Coal for the 21st Century

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Why does the world need coal?

- Coal currently used for:
  - 41% of global electricity
  - 70% of all steel produced
  - 90% of cement manufactured
  - also used in refineries, paper manufacture and many chemicals

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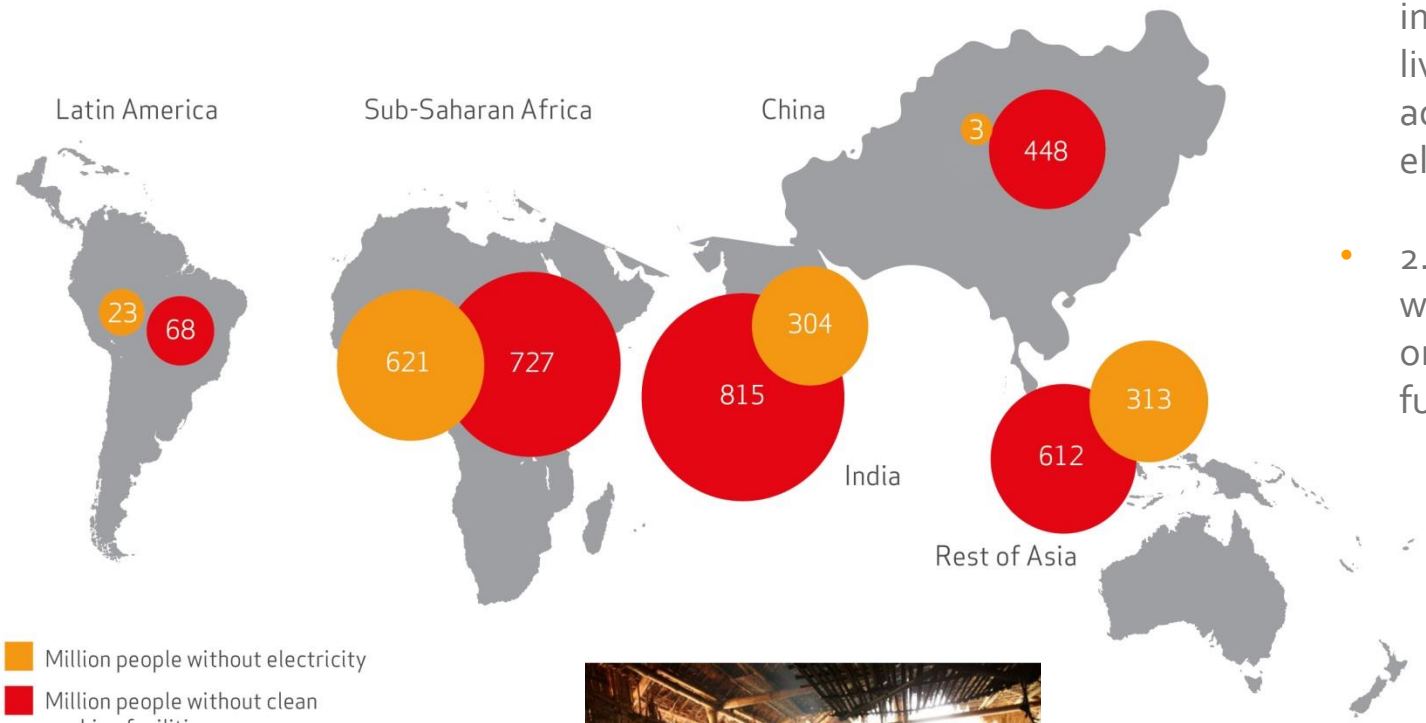
20% of the world population has no electricity

People without access to modern energy services by region



Million people without electricity

Million people without clean cooking facilities

Source: World Energy Outlook 2012

- 1.3 billion people in the world who live without access to electricity
- 2.7 billion (38% world) who rely on traditional fuels for cooking

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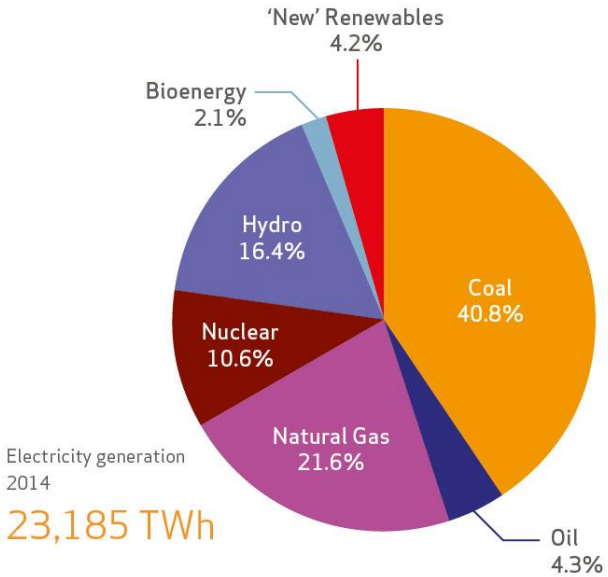
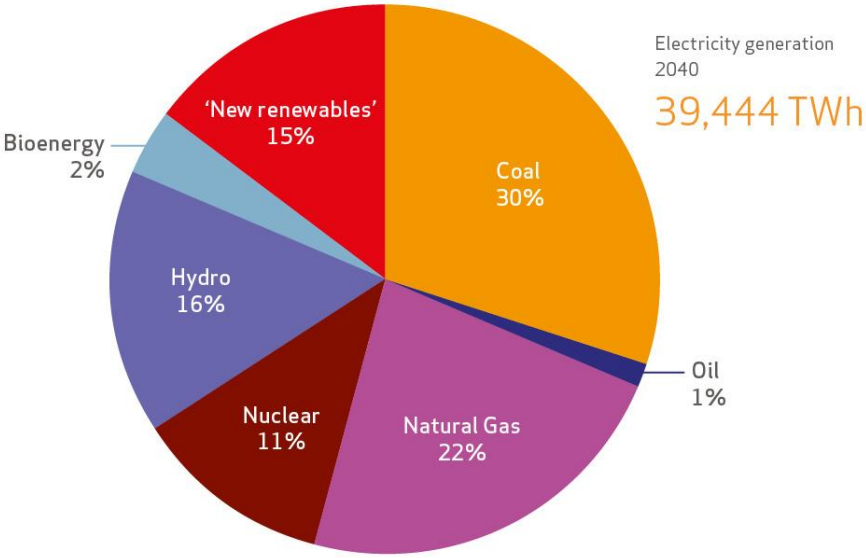
Coal continues to grow, even as share declines

Global electricity mix





Source: IEA WEO2015 New Policies Scenario and 2016 Key Electricity Trends

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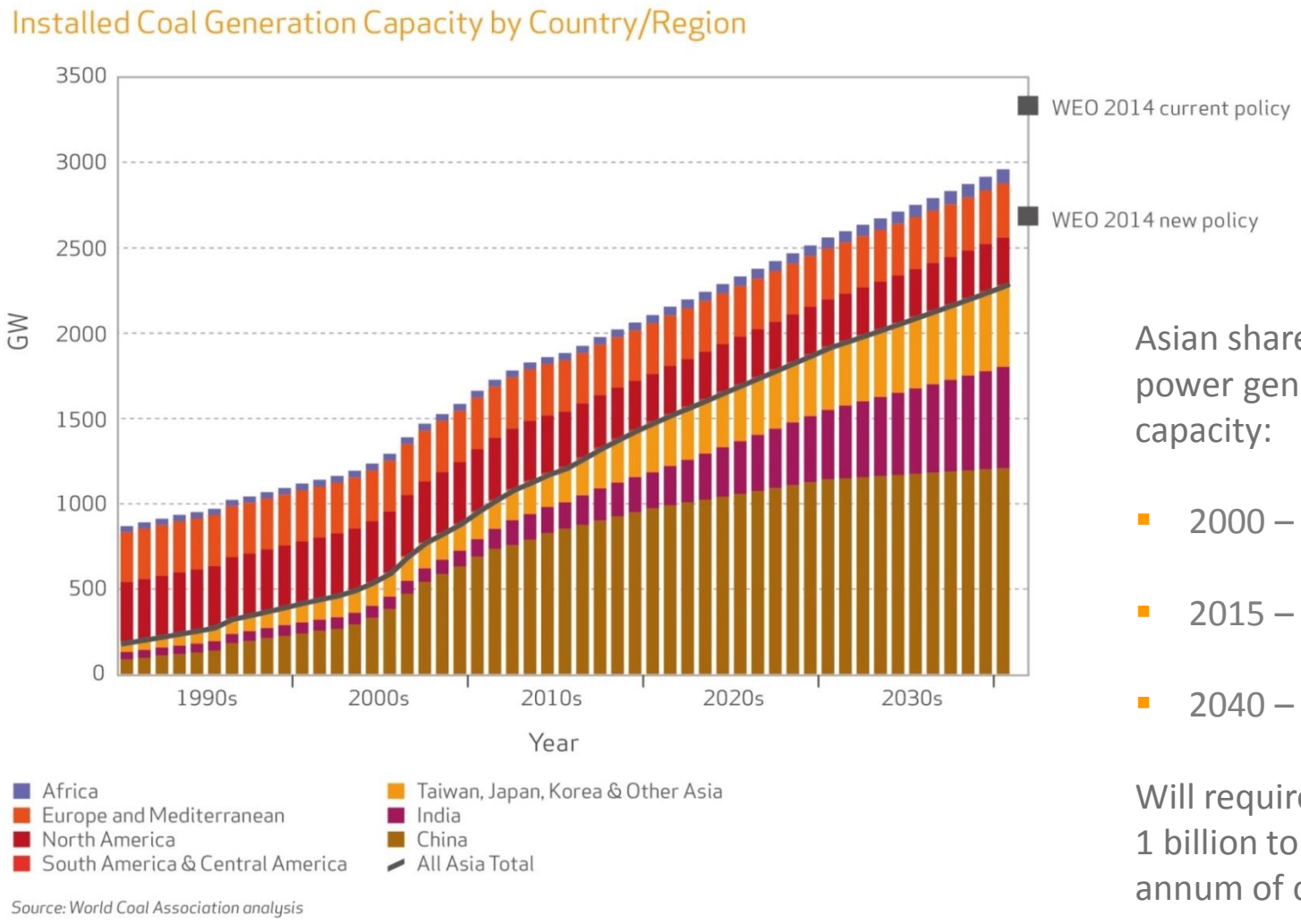
Asia will drive new coal generation capacity



Asian share of global coal power generation capacity:

- 2000 – 38%
- 2015 – 69%
- 2040 – 77%

Will require an additional 1 billion tonnes per annum of coal

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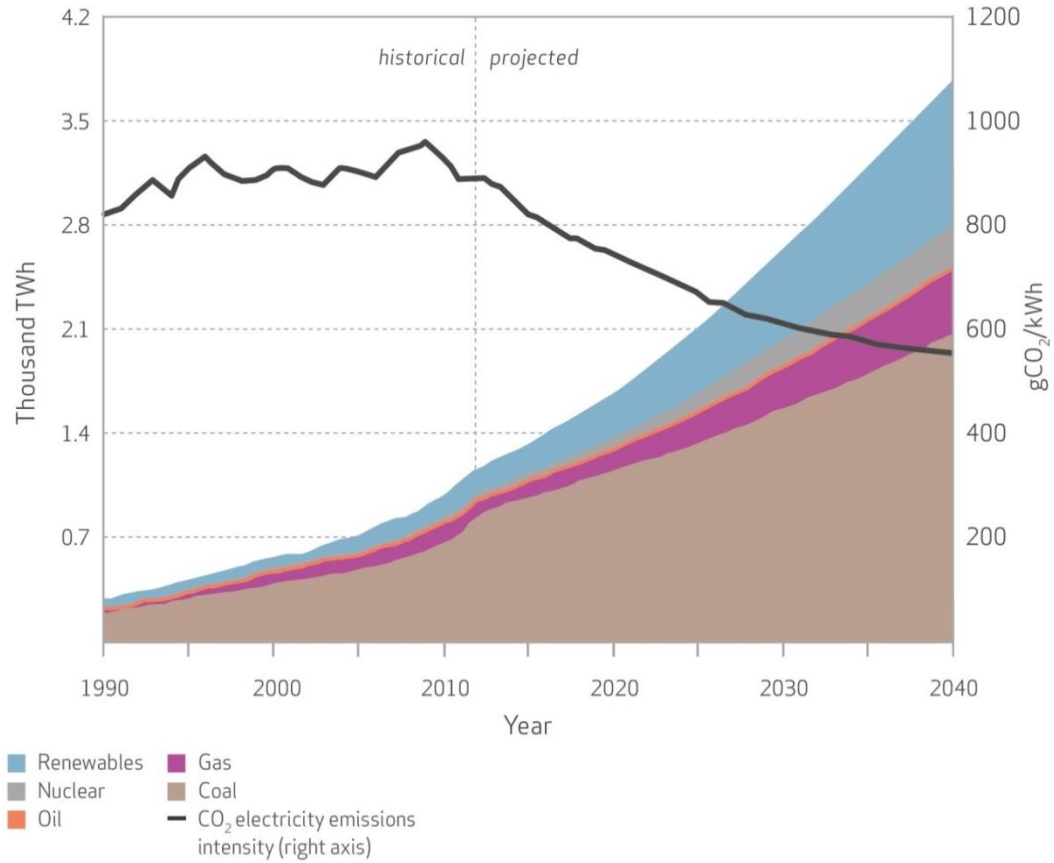
Large-scale power generation will be a critical enabler of growth in India

- Electricity demand in India is expected to average 4.4% pa over the next 25 years
- While coal generation capacity more than doubles, renewables are required to increase exponentially (non-hydro renewables over 10 times) 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 and CO_2 intensity in the New Policies Scenario



Source: IEA, WEO 2014

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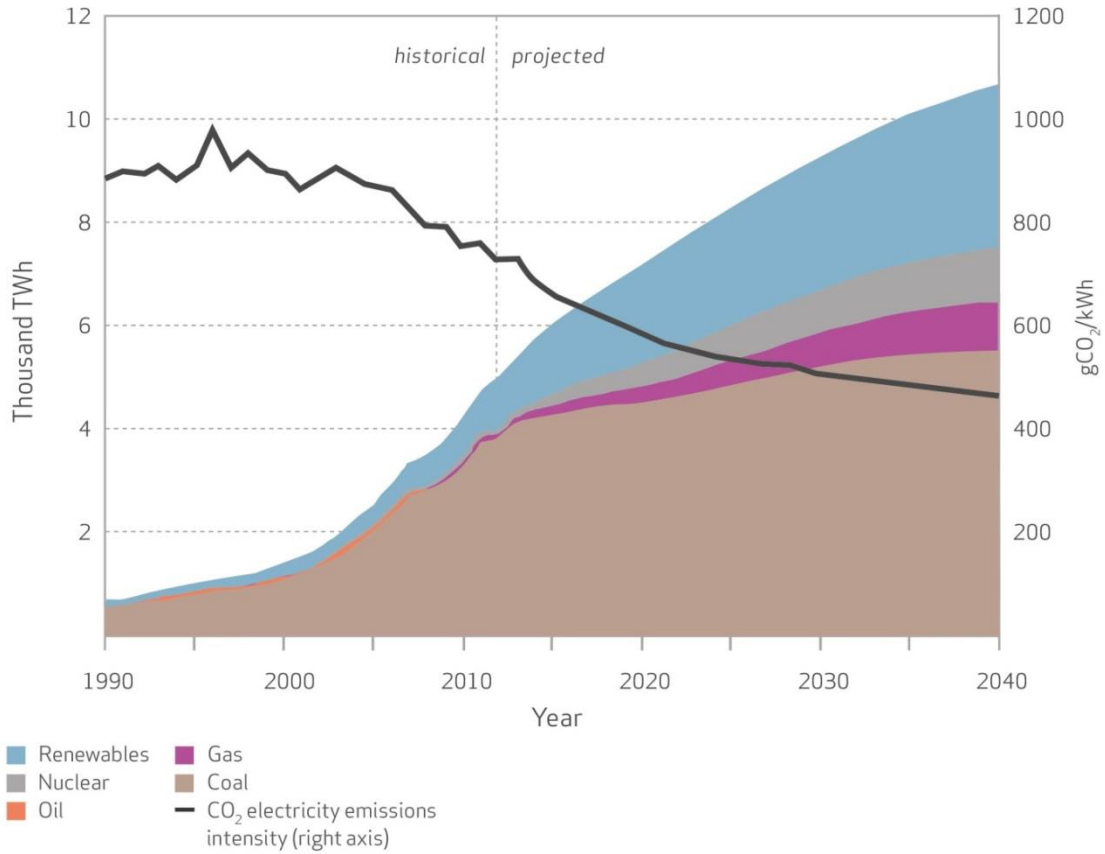
Coal will continue to play a big role in China

- 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 27% higher in 2040, despite its share of generation reducing from 75% to 49%
- Non-hydro renewables are expected to increase 1200% over the same period (25% of world generation)

China electricity generation by source and CO_2 intensity in the New Policies Scenario



Source: IEA, WEO 2014

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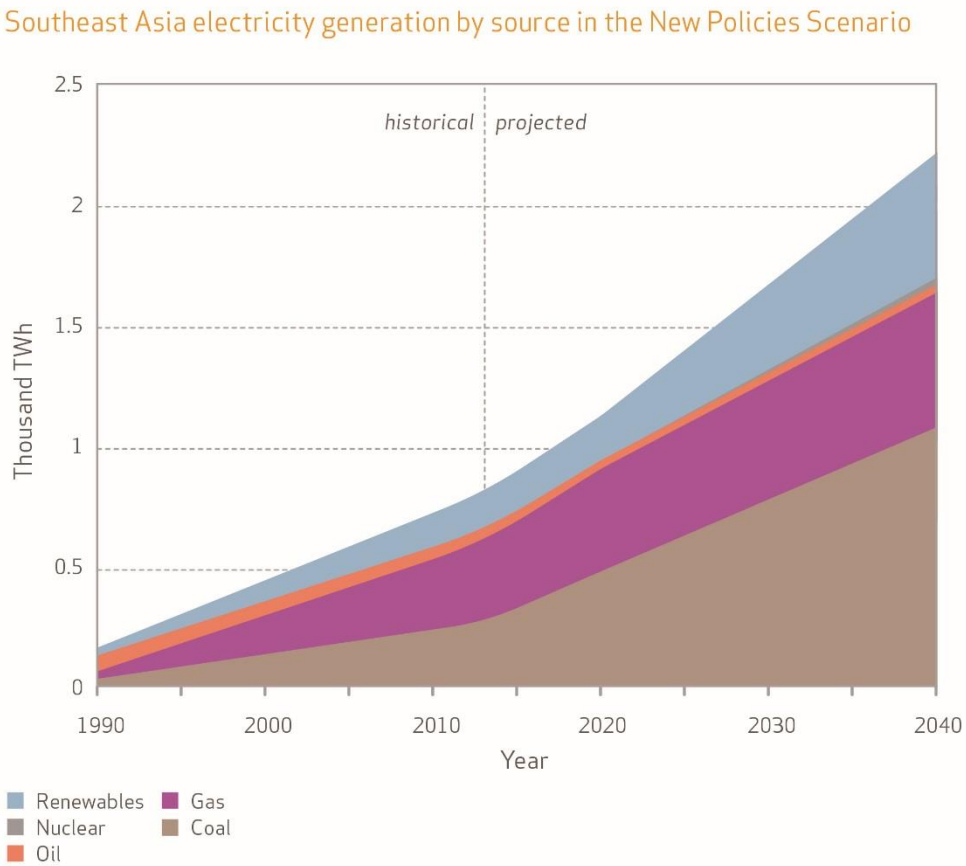
Coal will drive Southeast Asian energy

- Electricity demand almost triples over the period, to around 2 000 TWh in 2040, an increase bigger than current demand in India.
- 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 – requires $2.4 trillion investment over the period to 2040. This represents around 5% of the global total, or one-third of China's investment
- Southeast Asia will move from 46% to 60% urbanised by 2040, vs OECD 85%



Source: Adapted from IEA WEO 2015

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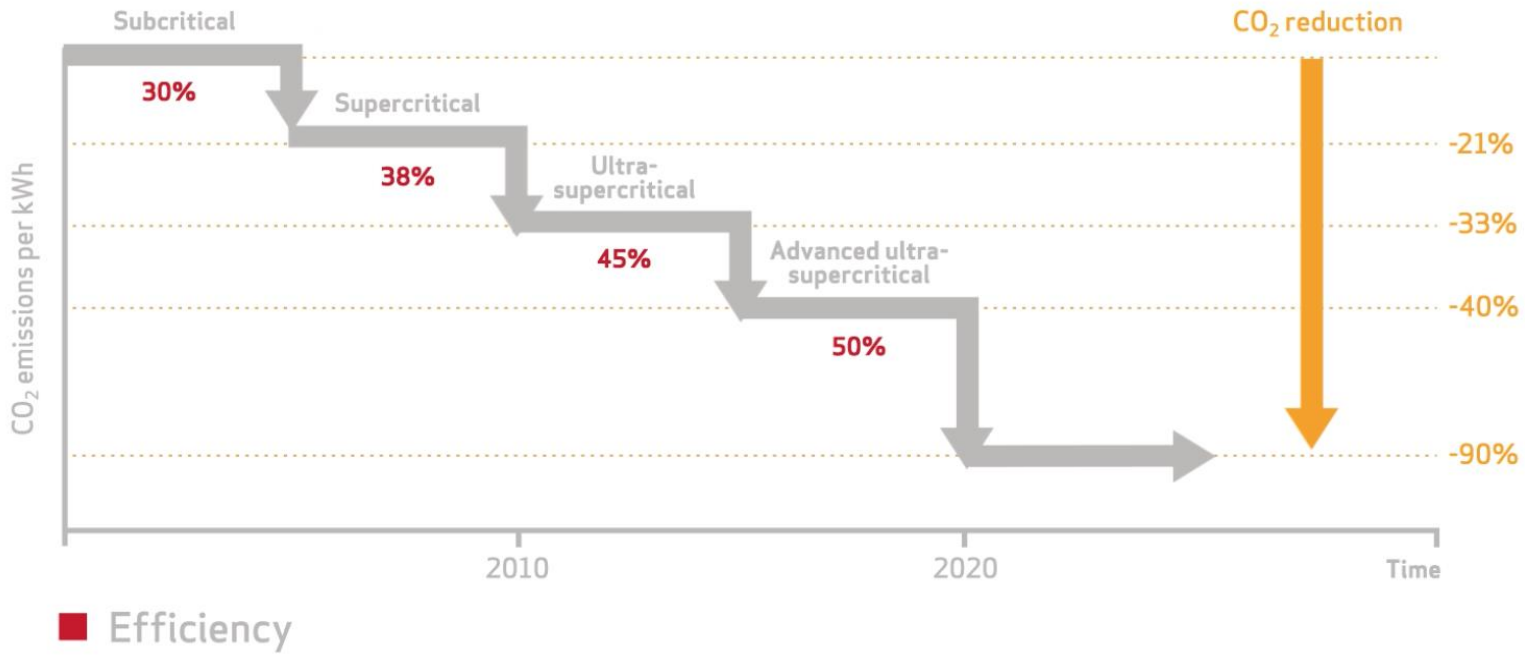
HELE technologies continue to develop

CO_2 reduction potential of coal-fired power plants by increased efficiency



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What is high efficiency low emissions coal?

Which are HELE technologies?

More efficient

Less efficient

	Efficiency rate*	CO_2 intensity	Coal consumption	Steam temperature
Advanced ultra-supercritical	**45-50%**	670-740g CO_2/kWh	290-320g/kWh	700°C+
Ultra-supercritical	**Up to 45%**	740-800g CO_2/kWh	320-340g/kWh	600°C+
Supercritical	**Up to 42%**	800-880g CO_2/kWh	340-380g/kWh	Approx. 550°C- 600°C
Subcritical	**Up to 38%**	≥880g CO_2/kWh	≥380g/kWh	<550°C

*Lower heating value

Source: Adapted from IEA, Technology Roadmaps, High-efficiency low-emissions coal-fired power generation, *2012*

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Higher efficiency reduces CO_2

For every

1%

efficiency improvement

we get

2-3%

reduction in CO_2 emissions

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HELE can become the global standard for coal

- 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 Ninghai plant has a capacity of 4,400MW 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

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WCA wants to see more action on HELE

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HELE is part of the Paris Agreement

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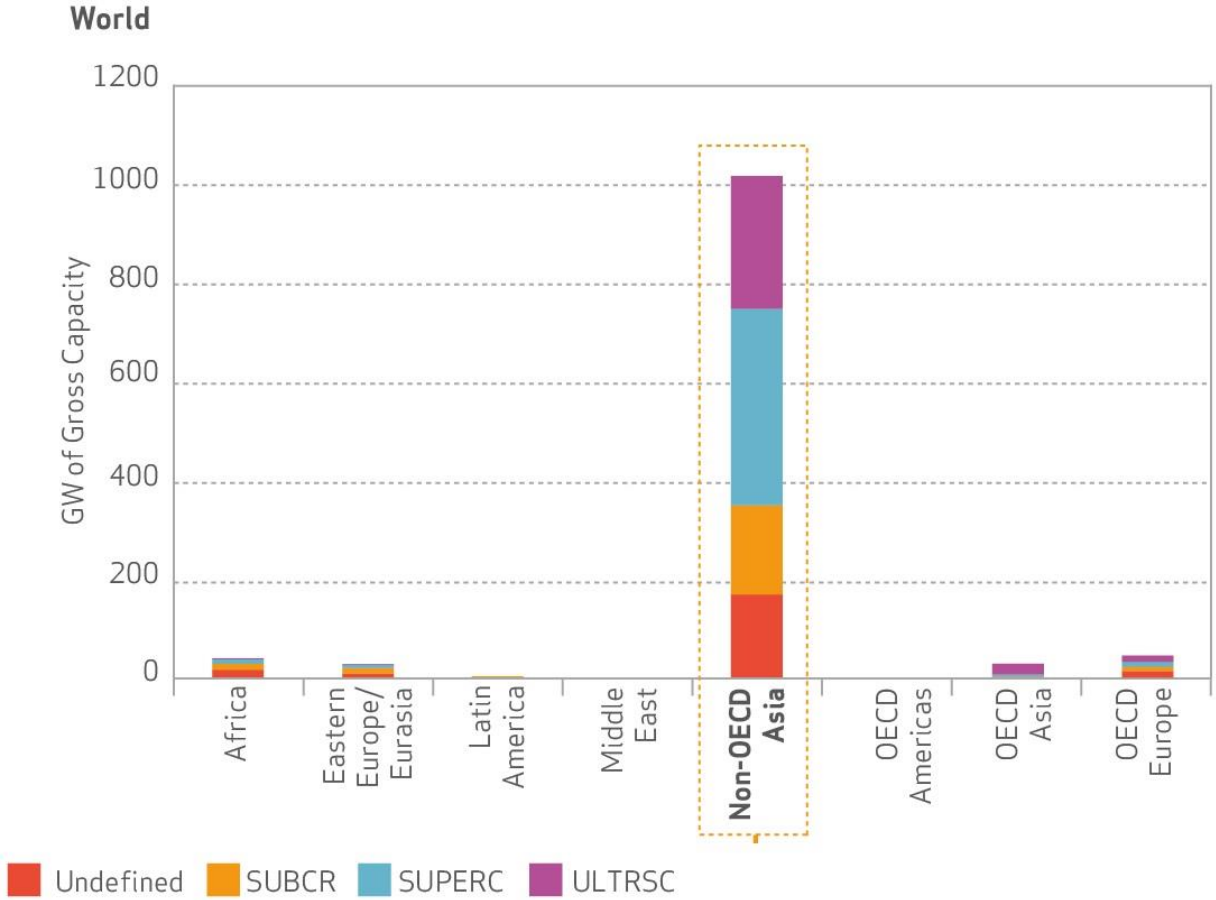
Coal plant development mix of HELE and not



Source: World Coal Association analysis, 2015

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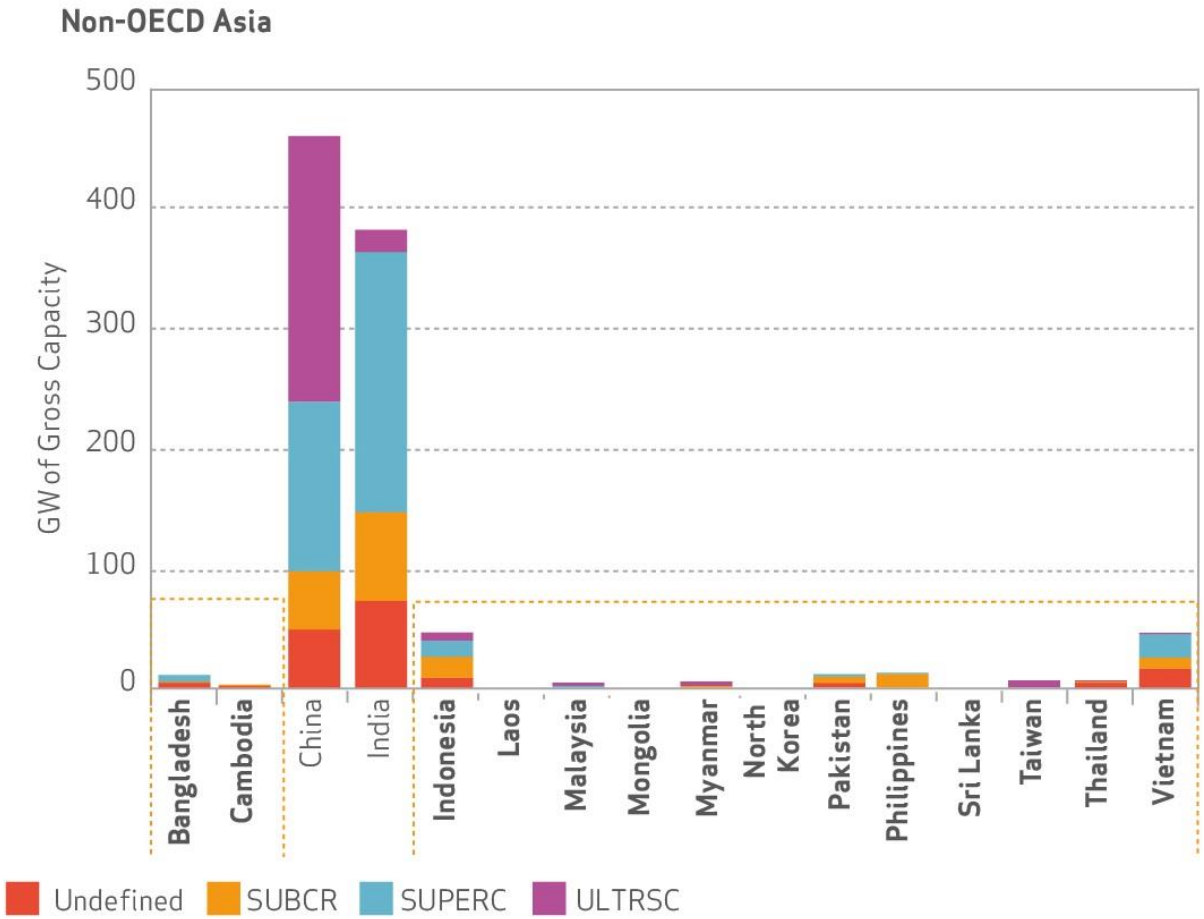
China committed to HELE, others less so



Source: World Coal Association analysis, 2015

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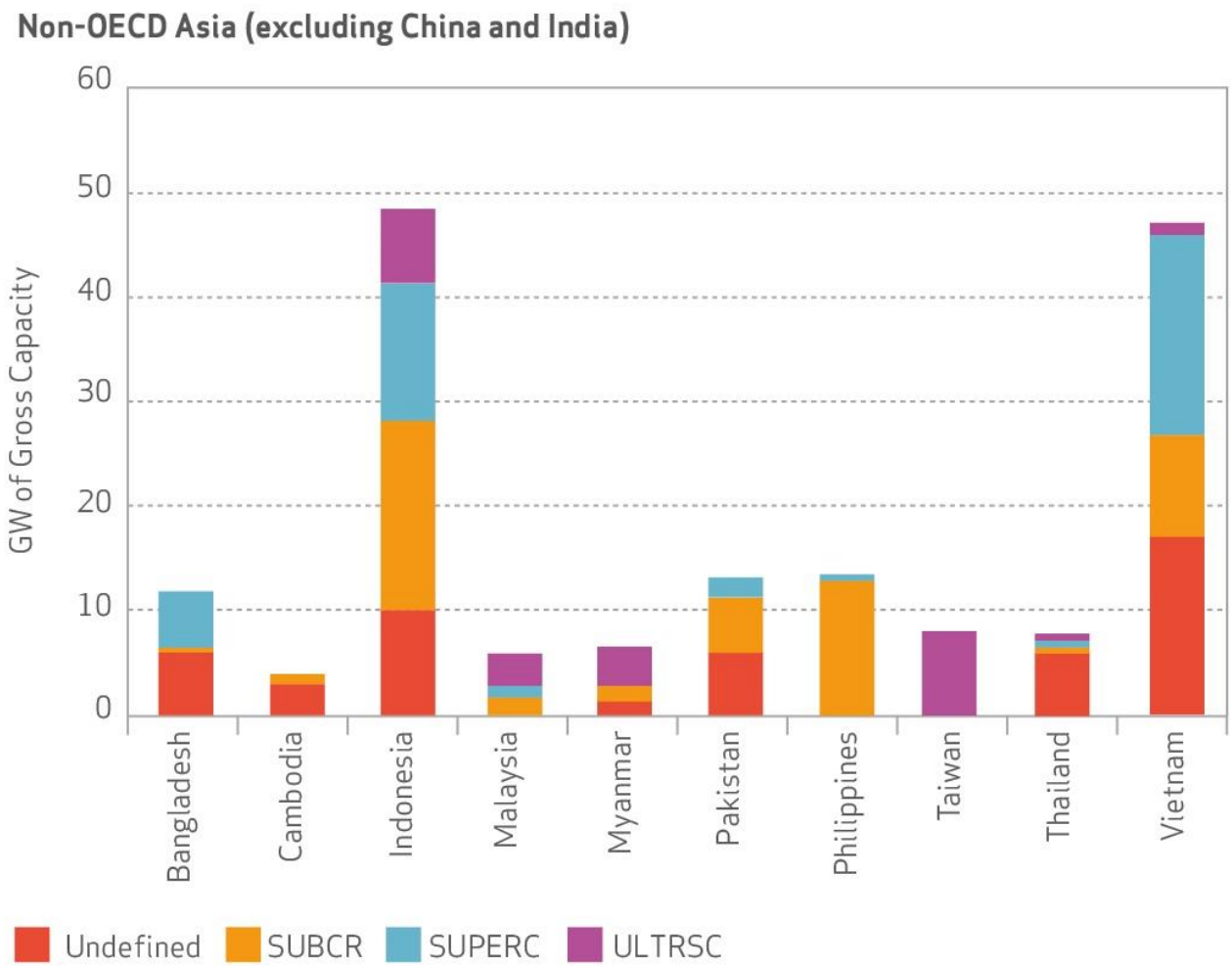
Non-OECD Asia needs to make HELE switch



Source: World Coal Association analysis, 2015

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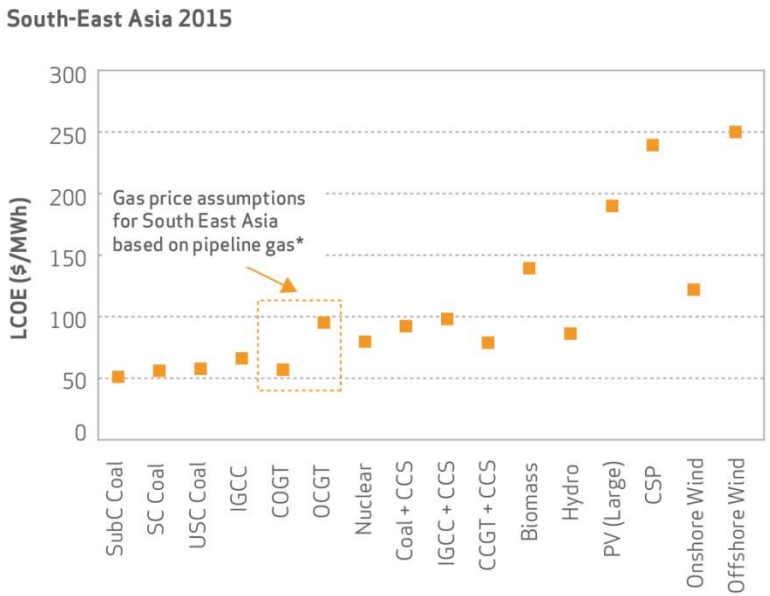
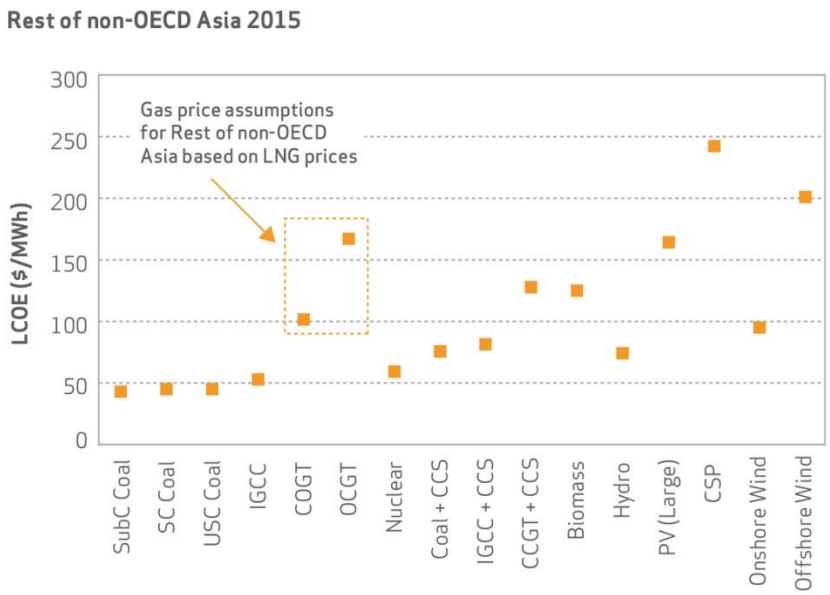
HELE is cost competitive today…

Lifetime Cost of Electricity per MWh across Generation Technologies in 2015





Source: World Coal Association analysis, 2015

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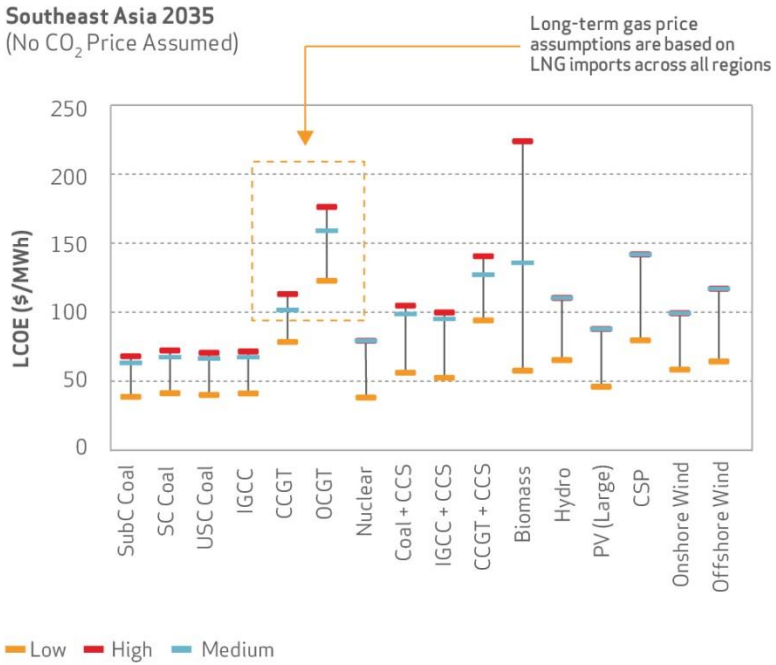
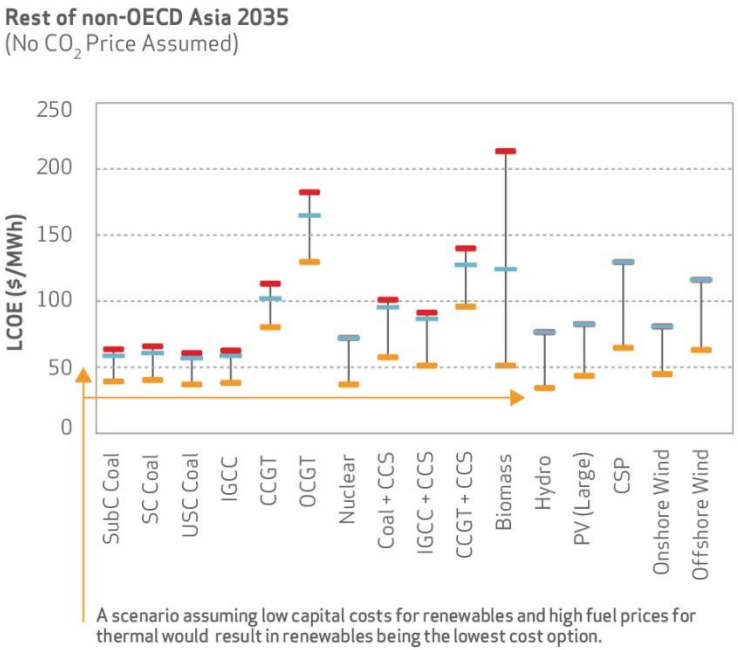
… and in the future (and so is coal+CCS)

Lifetime Cost of Electricity per MWh across Generation Technologies in 2035





Source: World Coal Association analysis, 2015

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Per $ of investment HELE more powerful

Compared to renewables, HELE technologies can reduce more emissions for the same upfront investment

Investment Option	Generation Mix for 10,000 TWh (%)		Required Capacity (GW)		Total CAPEX[1] ($Billion)	% Increase in CAPEX to Baseline	Annual Emission (Bn. tCO_2)
	Coal	Renewable	Coal	Renewable			
Sub-Critical Coal Only	**100**	**0**	**1,343**	**0**	**699**	**Baseline**	**9.5**
Ultra Super-critical Coal Only	100	0	1,343	0	932	33	**7.0**
Sub-critical Coal and Onshore Wind	95	5	1,269	241	932	33	9.0
Sub-critical Coal and Solar PV	96	4	1,284	264	932	33	9.1
Onshore Wind Only	0	100	0	4,391	4,944	607	0
Solar PV Only	0	100	0	6,008	6,002	759	0

$233 Billion of additional funding required

For the same additional financing, ultra super-critical coal technology generates the least amountof emissions

Low load factor renewable technologies means significantly higher required capacity - and therefore higher CAPEX - to generate the same TWh of electricity

Notes:
1) Based on IEA's WEO 2014 New Policy Scenarios capital cost estimates for China in 2035 with construction costs spread equally over the construction period

Source: World Coal Association analysis, 2015

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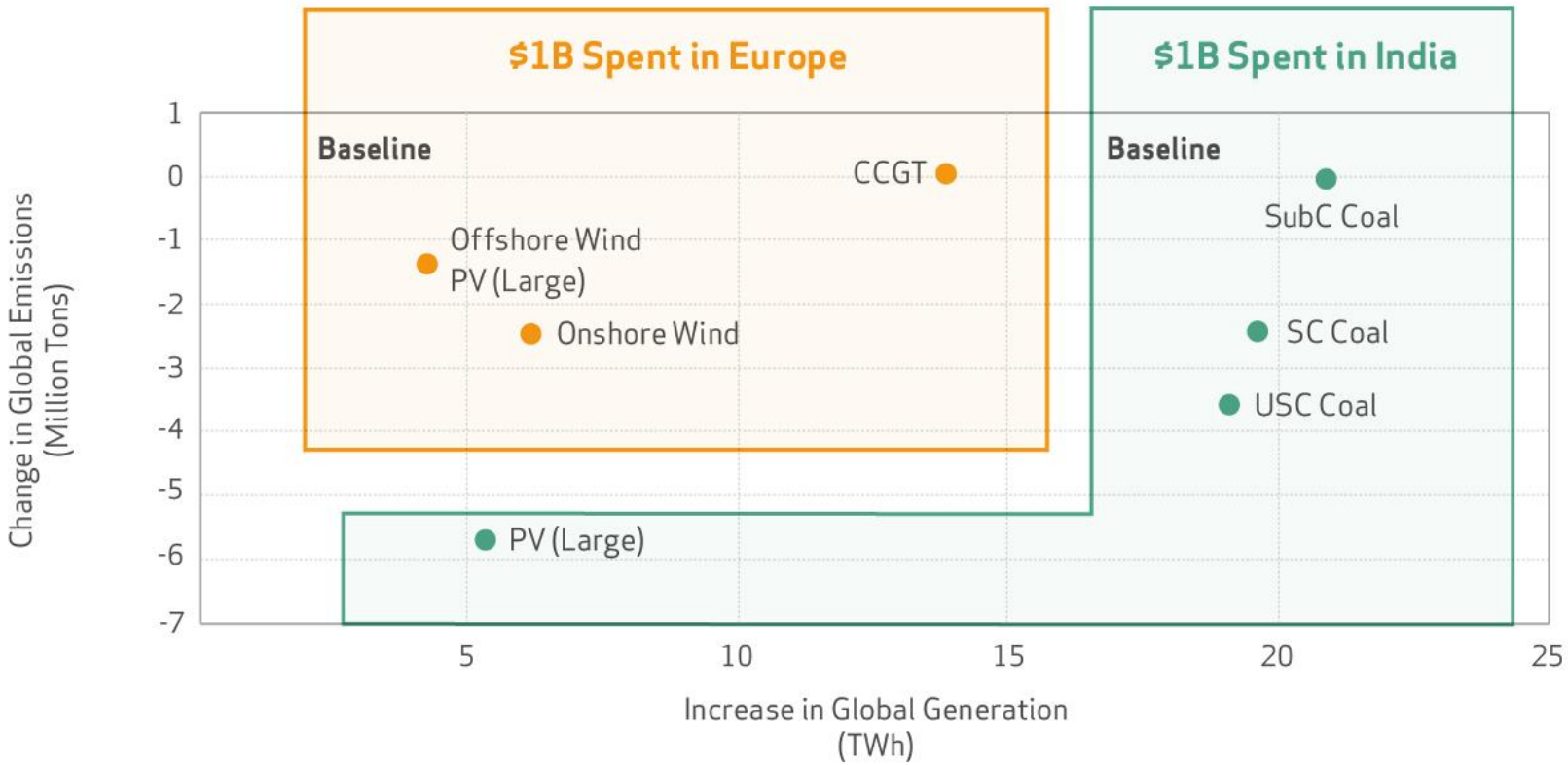
HELE in India – meeting twin objectives

Deploying cleaner coal technology promotes energy access, while managing emissions of carbon dioxide



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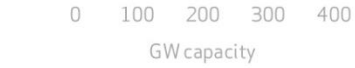
HELE in India – examining the impact

The environmental benefits of deploying cleaner coal technology in India

Scenario	Capacity mix	CO_2 emissions (tCO_2) (over 40 years)	CO_2 abated equivalent to: Subcritical plant closure	Number of new wind turbines	Cars removed from the road
Mix per development pipeline	USC 6, SC 167, SubC 118	84 Billion			
Shift to Supercritical	USC 6, SC 286, SubC 0	80 Billion	28	26,000	200 million
Shift to Ultra Supercritical	USC 292, SC 0, SubC 0	73 Billion	69	65,000	500 million



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WCA supports coordinated international action

A Global
Platform for
Accelerating
Coal
Efficiency

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

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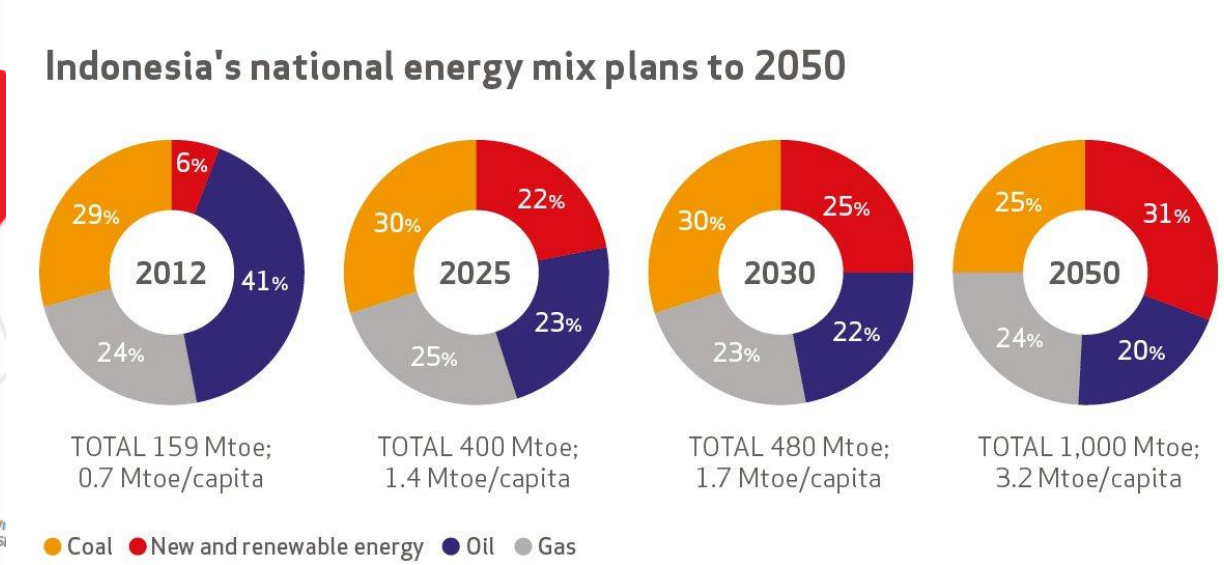
WCA PACE workshop with Indonesia



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A global initiative on HELE would have impact

Emission reductions by policies /actions, bn tonnes CO_2 equivalent

Policy / Action	Annual emissions
Montreal protocol	5.6bn
Hydropower worldwide	2.8bn
Nuclear power worldwide	2.2bn
Increase average global efficiency of coal-fired power plants to 40%	2bn
Other renewables worldwide	600m
US vehicle emissions & fuel economy standards	460m
Clean Development Mechanism	150m
Global Environment Facility	100m
EU energy efficiency	58m
EU renewables	29m

Source: Adapted from The Economist and the IEA 2014

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Deploying HELE also has other benefits

Air quality

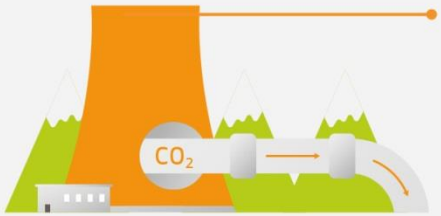
↓ 90-99.9%

Reduction of pollutants from coal combustion as a result of using cleaner coal technologies.

CCS

THE ROLE OF CARBON CAPTURE AND STORAGE (CCS)

CCS is an integrated suite of technologies that can capture up to 90% of the CO_2 emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the CO_2 from entering the atmosphere. The technology is also effective in capturing other emissions.



90%

Amount of CO_2 emissions that could be captured through CCS technologies.

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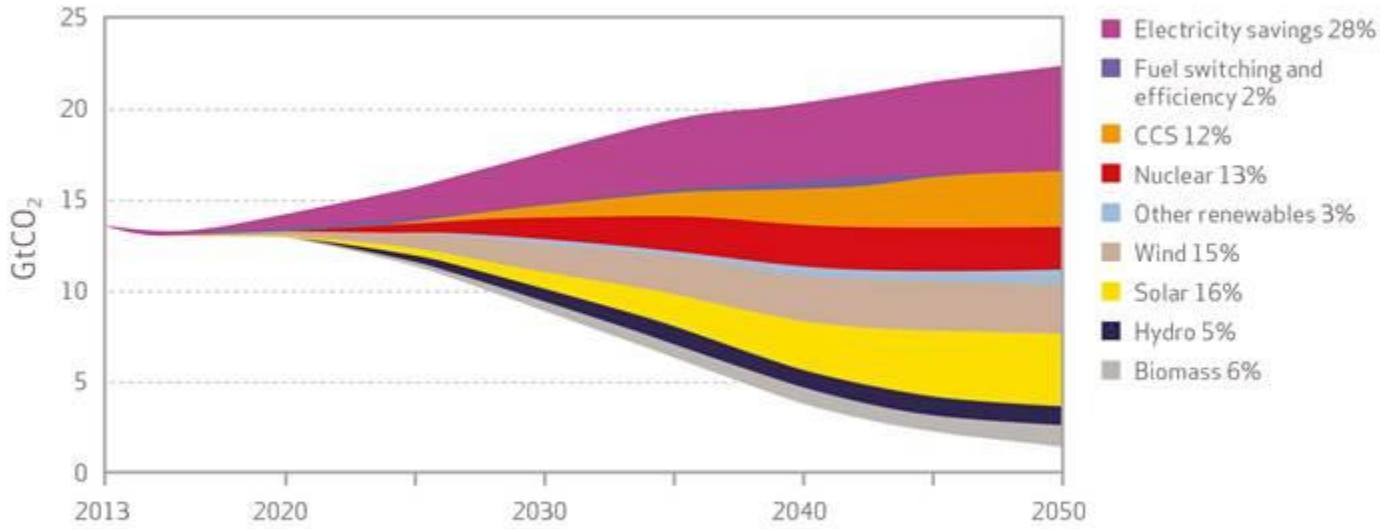
CCS is critical to global climate objectives

Contribution of different technologies to cumulative annual emissions reductions



Source: IEA, Energy Technology perspectives 2016

- CCS is expected to deliver 12% of cumulative GHG emissions cuts through to 2050. It is therefore a key low-carbon technology
- The world's first large scale integrated CCS project capturing CO2 from a coal-fired power plant – SaskPower's Boundary Dam – has just started full scale operation at the end of September 2014

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CCS is real, and happening now

- The world's first application of CCS at large scale in the power sector became operational in October 2014, at the Boundary Dam power station in Canada (1 Mtpa CO_2 capture)
- An upgrade of a 1960's coal unit chosen by Saskpower over gas and renewables
- Two more large scale applications of CCS in power will come on line in 2016 in the US
    - Kemper County Energy Facility (3 Mtpa, Mississippi)
    - Petra Nova Carbon Capture Project (1.4 Mtpa, Texas)
- Large-scale application of CCS will become a reality in iron and steel in 2016 at the Abu Dhabi CCS Project (0.8 Mtpa)
- A further 14 projects are in advanced planning (FEED)

- Boundary Dam, Saskatchewan, Canada
- Coal-fired 110MW CCS 1Mtpa plant operational October 2014
- $1.4Bn Government and Saskatchewan Power Co partnership

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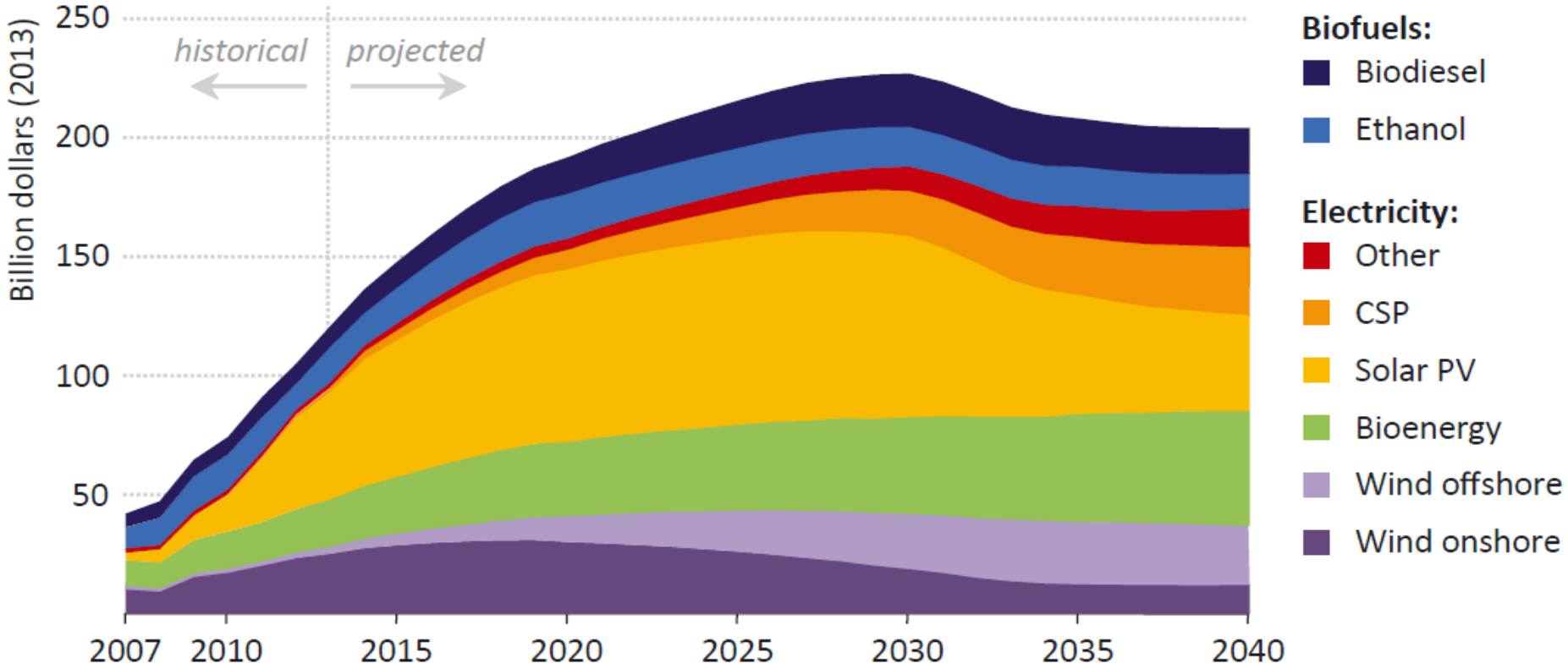
CCS needs policy parity with renewables



- In the period 2007 to 2016, value of global policy support for renewable energy deployment was around US$800B.
- Total value of policy support for deployment of CCS over all time is around $20B

Data source:IEA, World Energy Outlook 2014, Global CCS Institute

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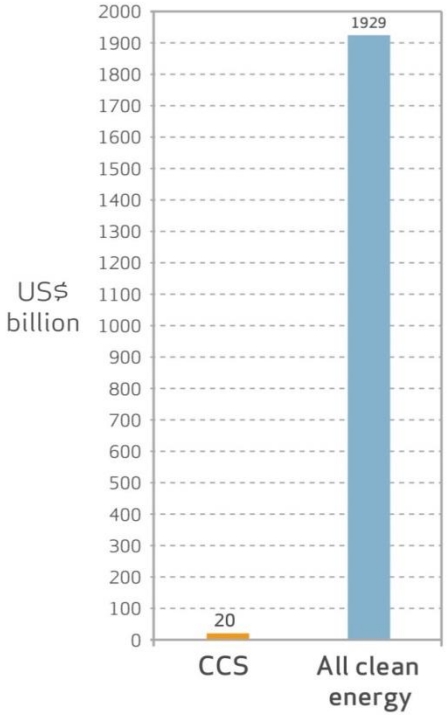
Why CCS has been slow to progress

Clean energy investment* between 2004 – 2013 (billion US$)

CCS:
$20
billion

All clean energy:
$1929
billion



1%

*includes technology development, projects, M&A
Source: IEA

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In summary…

- We must recognise that coal is an important driver of affordable, reliable energy to support economic development and competitiveness
- Coal plays a major role in industrialising and urbanising economies
- In any scenario coal is still going to play a major role in the world's energy mix – especially across Asia
- We can significantly reduce emissions from coal with commercially available technology today – we should encourage and support deployment of HELE technologies in preference of less efficient technologies
- More public support is needed to facilitate increased commercial demonstration of CCS to drive costs down so that we can begin a transition toward near-zero emission fossil fuels

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