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Overestimated Financial Viability of India's Coal-fired Power Plants

LCOE for India's Coal Power Project Pipeline Needs to Be Revised

Executive Summary

India currently has 33 gigawatts (GW) of coal-fired power plants under construction and another 29GW of proposed projects under various stages of regulatory approval.

With the electricity sector transition in India being driven by cheaper and cleaner renewable energy sources, IEEFA's view is that India's current coal-fired power project pipeline carries massive underutilisation risk.

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The need for this excessive coal capacity stems from the notion that coal is still 'cheap'. However, with tariffs now below Rs2/kilowatt hour (kWh) (US$27/MWh), solar power is cheaper than even the variable cost of coal-fired power and is ready to absorb incremental daytime demand.

The levelised cost of energy (LCOE) of coal-fired power plants in India, and globally, are massively underestimated based on an overestimated assumption of capacity utilisation factors (or plant load factors (PLF)).

The LCOE can be thought of as the average total cost of building and operating an asset per unit of total electricity generated over its assumed lifetime. The capacity factor - the estimation of the yearly amount of electricity likely to be produced by a power plant relative to its maximum electricity production capacity each year - is a critical element in calculating the LCOE.

These tools are commonly used for measuring the financial viability of energy assets. But are they based on accurate assumptions in order to provide the correct readings?

Using the misleading assumption of a constant, high capacity factor leads to an underestimation of the cost for each unit of electricity to be produced by a power plant throughout its lifetime.

IEEFA notes there has been a steady decline in the capacity factor of coal-fired power plants globally, and the decline has been steeper for India's coal-fired power fleet. The average utilisation rate of India's coal-fired fleet has collapsed to a financially unsustainable low of 53% in financial year (FY) 2020/21 from a high of 78% a decade ago in FY2011/12.

Leveraging an excellent report by RethinkX (led by leading Futurologist Tony Seba), IEEFA confirms that the LCOE of gas- and coal-fired power plants is being underestimated globally by energy authorities and financial institutions because they are basing calculations on the assumption that plants have a constant, high capacity factor over time and will be able to successfully produce the same quantity of electricity each and every year throughout their lifetime.

In fact, this constancy rarely occurs. What is constant is that thermal operating rate assumptions are over-estimated, meaning LCOEs are materially understated.

Consistent with RethinkX, our evidence shows that globally, the capacity factor for coal-fired power plants has been in decline since the beginning of last decade, leading to an underestimation of LCOE.

The average capacity factor of Chinese coal power assets has been below 50% for the last 5 years, meaning China is now consistently building idle new coal-fired power plants, which does not add to global emissions but does leave US$100 billion of stranded coal assets in the making.

Likewise, the average utilisation rate of coal power plants in India hit a decade low in 2020/21 of just 53%, well below the 85-90% modelling assumption used to justify the final investment decision.

This trend is reinforced by the ongoing deflation of Indian solar tariffs which hit a record low of just Rs1.99/kWh (a LCOE of US$20/MWh) in December 2020, down 18% year-on-year. Given the merit order dispatch system in electricity markets, and a zero marginal cost of production once built, solar inevitably cannibalises the demand for high marginal cost coal-fired power plants during daylight operation.

In 2020/21, the average utilisation rate of coal power plants in India hit a decade low of just 53%.

With zero fuel costs, the marginal cost of generation for renewables is practically zero. On the other hand, with inflation in Indian domestic coal prices and railway transportation costs for coal, the gap between cost competitiveness of renewables versus coal is widening.

India's Stressed Coal-fired Power Sector

Coal-fired power plants are rapidly losing viability in the Indian market as the cost of renewables continue to decline. With solar power tariffs now as low as Rs1.99/kWh (US$27/MWh), renewables are cheaper than the variable cost of coal-fired power generation.

Renewables are cheaper than the variable cost of coal-fired power generation.

Coal has remained a viable option in the Indian electricity market for decades due to its lower cost compared to gas, diesel and nuclear. However, some longstanding structural, operational and financial issues in India's coal-fired power sector have dramatically changed its landscape.

Key issues that have impacted the viability of coal-fired power projects include:

- Lack of fuel due to cancellations in assigned coal linkages or projects set up without any coal linkages
- Lack of purchase power agreements (PPAs) with state distribution companies (discoms)
- Inability of promoters to infuse equity and working capital
- Contractual and tariff-related disputes
- Issues related to banks and financial institutions
- Delays in project implementation due to environmental issues and litigations leading to cost overruns
- Over-aggressive tariff bidding by developers to win PPAs.

Despite these serious issues, there are 33GW of coal-fired projects under construction and another 29GW being pursued for regulatory approvals. The basis for pursual of these coal-fired power development in India are — a) additional capacity requirement to serve India's growing power demand, and b) an assumed lower levelised cost of energy (LCOE) of coal-fired power.

In IEEFA's view, the LCOE of coal-fired power in India is massively underestimated based on an overestimation of factors such as utilisation rates, project lifetime and coal prices.

In this briefing note, factors which impact the underlying LCOE of coal-fired power projects will be discussed such as capacity utilisation rates, coal transportation costs, and the price volatility of imported coal.

Measuring LCOE

The levelised cost of energy or electricity (LCOE) is often used to compare different methods of electricity generation produced by energy assets to try to normalise different asset lives, capacity factors and different fuel cost inflation trajectories.

It is widely used by energy authorities such as the International Energy Agency (IEA), the Australian Energy Regulator (AER), and the U.S. Energy Information Administration (EIA), as well as researchers, governments and investors around the world to evaluate energy assets from a financial perspective.

The LCOE is the required tariff at which the net present value of the investment is zero. In other words, it is the minimum required average tariff for the power asset to reach a breakeven return at the end of its life. Anything less than that suggests the asset is unviable.

The greater the amount of electricity produced, the lower the cost per unit of energy produced. For example, the EIA recently calculated the LCOE of ultra-supercritical coal-fired power plants in the U.S. at around US$72 per megawatt hour (MWh) (Rs5.3/kWh).[1] This means that an investor, on average, would incur US$72 per MWh of electricity produced by this type of powerplant over its lifetime in today's dollar terms (i.e. the real price).

The Central Electricity Authority (CEA) of India estimates the levelised tariff for a new supercritical mine mouth thermal power station with a 60% plant load factor (PLF) to be Rs4.39/kWh.[2]

An estimation of electricity production over a plant's life relative to the plant's maximum capacity of electricity production is a critical factor affecting LCOE and the financial valuation of power plants. However, there are historically misleading assumptions about utilisation rates and the electricity production of coal-fired power plants over their lifetime.

Capacity Factor Is a Key Element

The capacity factor[3] of a power plant is the ratio of actual energy produced compared to the plant's maximum possible energy output over one year. A capacity factor of 100% for a power plant means the plant is producing power 24 hours per day, 365 days a year. Capacity factor is used to calculate the LCOE and therefore to evaluate the future cash flows of any given power plant in today's dollar terms.

Widely cited energy authorities and consequently many financial institutions assume a constant, high capacity factor throughout a power plant's lifetime.

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[1] EIA. Levelized Costs of New Generation Resources in the Annual Energy Outlook 2021. February 2021.
[2] CEA draft report on New Environmental Norms on Thermal Power Plant. Page 9. A scanned copy of this document can be shared by IEEFA upon request.
[3] Sometimes capacity factor and utilisation rate are used interchangeably, but technically they could be a bit different. See Power Engineering International. Capacity factors, utilisation factors and load factors. 21 November 2013.

Historical evidence and forward-looking reputable research shows however that the capacity factor for coal-fired power plants has been declining globally since the beginning of the last decade.

India also uses a different, if related term - the Plant Load Factor (PLF), which is the capacity factor for the percentage of the year that coal is actually available to run the coal power plant (India's coal supply has historically been heavily disrupted by low rail speeds and the impact of monsoonal rains). India's PLF is higher than the capacity factor because a coal plant is regularly idle for 5-10% of the year due to circumstances outside of its direct control, and coal plant owners can charge the customers for the fixed cost part of this lost generation opportunity.

India's average capacity utilisation factor has been sitting at ~55% for the last few years.

For most coal plants in India, the LCOE is calculated with an assumption of utilisation factor of 85-90% throughout the life of the project. However, the LCOE turns out to be 64% higher with India's average capacity utilisation factor sitting at ~55% for the last few years.

Figure 1 illustrates the hike in estimated LCOE as utilisation rate drops below the assumed rate of 90%.

The LCOE of the 1.6GW Uppur Thermal Power Project currently under construction in Uttar Pradesh is estimated based on the project cost of Rs12,655 crore (US$1.7bn). In the absence of details about the project's LCOE, other financial details such as the annual operational expenditure (opex), the opex escalation rate, and the landed fuel cost in the environmental impact assessment (EIA) report of the project, an annual opex of Rs3.8 crore/MW is arrived at for the LCOE calculation.[4] (The opex is derived from the EIA report of the 1.2GW Khurja power plant in Uttar Pradesh.)

[4] The opex is derived from a quoted LCOE in EIA of Khurja Thermal Power Plant (1.2GW) project in Uttar Pradesh.

Figure 1: Change in Estimated LCOE with Falling Utilisation Rates

Capacity	1,600	MW
Lifetime of the project	40	Years
Capital cost	12,655	Rs crore
Opex per MW	3.8	Rs crore/MW
Operational cost over the lifetime	240,079	Rs crore

Utilisation Factor (%)	**90%**	**85%**	**80%**	**75%**	**70%**	**65%**	**60%**	**55%**
Generation (TWh)	12.6	11.9	11.2	10.5	9.8	9.1	8.4	7.7
Estimated LCOE (Rs/kWh)	5.0	5.3	5.6	6.0	6.4	6.9	7.5	8.2
Hike in Estimated LCOE with below 90% CUF		6%	13%	20%	29%	38%	50%	64%

Source: IEEFA estimates, Environmental Impact Assessment reports of multiple coal power projects.

IEEFA notes the assumption of a constant capacity factor should be revised in order to avoid financial overvaluation of fossil-based energy assets.

Collapsing Utilisation Rates in India

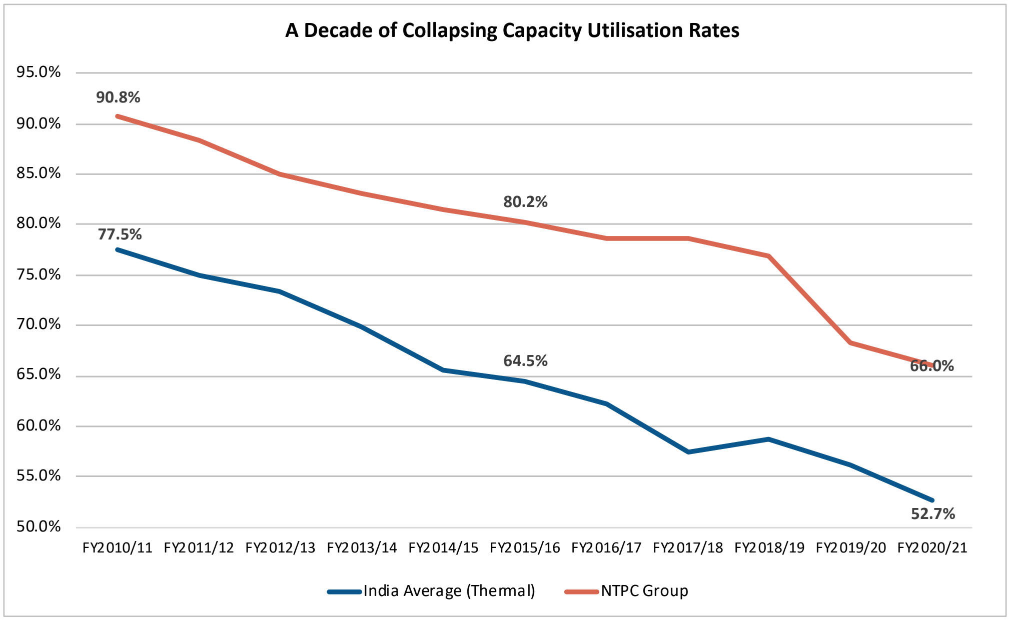
The average utilisation rate of India's coal-fired power fleet collapsed to a financially unsustainable low of 53% in FY2020/21 from a high of 78% in FY2011/12 (See Figure 2).

This is reflected in the performance of one of India's top coal plant operators. The Indian government-owned NTPC's utilisation rates have suffered a major decline over the past decade from 91% in FY2011/12 to 68% in FY2019/20.

An average ~20GW of coal-fired capacity was added annually between FY2011/12 to FY2014/15. This led to an overcapacity situation against lower-than-expected growth in electricity demand, severely impacting utilisation rates of the coal-fired power fleet.

Moreover, discoms' poor financial health and cashflow issues have resulted in the backing down of despatch from power plants. Coal availability and rising competition from cheaper renewables have been other contributing factors to the declining capacity utilisation rates of the Indian coal-fired fleet.

Figure 2: All India vs NTPC's Capacity Utilisation Rates FY2011/12 - FY2020/21



Source: CEA, NTPC, IEEFA estimates.

International Trends

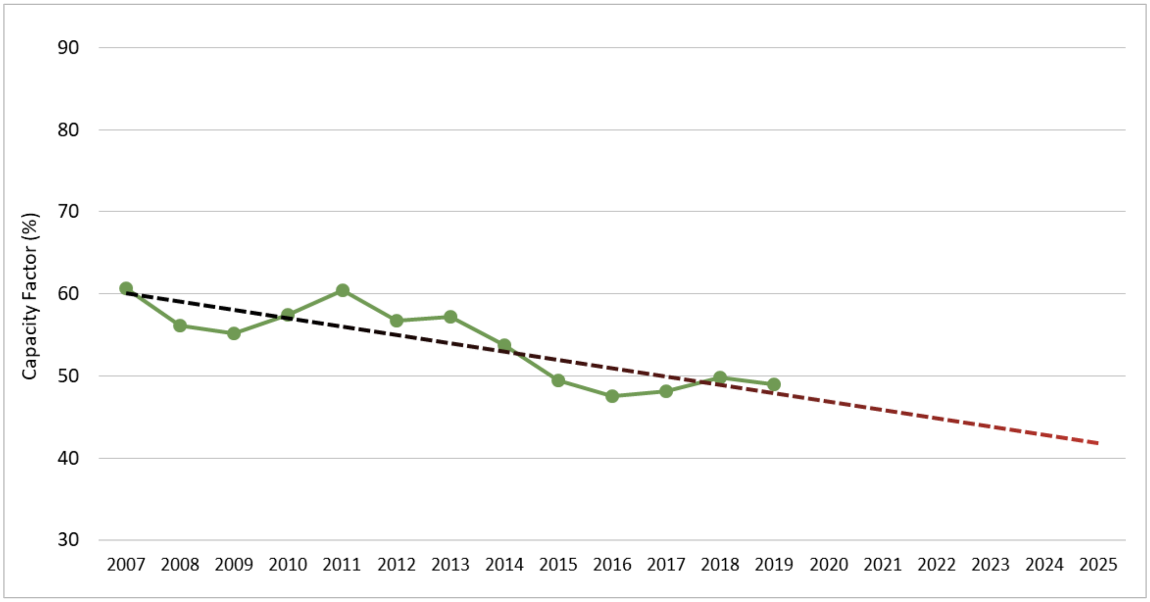
Utilisation factors of coal-fired power plants have declined across major electricity markets such as China, the United Kingdom (UK) and the United States (U.S.).

China

The capacity factor of China's coal-fired power plants shows a 20% decline rate from 61% in 2007 to 49% in 2019 (Figure 3). Linear forecasting shows the capacity factor will fall below 40% in the next 4 years.[5]

[5] It may actually plunge much faster if disruptive solar, wind and battery technologies and the new wave of decarbonization initiated by the U.S. Climate Summit is considered.

Figure 3: Coal-fired Power Plants' Capacity Factor Trend in China (2007-2019)



Source: China Electricity Commission (CEC), Carbonbrief.org.[6]

UK

Figure 4 demonstrates the collapse in the capacity factor of UK's coal-fired power plants, accounting for numerous stranded assets in the UK's coal sector. The linear forecast trend shows the UK's coal era will end this year.

[6] Carbon Brief. Analysis: Will China build hundreds of new coal plants in the 2020s? March 2020.

Figure 4: Coal-fired Power Plants' Capacity Factor Trend in the UK (2010-2019)

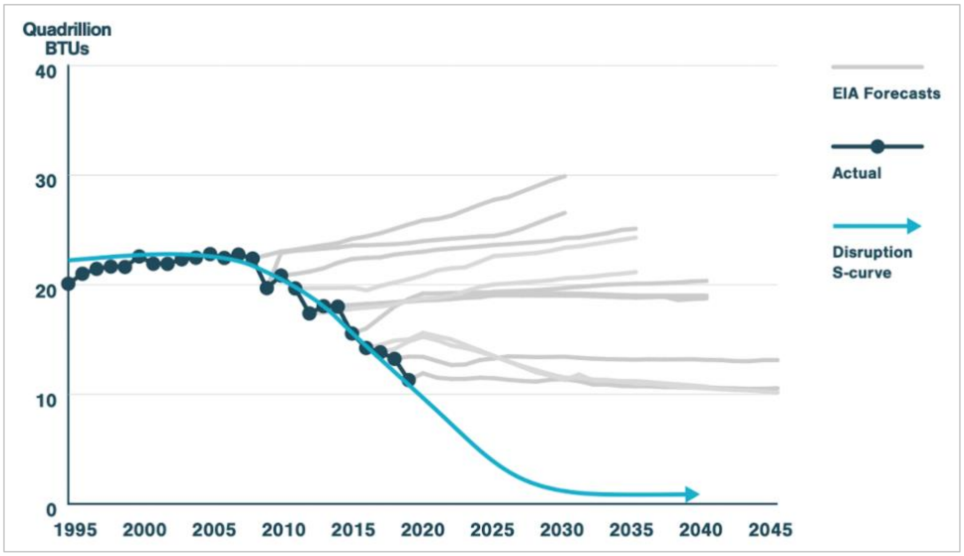
Source: IEEFA Calculations, Data: Digest of UK Energy Statistics (DUKES): Electricity.[7]

United States

Despite the downturn in the capacity factor of U.S. coal-fired power plants, Figure 5 shows how optimistic the EIA is about the future of coal-fired power generation in the U.S.[8] The EIA and others continue to consider a constant (and sometimes increasing) capacity factor and consequently a constant amount of yearly electricity production from these power plants. The grey lines are the EIA's forecast for coal-fired power generation over the coming decades. However, as think tank RethinkX forecasts[9], the blue S-curve is the more realistic forecast of declining U.S. coal-fired power plants based on historical data and the huge impact of disruptive new technologies including solar, wind and batteries.

[7] UK Government. Digest of UK Energy Statistics (DUKES): Electricity. July 2020.
[8] The EIA stepping on the same rake is not a new thing, and there are a lot of resources that discuss the potential reasons for that. See [1], [2], [3].
[9] RethinkX. Rethinking Energy. February 2021.

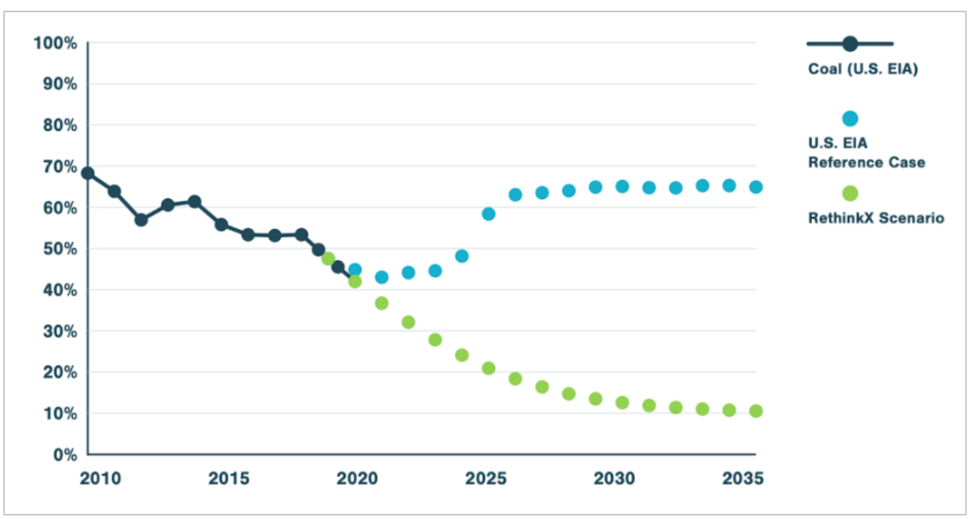
Figure 5: Coal-fired Power Plants' Generation in the U.S: Disruption Forecast (RethinkX) vs EIA Forecast



Source: RethinkX, U.S. EIA Annual Energy Outlook Series, 1995-2020.

EIA's forecast of a 65% capacity factor for coal-fired power plants until 2035 as depicted in Figure 6 (blue curve) relies on the assumption of a constant (sometimes increasing) capacity factor. However, based on RethinkX's forecast (green curve), the capacity factor of U.S. coal-fired power plants will drop to 10% by 2035. We suggest this is still optimistic.

Figure 6: Coal-fired Power Capacity Factor in U.S: RethinkX 's Forecast vs IEA's Forecast



Source: RethinkX, U.S. EIA Annual Energy Outlook, 2021.[10]

[10] EIA. Annual Energy Outlook 2021.

Inflation in India's Coal Transportation Costs

The majority of India's coal-fired power plants under construction are non-mine mouth with coal linkages several hundred kilometres (km) from the plant. This requires coal to be transported via railway from the mine to the plant location.

Brookings India in its report from July 2018 highlights rising inflation in Indian Railways' coal freights owing to a cross-subsidy burden from passenger freight. Brookings suggests that Indian Railways' coal freight charges grew more than four times the wholesale inflation rate between 2011/12 to 2016/17.[11] Coal freight charges were further revised upward in the beginning of 2018, with a busy season surcharge levy of 15% for nine months of the year and a 5% development charge levied on standard rates.[12] Moreover, these charges continue to rise. We note a rise of 6-9% in coal freight charges between 2018-2021 for distances of 200-1,200km.

Figure 7 illustrates our estimated impact of railway coal-freight charges on landed tariffs of coal-fired electricity for three different transportation distances of 200km, 700km and 1,200km. Coal transportation costs would have an incremental impact of Rs1.78/kWh for a plant hauling coal from a mine distanced at 1,200km from the plant location.

Figure 7: Coal Transportation Costs

Distance (km)	**200**	**700**	**1,200**
Freight Rate (Rs/T)	532	1,398	2,230
Freight Rate (Rs/Kg)	0.53	1.40	2.23
Coal Requirment (Kg/kWh)	0.80	0.80	0.80
Cost of Coal Transportaion (Rs/kWh)	**0.43**	**1.12**	**1.78**

Source: IEEFA Estimates, Indian Railways Freight Operations.[13]

Landed fuel cost is a significant part of coal power tariffs. The uncertain and varying level of inflation in this cost impacts the underlying LCOE assumptions if the actual inflation in freight costs is higher than the assumed rate for the project's LCOE.

International Coal Price Volatility

About 16.2GW of India's coastal coal-fired power plants are built to operate on 100% imported coal. High volatility in international coal prices would vary the variable cost of coal-fired power plants and undermine the stated LCOEs which do not account for this volatility.

Figure 8 depicts the high volatility in international thermal coal prices (6000kcal/kg) across Europe and Asia between 2017 to 2020.

[11] Brookings India. Indian Railways and Coal: An Unsustainable Interdependency. July 2018.
[12] The Indian Express. Railways tweaks coal freight rates. 11 January 2018.
[13] Freight Operation Information System. June 2021.

Figure 8: Thermal Coal Price Markers in Europe and Asia, 2017-2020

Source: IEA.

The Indian government has rightly set an objective to reduce coal imports to zero by 2023-24. Pursuant to this longstanding objective, no imported coal-based plants have been approved in the last 3-4 years and there are currently no coastal, 100%-imported coal-based power projects being planned.

Capacity Factor Overestimation Leads To Financial Bubble

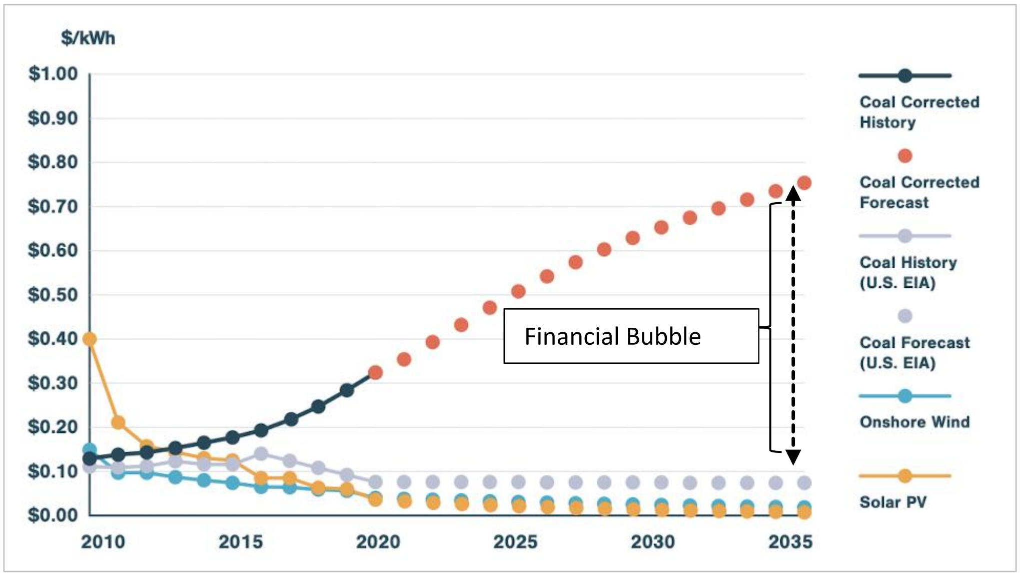
Using a constant rather than a declining or variable capacity factor over the lifetime of a coal-fired power plant's life brings about an unrealistically low cost figure for generating one unit of energy. As a result, the energy assets may look like low-cost projects and worthwhile ventures but may not be so.

Due to the use of a constant capacity factor, a financial bubble surrounds coal-fired plants meaning those assets are overvalued. In other words, in calculating the net present value (NPV) of a fossil-fuel power plant's cash flow over its lifetime, the deemed low cost per unit of energy would make the project look more financially attractive than it really is for potential investors.

For instance, Figure 9 demonstrates the difference between EIA's LCOE forecast (grey curve) and the corrected LCOE trend forecast provided by RethinkX for coal-fired power plants in the U.S. The red curve is the corrected LCOE until 2035 demonstrating the declining capacity factor. The gap between the corrected forecast and EIA's forecast - which is the financial bubble - gets wider as the future unfolds.

Interestingly, even considering the underestimated LCOE (grey curve), coal-fired power plants in the U.S. were overtaken by onshore wind (blue curve) in 2013 and by solar PV (orange curve) in 2016 in terms of their LCOE.

Figure 9: U.S. Coal Power LCOE Corrected History vs EIA's Forecasts



Source: RethinkX, U.S. EIA Annual Energy Outlook, 2021.

India's coal-fired power sector already carries a massive stranded asset risk.

Debt servicing for underutilised coal-fired power assets becomes extremely difficult and creates a liquidity crunch in the whole value chain. The financial stress then spills over to the power distribution sector as well as affecting India's financial lending institutions. This further inhibits growth in other important segments of the power industry such as renewables and transmission infrastructure, which are extremely critical for India's electricity sector transition.

The financial viability of India's proposed and under construction coal-fired power projects should be re-evaluated based on the right estimation of utilisation factors including LCOE, capacity factor to avoid further bloating of India's non-performing assets.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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