The new global dynamics for coal

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Chief Executive

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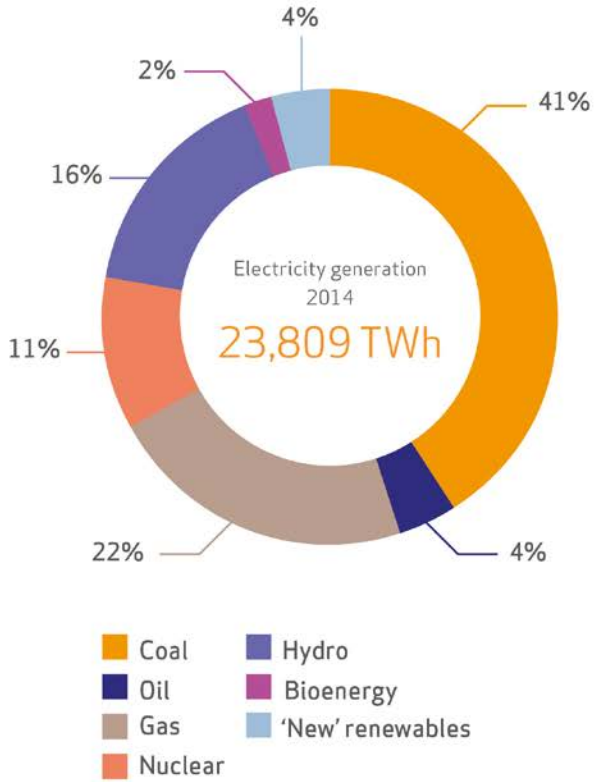
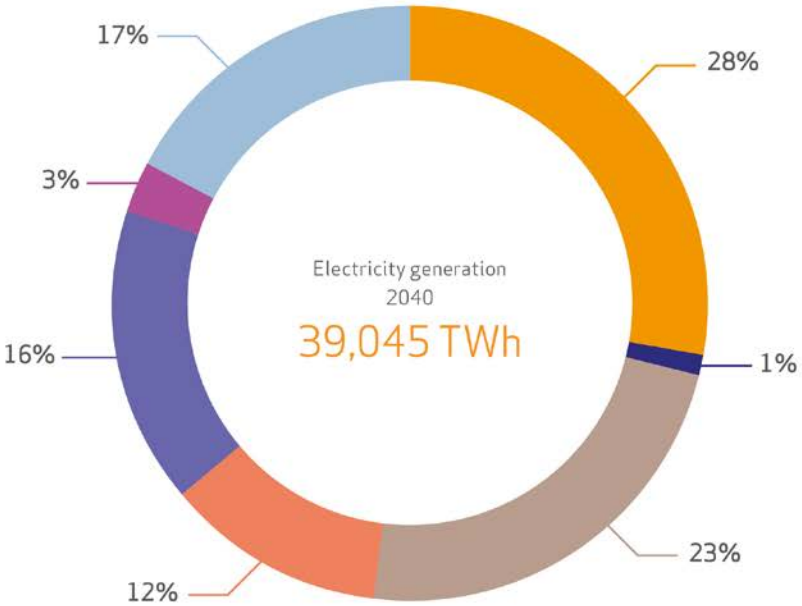
As electricity changes, coal retains an edge

Global electricity mix





Source: International Energy Agency, World Energy Outlook 2016

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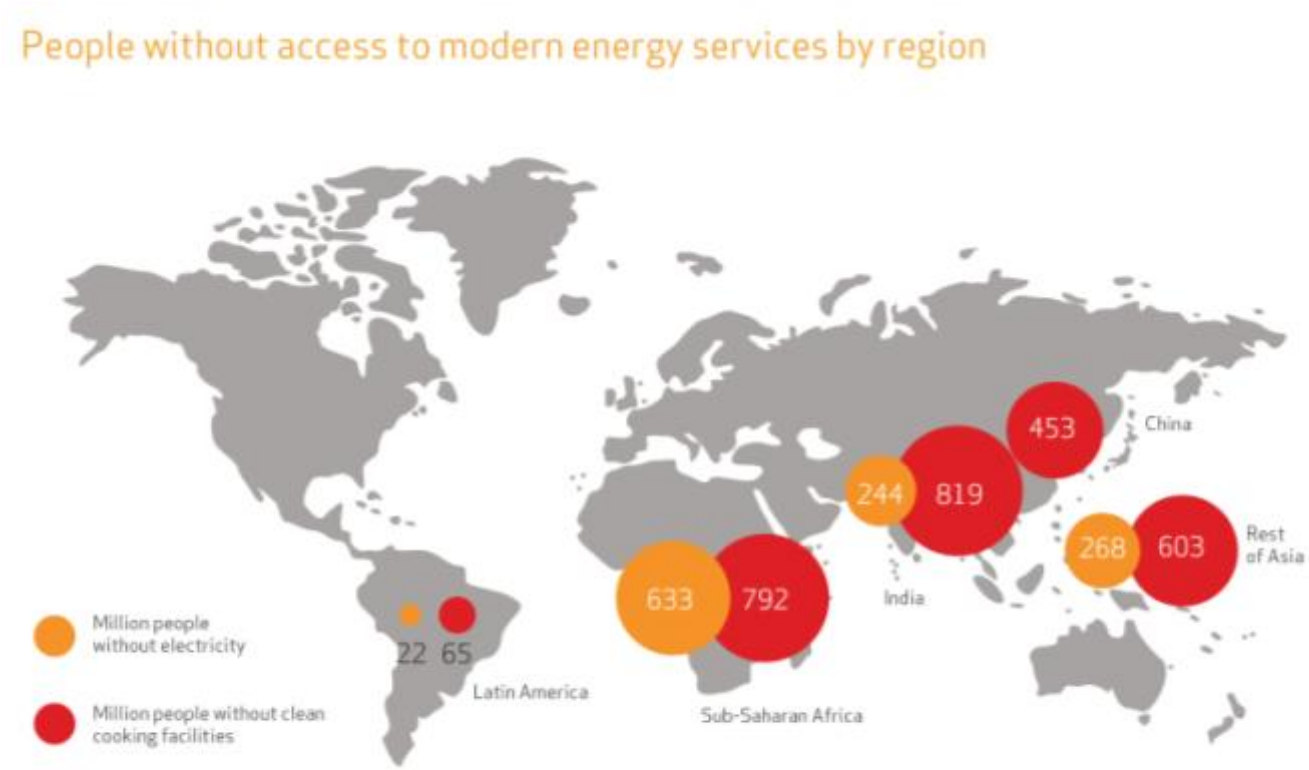
1.2 billion people live without access to electricity

- 1.2 billion people worldwide live without access to electricity
- 2.7 billion rely on traditional fuels for cooking



Source: International Energy Agency, World Energy Outlook 2016

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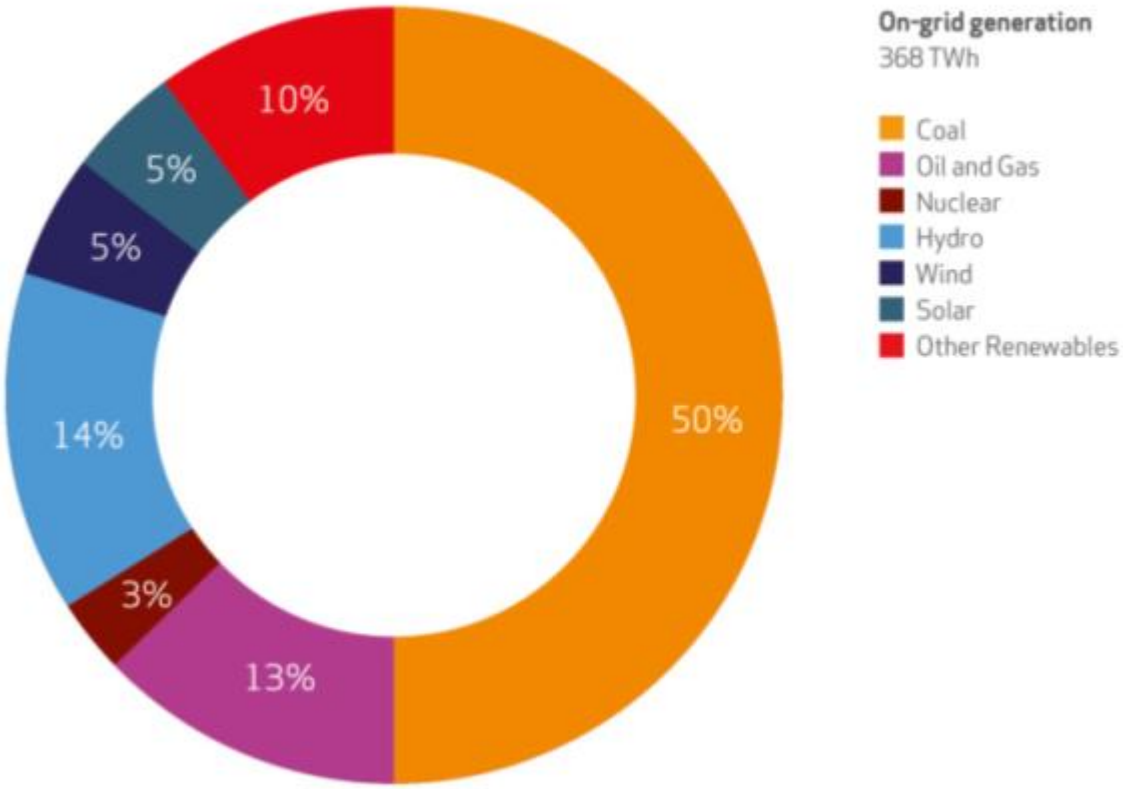
Coal is key in addressing global energy poverty

Additional on-grid electricity generation by fuel in the "Energy for All Case" compared with the New Policies Scenario, 2030



Source: World Energy Outlook, 2011

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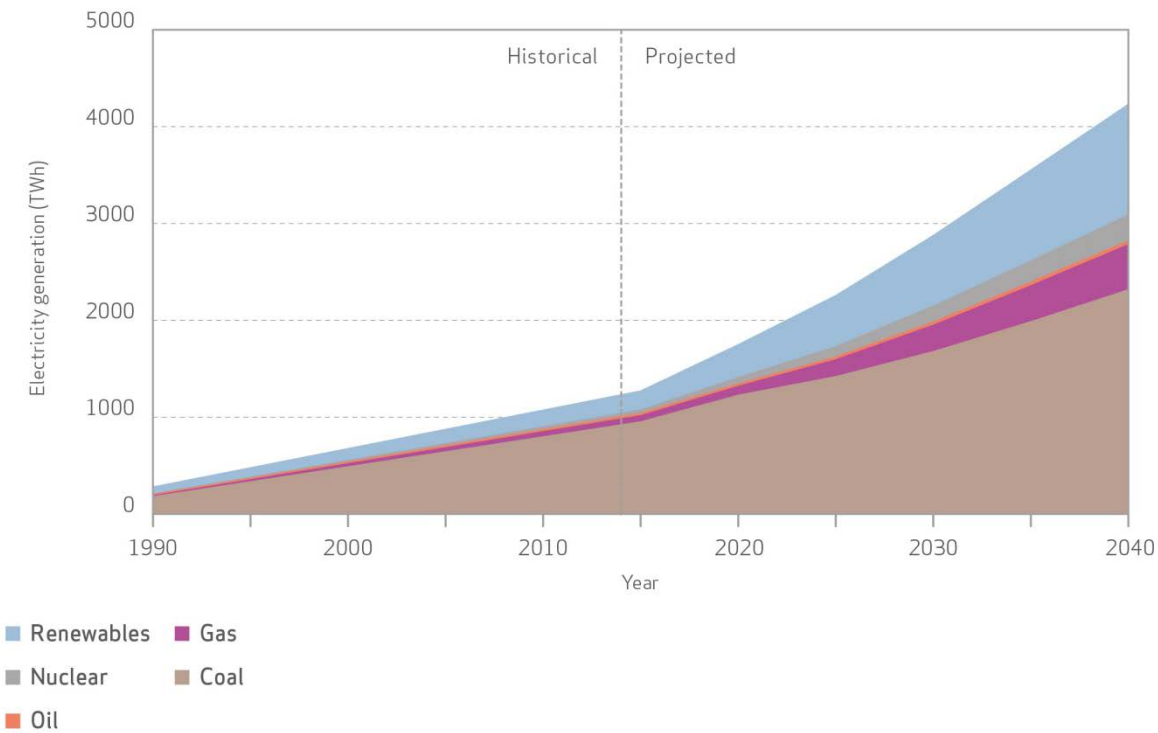
Coal will drive India's economic growth…

- Electricity demand in India is expected to average 4.4% pa over the next 25 years
- Coal generation capacity more than doubles, while renewables also increase significantly to meet demand
- IEA indicates that maintaining an adequate electricity supply represents a significant investment challenge requiring $2 trillion (in 2013 dollars)

India's electricity generation by source in the New Policies Scenario



Source: International Energy Agency, World Energy Outlook 2016

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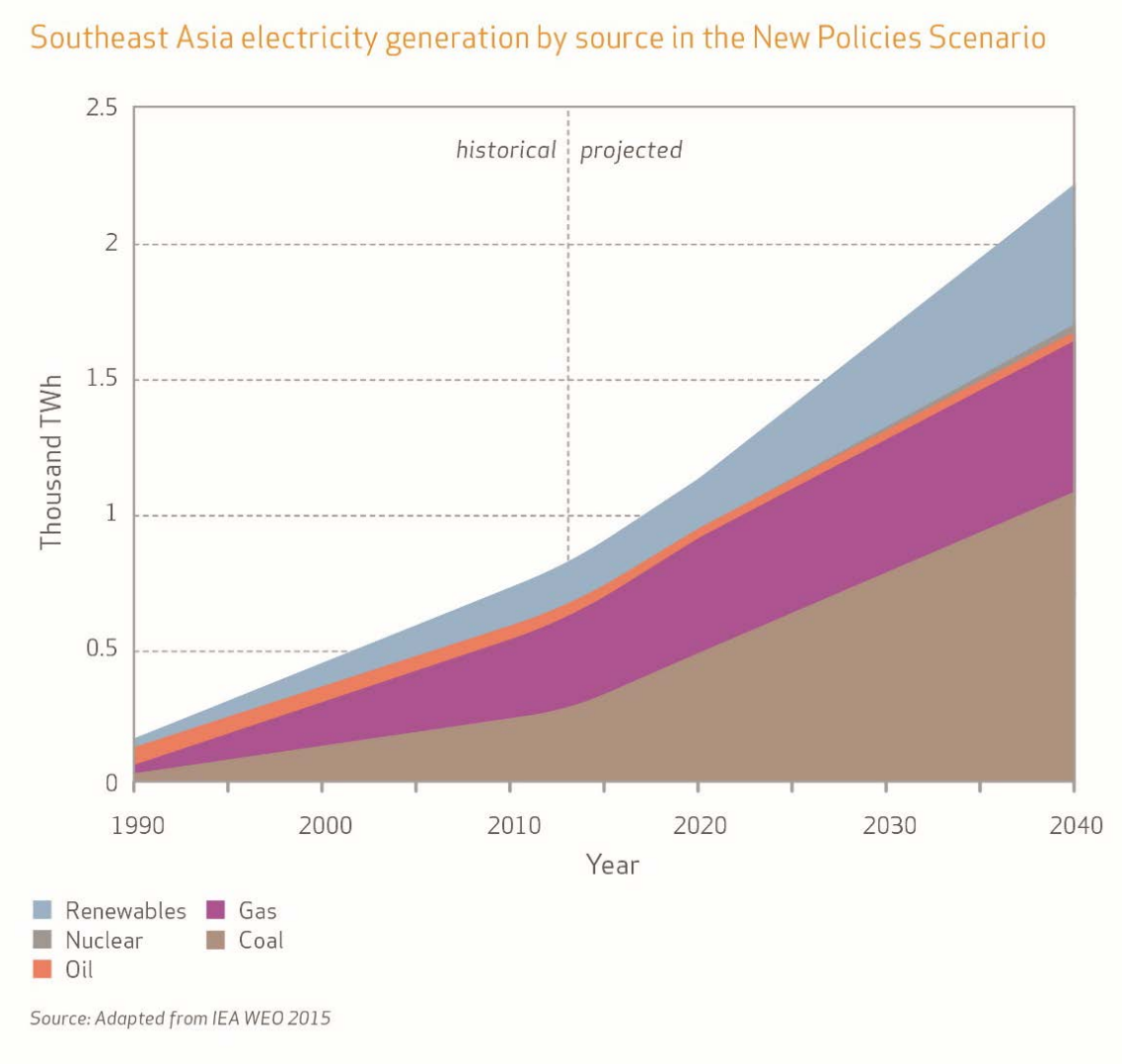
… and will be critical in powering up SE Asia

- The share of coal in power generation rises from 32% to 50%
- Renewables-based electricity generation increases three and half times from today to 2040 (481 TWh)
- IEA highlights $2.4 trillion investment is required over the period to 2040. This represents around 5% of the global total, or one-third of China's investment



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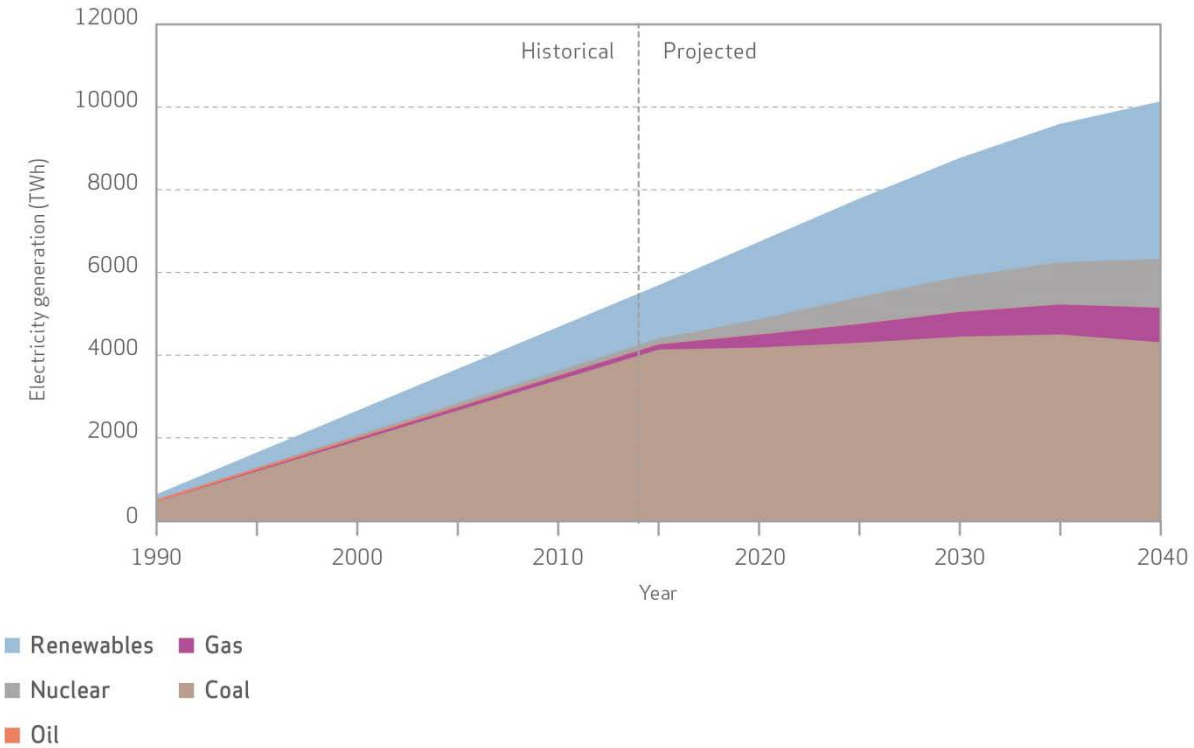
Coal will be critical to China for decades

- China's electricity demand growth will be around 4.8% to 2020, then decline to around 2% through to 2040
- Electricity generation from coal will be 4.3% higher in 2040, despite its share of generation reducing from 73% to 43%
- Non-hydro renewables are expected to increase 1200% over the same period (25% of world generation)

China's electricity generation by source in the New Policies Scenario



Source: International Energy Agency, World Energy Outlook 2016

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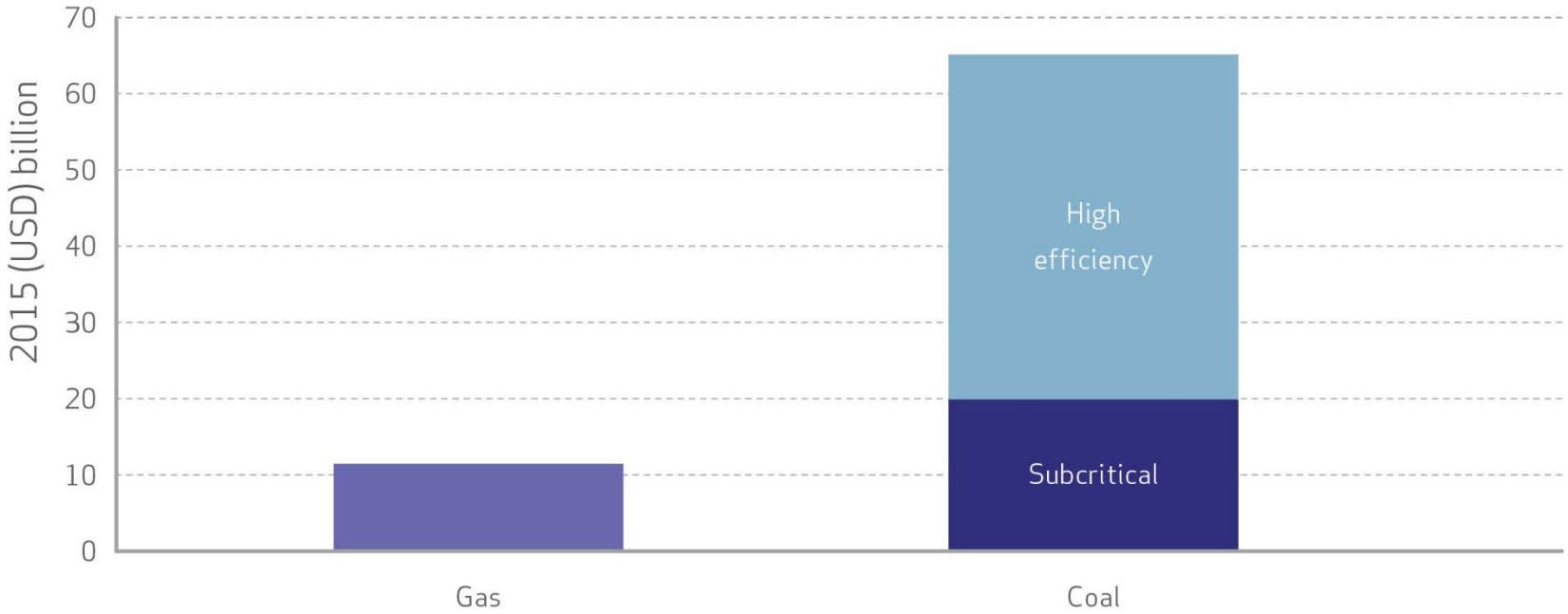
Coal, not gas, leads the charge in Asia…

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



Source: IEA World Energy Outlook 2016

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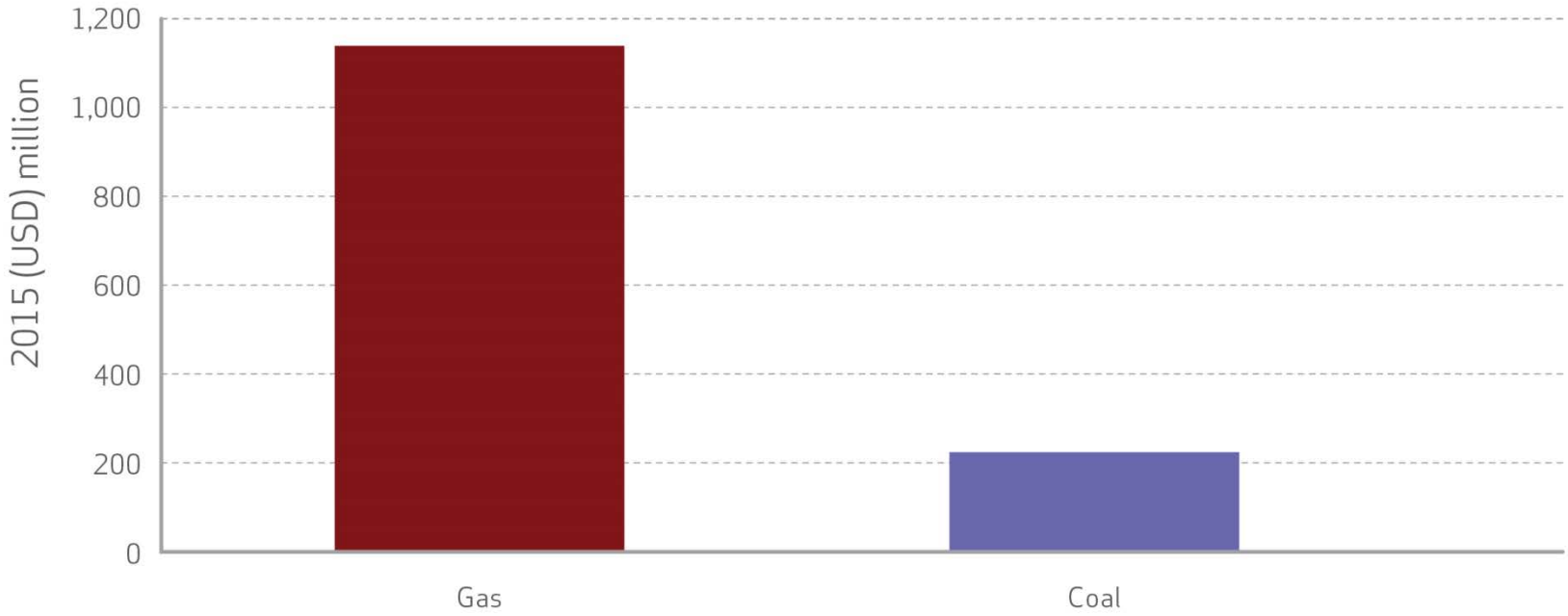
… because its costs are far lower

Infrastructure investment cost for a 1 GW power plant in Asia



Source: IEA World Energy Outlook 2016

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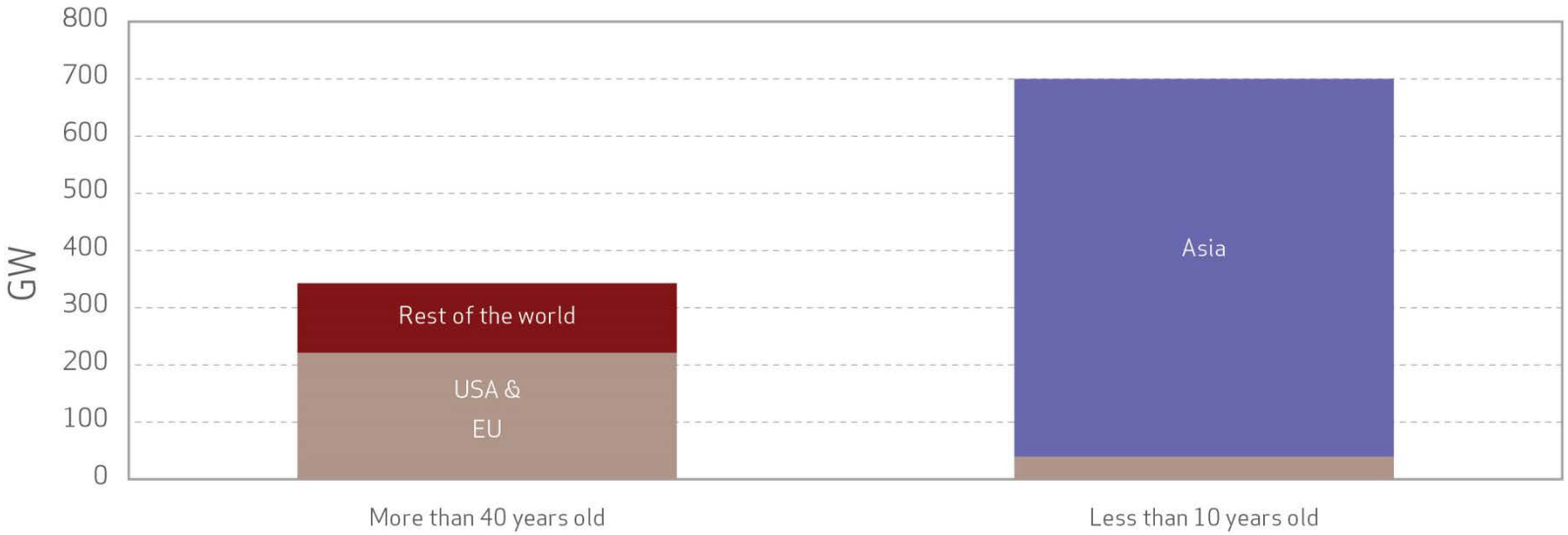
So the global coal fleet is at its youngest in decades

Age of coal plants globally



Source: International Energy Agency, Laszlo Varro, Chief Economist, 2016

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The Paris Agreement includes low emissions coal

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New technology dramatically reduces CO_2

For every

1%

efficiency improvement

we get

2-3%

reduction in CO_2 emissions

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Efficiency improvements can significantly contribute to CO2 emission reductions

- The most important near-term action to reduce CO2 emissions is to increase the efficiency of coal-fired power plants
- 1% increase LHV efficiency = 2–3% points decrease in CO2 emissions

Source: VGB PowerTech 2013

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Cleaner coal is real but needs more action

- Japan and China have been the most active in building USC plants
- J-Power upgraded their 1967 sub-critical Isogo 38% efficient coal-fired power plant to an USC 43% efficiency plant with SOx, NOx, PM reduced to less than 1/3 of previous levels
- China's Waigaoqiao plant has a capacity of 5,000MW and China is relying on these larger, advanced units for dispatch to displace higher emission from older, less efficient power stations
- The units have integrated advanced air quality control systems, yielding non-carbon air emissions well below China's latest more stringent standards, and also below comparable standards in North America and Europe

Japan: Isogo Power Station – Ultra Supercritical Technology (Courtesy of J – Power)

China: Waigaoqiao No3 *Power Station, Pudong New Area of Shanghai – 500MW*

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WCA proposes the PACE concept to support HELE

A Global
Platform for
Accelerating
Coal
Efficiency

- International platform to help drive deployment of HELE technologies in developing and emerging economies
- Public private partnership
- Currently seeking partners to help build an initial alliance

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The potential impact of HELE is significant in a global context

Emission reductions by policies / actions, bn tonnes CO_2 equivalent

Policy / Action	Cumulative emissions	Period	Annual emissions*
Montreal protocol	135.0bn	1989-2013	5.6bn
Hydropower worldwide	2.8bn	2010	2.8bn
Nuclear power worldwide	2.2bn	2010	2.2bn
Increase average global efficiency of coal-fired power plants to 40%			2bn
China one-child policy	1.3bn	2005	1.3bn
Other renewables worldwide	600m	2010	600m
US vehicle emissions & fuel economy standards†	6.0bn	2012-2025	460m
Brazil forest preservation	3.2bn	2005-2013	400m
India land-use change	177m	2007	177m
Clean Development Mechanism	1.5bn	2004-2014	150m
Collapse of USSR	709m	1992-1998	118m
Global Environment Facility	2.3bn	1991-2014	100m
EU energy efficiency	230m	2008-2012	58m
EU renewables	117m	2008-2012	29m

* Annual emissions are cumulative emissions divided by the relevant period.
The estimate for the current emissions avoided under the Montreal protocol is eight billion tonnes of CO_2e.
The annual figure for the collapse of the USSR refers to the years 1992-1998. †Cars and light trucks

Sources: The Economist 2014 and International Energy Agency 2013

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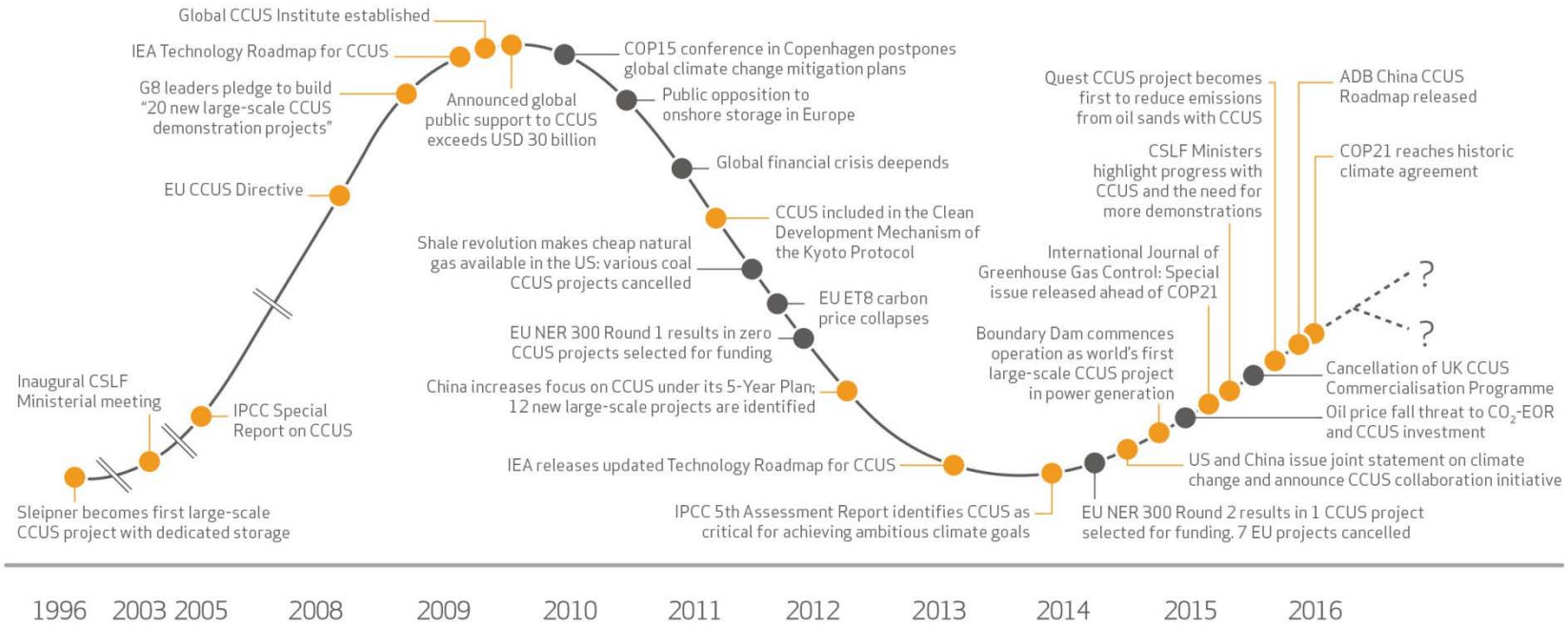
CCS has faced a tumultuous policy environment

Fluctuating policy and political support for CCS



Source: IEA (2016), 20 years of Carbon Capture and Storage: Accelerating Future Deployment. Figure adapted from SBC Energy Institute (2016), Low Carbon Energy Technologies Fact Book Update: Carbon Capture and Storage at a Crossroads.

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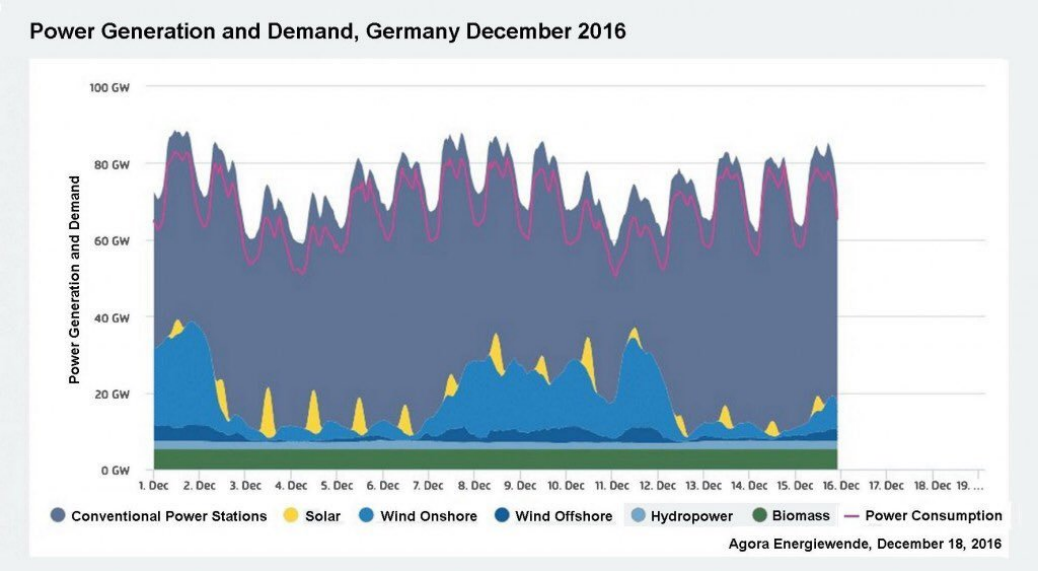
There are real challenges to high renewable penetration



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ASEAN's Energy Equation

- 'Coal and Cleaner Coal Technologies' (CCT) were identified as a key programme area in APAEC 2016 – 2025
- **'ASEAN Energy Equation'** provides a comprehensive analysis of the energy security and sustainable development opportunities that CCT provide

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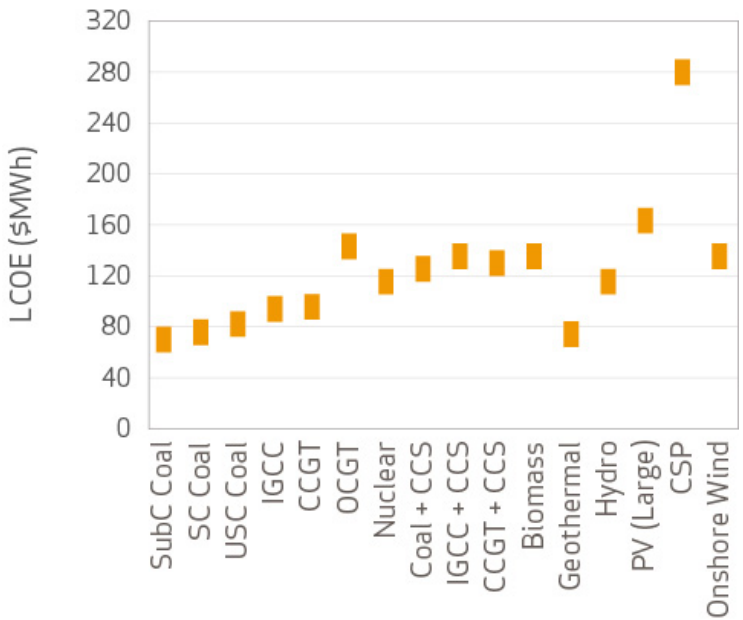
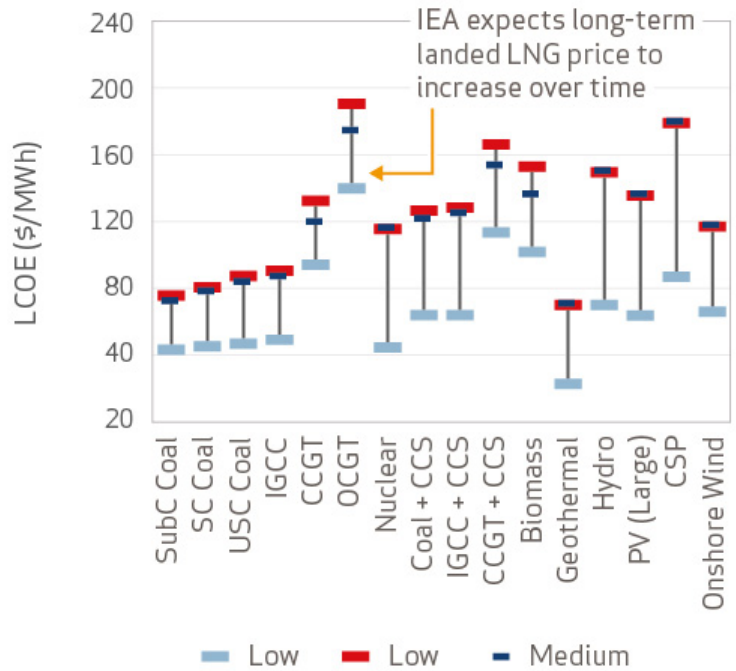
Cleaner coal is the lowest cost option among the low-carbon technologies

ASEAN Average
2020 Commercial Operation



ASEAN Average
2035 (No CO_2 Price Assumed)



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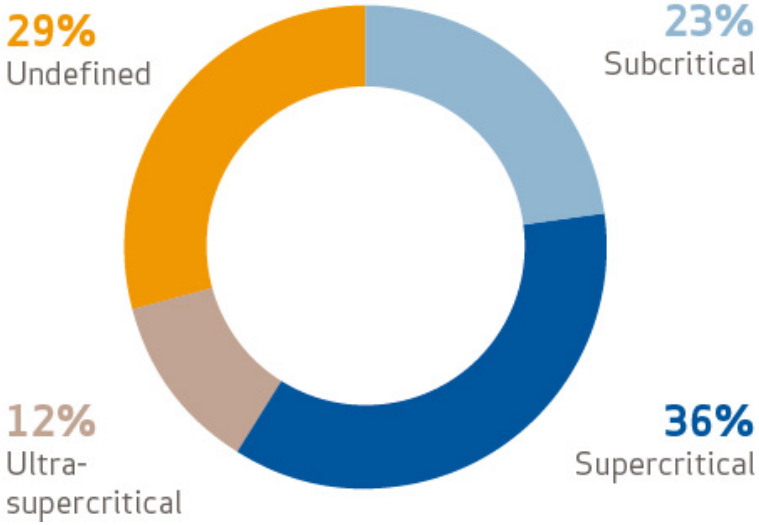
Improving coal efficiency delivers cost benefits locally and emissions reductions globally

ASEAN
Under Construction and Planned Coal Fired Capacity (80GW)



- Promoting HELE deployment across ASEAN would result in significant carbon emissions reduction to global benefit.
- Shifting the region's forecast coal capacity in 2035 from the current mix to ultra-supercritical would reduce cumulative emissions by 1.3 billion tonnes.
- <u>This is an equivalent reduction of –</u>
  - The yearly emissions from China, United States and the EU (top three CO_2 contributors), or
  - Three years of international shipping, or
  - More than four years of international aviation

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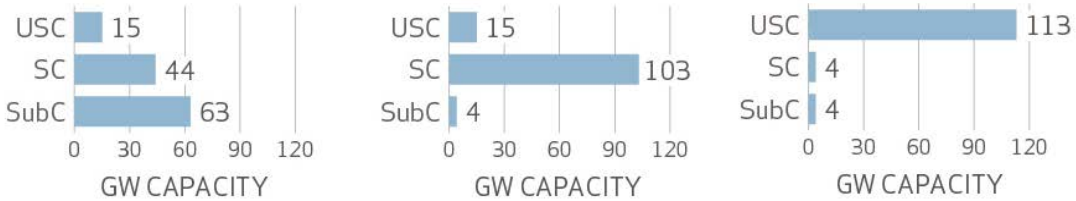
Mobilising finance will be an important factor in realising this outcome…

	Mix per current pipeline	Shift to Supercritical	Shift to Ultra-supercritical
Scenario Description	Total installed coal capacity by 2035 based on IEA SEA-EO[1] projections with linear extrapolation between current pipeline of projects as reported by the Platts WEPD[2] (percentage of subcritical capacity through 2035 based on current pipeline)	Shift capacity from subcritical to supercritical except plant that are under construction or planned subcritical plant with capacity lower than 300 MW	Shift all capacity from supercritical in the previous scenario to ultra-supercritical

Capacity Mix[3]



NPV[4] Capital Costs[5] ($ Billion)
(from 2016 through 2040)

$89 Billion → $96 Billion → $108 Billion

Additional $19 billion required to shift to ultra-supercritical

CO_2 Emissions (tCO_2)
(Cumulative from 2016 through 2040, undiscounted)

8.9 Billion → 8.1 Billion → 7.5 Billion

Additional funding can reduce carbon emissions by 1.3 billion tons

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...The benefits are significant

Scenario	Capacity mix[1]	CO_2 emissions (tCO_2) (over 40 years)	CO_2 abated equivalent to: Subcritical plant closure[2]	Number of new wind turbines[3]	Cars removed from the road[4]
Mix per development pipeline	USC 15, SC 44, SubC 63 (GW CAPACITY)	22.8 Billion			
Shift to Supercritical	USC 15, SC 103, SubC 4 (GW CAPACITY)	20.8 Billion	20	15,000	96 million
Shift to Ultra-Supercritical	USC 113, SC 4, SubC 4 (GW CAPACITY)	19.5 Billion	32	25,000	157 million

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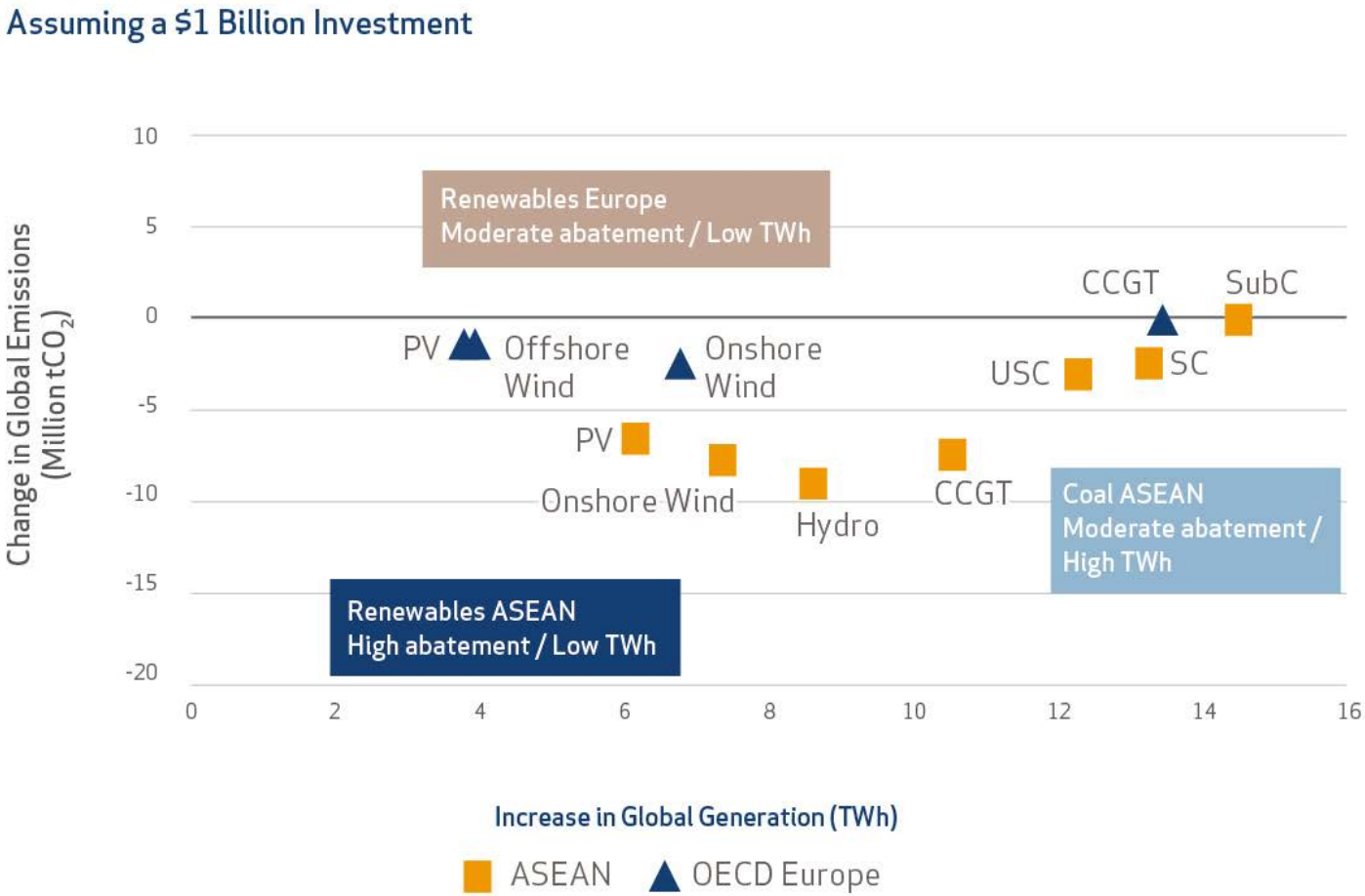
Investment to ensure an efficient coal fleet in Southeast Asia is vital for global climate ambitions



Enhanced investment in coal to improve efficiency is arguably one the most effective mitigation actions available

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WCA encourages ASEAN Member States to adopt 'ASEAN's Energy Equation's Call to Action'

1. Statement emphasising continued commitment to the deployment of cleaner coal technologies
2. With necessary support from partners, member states commit to enhanced action, ultimately leading to a pledge to end the use of subcritical coal (where feasible)
3. Calling on the international community to provide support for cleaner coal technology deployment

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