THE CASE FOR COAL

INDIA'S ENERGY TRILEMMA

WORLD COAL ASSOCIATION

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In an uncertain global economy, India stands out as a significant growth area for global coal demand. This projected demand will be driven not simply by economic growth but also by government efforts to reduce those impacted by energy poverty.

Background

The International Energy Agency (IEA) has estimated that 304 million people in India are without access to electricity[1]. Unsurprisingly, in a speech earlier this year, Piyush Goyal, Minister of State for Power, Coal and New and Renewable Energy, stated that "universal and affordable energy access 24/7 … is the mission of this Government under Prime Minister Modi".

India is currently the world's third largest energy consumer[2]; this position will be consolidated over the coming years driven by economic development, urbanisation, improved electricity access and an expanding manufacturing base. Indeed, the IEA forecasts that by 2040 India's energy consumption will be more than OECD Europe combined, and rapidly approaching that of the United States[3].

Like China before it, India's economic growth will be fuelled by coal. Reflecting this, in 2012 45% of total primary energy demand and 72% of generated electricity demand was met by coal. India currently has approximately 205 gigawatts (GW) of coal-fired electricity generation capacity, this will soon be augmented by 113 GW of new coal-fired capacity currently under construction[4].

Recognising India's growing role in the international coal market, the World Coal Association (WCA) commissioned external analysis to consider future demand, CO_2 abatement costs and levelised electricity cost for India, including comparison with Europe. This paper provides a high-level summary of the outcomes of this analysis.

Note: unless otherwise indicated all data and figures are taken from analysis conducted for WCA. Unless otherwise specified, all figures are in US$.

[1] *International Energy Agency, World Energy Outlook 2014, p.74*
[2] *Australian Government, Office of the Chief Economist, Coal in India, p.12*
[3] *ibid*
[4] *ibid*

Government policies to meet growing energy needs

The Indian government's policies to meet the growing need for electricity are focused on developing large-scale coal-fired power plants.

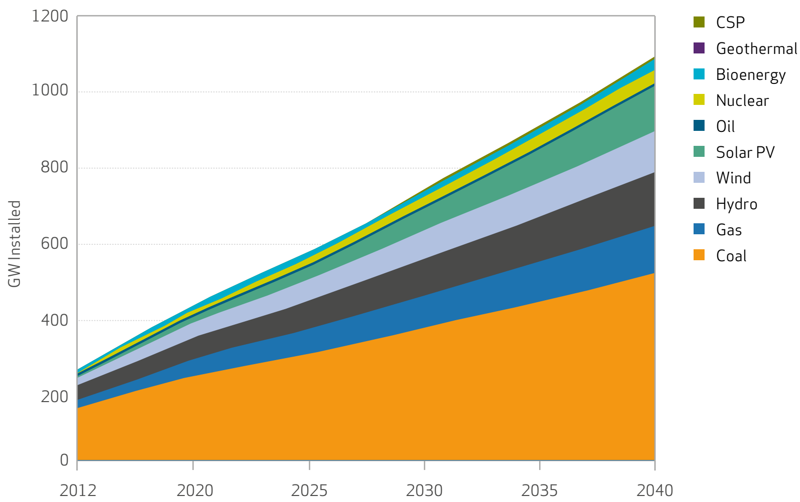
Over the next 25 years, electricity demand in India is forecast to grow at over 4% per annum. Under its New Policies Scenario, the IEA estimates that installed coal capacity will reach almost 500 GW by 2040 (more than three times the 2012 installed capacity). Although comparatively lower, under the 450 scenario, increases to coal-fired capacity will still exceed 300 GW by 2040 .

The dominance of coal in India's energy mix can be attributed to two key factors: affordability and access. Although the competitiveness of renewables and gas-fired technology is likely to improve over time, coal is expected to remain the most affordable option through to 2035, driven by low domestic coal prices and limited gas availability.

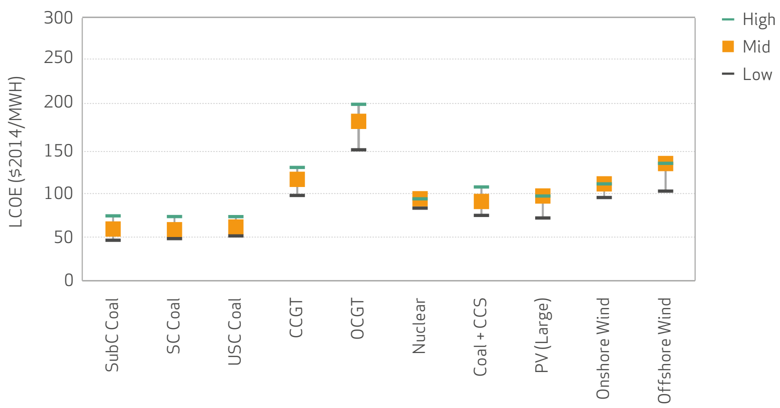
Since 2010, approximately 87 GW of new coal capacity has been added to the grid, of which 61 GW has been subcritical. By 2018, an additional 88 GW of new coal capacity is forecast to come on-line, with 32 GW of this subcritical. In addition, India currently has a further 292 GW of coal capacity in the planning stages[5]. The IEA estimates that India will require around $1.2 trillion investment in power generation through 2040 .

India Installed Capacity

New Policies Scenario



India Levelised Cost of Electricity - 2035



[5] *Platts, World Electric Power Plants Database*

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

0 100 200 300 400
GW capacity

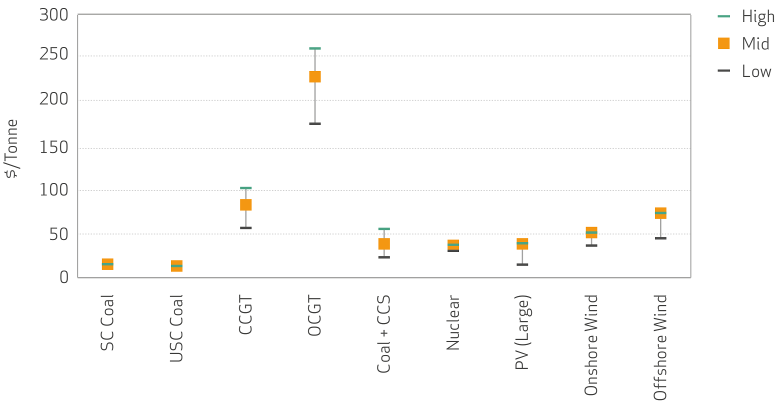
While the government has suggested that the 13th five-year plan will call for the development of 100% supercritical coal plants, cost difference could impact developers' choices. There is as much as a 40% price difference between the capital costs of an ultra-supercritical and a subcritical coal plant. Analysis show that if all coal plants built from 2020 onwards were ultra-supercritical, total capital expenditure would reach $500 billion by 2040, compared to around $387 billion if all coal plant built from 2020 onwards were subcritical.

Implications of energy technology choices

Leaving cost considerations aside, there are clear benefits for deploying supercritical or ultra-supercritical technology. Analysis shows replacing the subcritical capacity currently in the development pipeline with supercritical or ultra-supercritical capacity would translate into significant reductions in CO_2 emissions for India over the life of the power plants.

Avoided cost of CO_2 – India, 2015

(Subcritical coal plant used as baseline) *No CO_2 price assumed



Analysis also indicates that replacing subcritical with supercritical and ultra-supercritical coal technology saves CO_2 at a cost of around $10/tonne in 2035. By comparison, abating a tonne of CO_2 through the deployment of large-scale solar PV in India can cost up to $40/tonne, even accounting for the cost declines expected through 2035 (~$16/tonne under a low weighted average cost of capital and low capital cost scenario).

CO_2 abatement of ultra-supercritical coal compared to renewables

Building on the abatement research, the analysis considers the impact of spending $1 billion across different generation options in India and Europe, taking into account differences in Levelised Cost of Electricity (LCOE), emission rates across technologies, and the marginal generation technology in each region.

- For India, the analysis assumes that $1 billion is spent on replacing subcritical power plants (baseline technology) with supercritical and ultra-supercritical technologies, causing a reduction in emissions equivalent to the difference in emission rates between the different coal technologies.

- For Europe, the analysis assumes that $1 billion is spent on building renewables, which are assumed to replace Combined Cycle Gas Turbines (CCGTs) (baseline technology), causing a reduction in emissions equivalent to the avoided emissions from gas-fired CCGTs.

Replacing subcritical capacity currently in the development pipeline with supercritical or ultra-supercritical capacity would translate to significant reductions in CO_2 in India.

As illustrated in the graph opposite the \$1 billion expenditure can result in more generation (in TWh) and higher CO_2 emission reductions when spent in replacing subcritical plant in India compared to replacing CCGTs with renewable technologies in Europe.

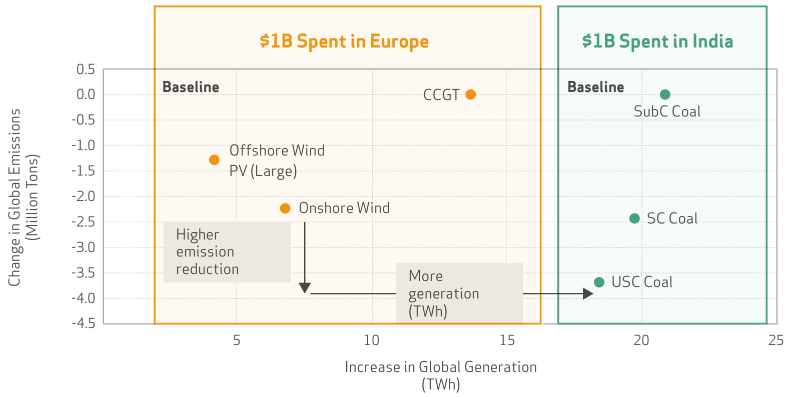
The analysis also considered for comparison solar PV deployment. Research showed that while renewable technologies in India could result in high-emission abatement, they do not provide the scale of generation growth required to meet electrification targets.

Low emission coal technology for cost-effective CO_2 abatement

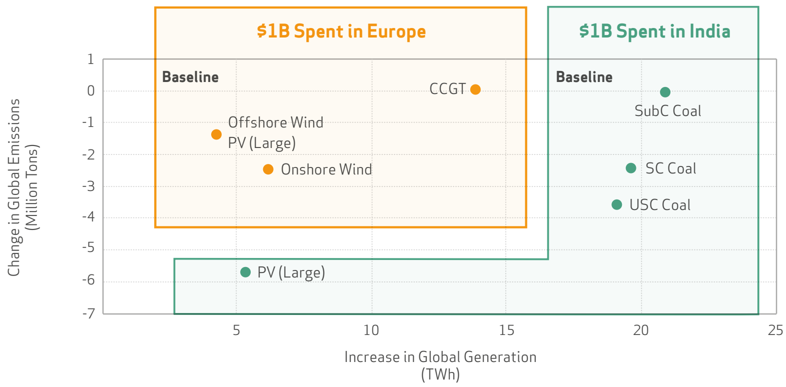
The WCA's research demonstrates on a generation basis, coal has the potential to deliver the most TWh of all technology options assuming the same expenditure (on an LCOE basis). Moreover, deployment of supercritical and ultra-supercritical technologies deliver the most cost-effective form of CO_2 abatement when compared to subcritical coal, while supporting the objective of increased generation at an affordable price[6].

Investing in ultra-supercritical technologies in India may lead to higher CO_2 abatement than investing in renewables in Europe.

Potential abatement of cleaner coal technology in India compared to renewables in Europe



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



2015 Technology Comparison in India (in \$2014)

Technology	CAPEX (Billion \$/GW)	Tariff (\$/MWh)	Load Factor	% of SubC Coal Installed Capacity	% of SubC Coal Generation	Avoided cost of CO_2 (\$/Tonne)
SubC Coal	1.05	48	85%	-	-	-
SC Coal	1.26	51	85%	**83%**	**95%**	**20**
USC Coal	1.47	54	85%	**71%**	**90%**	**27**
CCGT	0.73	73	60%	**143%**	**66%**	**36**
Nuclear	2.93	96	85%	**36%**	**51%**	**46**
PV (Large)	1.94	180	17%	**54%**	**27%**	**127**
Onshore wind	1.55	128	22%	**67%**	**38%**	**77**

[6] *Based on underlying cost assumptions of research*

Conclusions

- Coal will continue to be an important source of energy for developing economies like India.
- In India the cost competitiveness of coal is driven primarily by low coal prices and limited availability of alternative fuels. This is likely to continue into the future.
- Even incorporating cost declines in renewable technologies, coal is expected to remain the most cost-effective option for meeting electricity demand growth in India.
- Despite the significant efficiency and emission rate advantages of supercritical and ultra-supercritical compared to subcritical technologies, of the coal plant built in India over the last five years and currently under construction around 50% are subcritical.
- Subcritical technologies enjoy a significant cost advantage over more efficient options, which may lead to continued deployment over the next couple of decades.
- With a lot more coal plants currently in development, the choice of coal technology will have significant implications on the carbon intensity of the Indian economy going forward.
- WCA analysis shows that investing in super- and ultra-supercritical technologies in India remains a cost-effective carbon abatement alternative compared to investment in other generation technologies.
- Further, from a global perspective, investing in ultra-supercritical technologies in India may lead to higher CO_2 abatement than investing in renewables in Europe.
- This has important policy implications for governments and should be analysed carefully when assessing climate change initiatives.

As the analysis demonstrates, high efficiency low emission (HELE) technology allows developing countries to minimise CO_2 emissions, while not sacrificing legitimate economic development and poverty alleviation efforts. This understanding provided the framework for India's intended nationally determined contribution (INDC), which recognised the role of HELE technologies.

Expanding efficient coal consumption will help address India's energy trilemma of meeting demand, reducing energy poverty and actively participating in climate change commitments.

Moving the current average global efficiency of coal-fired power plants to 40% with off-the-shelf technology could cut two gigatonnes of CO_2 emissions now.

Platform for Accelerating Coal Efficiency

HELE coal-fired power generation has a vital role in promoting energy access and economic development, whilst reducing emissions from the use of coal.

Recognising this, the WCA published a concept paper on establishing a global Platform for Accelerating Coal Efficiency (PACE).

PACE provides a vision that for countries choosing to use coal, the most efficient power plant technology possible is deployed. The overriding objective is to raise the global average efficiency of coal-fired power plants and so minimise CO_2 emissions which will otherwise be emitted while maintaining legitimate economic development and poverty alleviation efforts.

It is the WCA's position that there should be coordinated global action to support developing and emerging economies already choosing to use coal to do so with the lowest possible emissions profile.

Key messages from the PACE proposal include –

- Over the next 20 years, continuing industrialisation and urbanisation will result in a continued demand for coal. Additionally, with 1.3 billion people globally without access to electricity, it is clear all sources of energy will be needed to meet this demand, including coal.

- Technologies such as HELE coal plants and carbon capture, use and storage (CCUS), can make a significant contribution to reducing global CO_2 emissions as part of the energy mix. Moreover, deploying HELE technology is a key first step along a pathway to near-zero emissions from coal with CCUS.

- Moving the current average global efficiency rate of coal-fired power plants from 33% to 40% by deploying more advanced off-the-shelf technology could cut two gigatonnes of CO_2 emissions now, while allowing affordable energy for economic development and poverty reduction.

World Coal Association

The World Coal Association is a global industry association formed of major international coal producers and stakeholders. The WCA works to demonstrate and gain acceptance for the fundamental role coal plays in achieving a sustainable and lower carbon emissions energy future. Membership is open to companies and not-for-profit organisations with a stake in the future of coal from anywhere in the world, with member companies represented at Chief Executive or Chairman level.

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The analysis in this report was conducted by Charles River Associates on behalf of the World Coal Association. Responsibility for the report lies with the World Coal Association.

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First published in the UK in November 2015

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