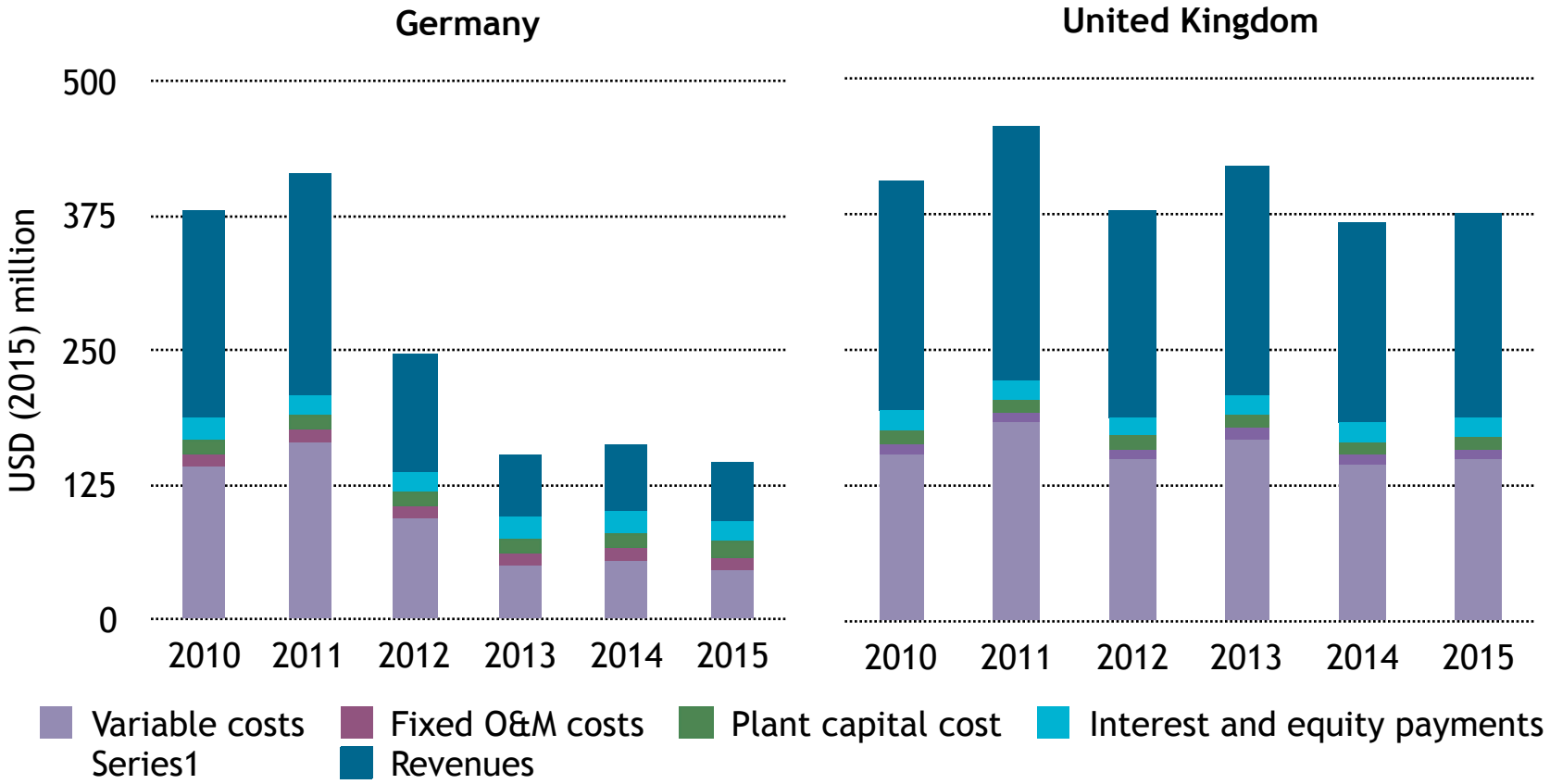
Enabling conditions for corporate procurement of renewables

Select market and policy enablers for corporate renewable power procurement

	Enabler	Brazil	China	India	Indonesia	Japan	Mexico	United Kingdom	United States
Offsite projects	Ownership	🟢	🟢	🟢	🟡	🟢	🟢	🟢	🟢
	Third party contracting	🟡	🟡	🟡	🟡	🟢	🟡	🟢	🟡
	Grid power wheeling & banking	🟡	🟡	🟡	🟡	🟡	🟢	🟢	🟡
	Unbundled attributes & power price	🟡	🔴	🟡	🔴	🔴	🟢	🟢	🟢
	Utility green tariff offering	🔴	🔴	🔴	🔴	🟡	🔴	🟢	🟡
Onsite projects	Ownership + self generate	🟢	🟢	🟢	🟡	🟢	🟢	🟢	🟢
	Third party contracting	🟡	🟡	🟡	🔴	🟢	🟢	🟢	🟡
	Valuation for grid injections	🟡	🟡	🟡	🟡	🟢	🟢	🟢	🟡

Investment uncertainties have risen for flexible thermal generation in some competitive markets

Capital cost recovery for a new gas-fired power plant in Europe



In Europe and some US regions, stagnant demand with rising renewables has increased risks for all generators of market revenues not covering full generation cost

High nuclear investment in 2016, but slowing new construction

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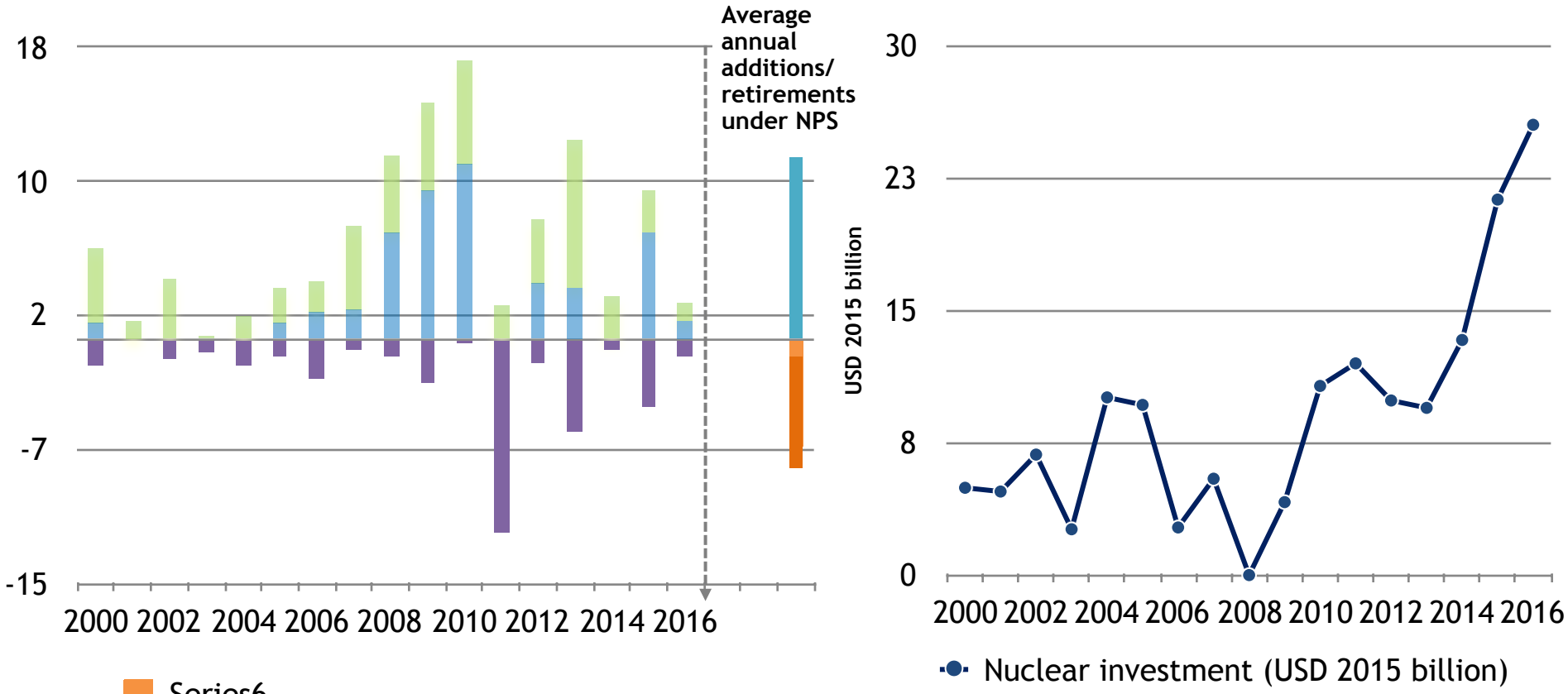
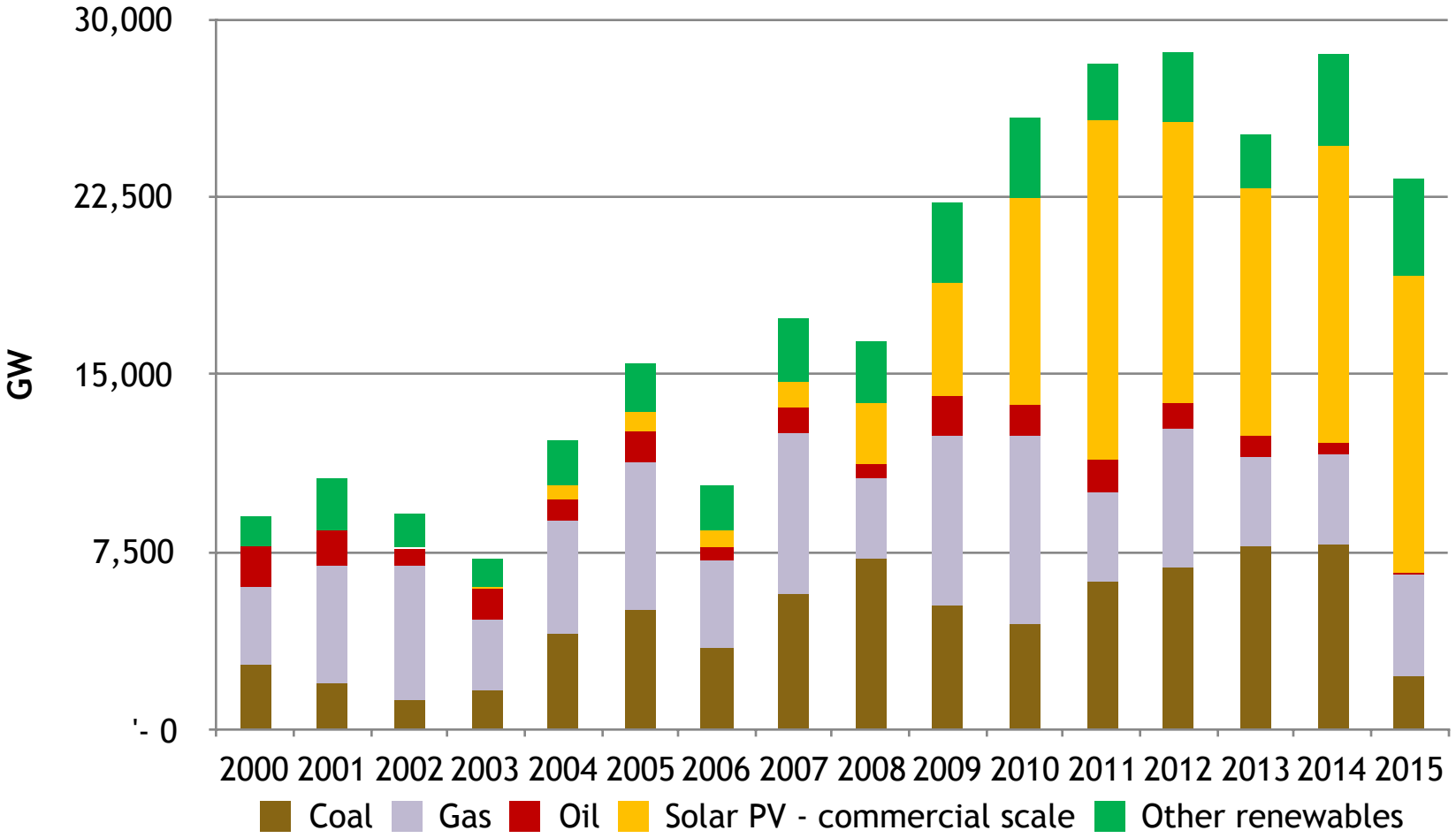
Nuclear construction starts, shutdowns, and annual investment



Nuclear expansion, accounting for retirements, is not at the pace needed for adequacy and climate change goals, with persistent economic and

Commercial and industrial consumers have long been a major source of power investment

Power capacity additions serving commercial and industrial applications



Over one-fifth of fossil fuel generation investment in 2015 was for self consumption, led by heavy industry seeking reliable sources to match