



Australia's Gas-fired Recovery Under Scrutiny

Inaccurate Assumptions Behind Fossil Fuel Power Plants' Capacity Factor Leads to Financial Overvaluations

Executive Summary

The Australian government launched the country's so-called gas-fired recovery in September 2020, suggesting gas was the "critical enabler of Australia's economy"¹.

This briefing note looks at the stranded asset risks of this recovery plan.

From a financial perspective, the Australian government repeats a global modelling error by using patently optimistic assumptions of there being a 'constant' capacity factor of fossil-based power plants, one not supported by historic evidence.

IEEFA notes there has been a steady decline in the capacity factor of coal-fired power plants globally, and expects a similar trend going forward for gas-fired plants.

Using the misleading assumption of a *constant capacity factor* leads to an underestimation of the cost for each unit of electricity to be produced by a power plant throughout its lifetime - which is called the levelized cost of energy or LCOE.

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?

**The Australian
government is repeating
a global modelling error.**

¹ Prime Minister of Australia. [Media Release](#). 15 September 2020.

Leveraging an excellent report by RethinkX (led by leading Futurologist Tony Seba)², IEEFA confirms that the LCOE of gas- and coal-fired power plants is being underestimated globally by energy authorities and financial institutions alike because they are basing calculations on the assumption that plants have a constant, high capacity factor overtime and will be able to successfully produce the same quantity of electricity each and every year throughout their life.

The capacity factors of fossil fuel power plants are being over-estimated, meaning their LCOEs are materially understated.

In fact, this constancy rarely occurs. What is constant is that the utilisation rate of fossil fuel power plants are being 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.

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

Likewise, the average utilisation rate of coal-fired power plants in India hit a decade-low in 2020/21 of just 53%, well below the 70-80% 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 (an LCOE of US\$20/MWh) in December 2020, down 18% year-on-year.

Given the merit order dispatch system in electricity markets, a zero marginal cost of production once built, solar inevitably cannibalises the demand of high marginal-cost coal-fired power plants during daylight operation.

The same story has been happening for gas-fired power plants in some parts of the world including Australia, and for projects yet to begin, it is forecasted that they will experience the same declining trend soon.

Assuming a constant and inflated capacity factor for fossil-fuelled power plants leads to an underestimated LCOE, and this in turn means that the underutilisation relative to expectations creates an overvaluation of fossil-based energy assets, another factor driving the surge in stranded fossil fuel assets globally.

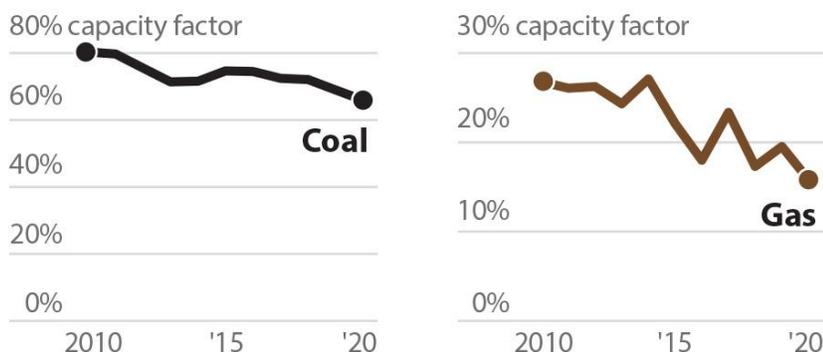
Australian government investment in new gas-fired power plants assumes a constant capacity factor that both is higher than what will likely occur, and ignoring

² RethinkX. [The Great Stranding: How Inaccurate Mainstream LCOE Estimates are Creating a Trillion-Dollar Bubble in Conventional Energy Assets.](#)

the likely declining capacity factor over time as demand response management, batteries and pumped hydro storage increasingly crowd out higher marginal cost gas generation.

Australian Gas and Coal Power Plants Used Less

Decline in capacity factors for fossil fuels over 10 years



Sources: OpenNEM (AEMO), Global Energy Observatory.

An inaccurate estimate of LCOE for existing and new gas-fired power plants leads to the wrong conclusions in the investment community about the government's panacea post-COVID: the 'gas-fired recovery'. For example, the Kurri Kurri gas plant is expected to operate just 2.5% of the year, making cost-effective recovery prohibitively expensive for Australian electricity consumers.

We argue that the Australian government through its 'gas-fired recovery' is funding and encouraging investment in assets which are financially overvalued and likely to be stranded before they have even been built.

The assumption of a constant, high capacity factor should be revised in the face of a decade of global evidence in order to avoid financial overvaluation of fossil-based energy assets.

Investors should take note.

Financial Valuation of Energy Assets

Levelized Cost of Energy (LCOE)

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

LCOE is widely used by energy authorities such as the International Energy Agency (IEA), Commonwealth Scientific and Industrial Research Organisation (CSIRO)³ and

³ CSIRO. *GenCost 2020-21*. Apx Table B.8 Data assumptions for LCOE calculations. June 2021. For both low assumption and high assumption scenarios, constant capacity factors have been considered for fossil fuel power plants over the years 2020, 2030, 2040, and 2050.

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.

LCOE is defined as the net present cost of one unit of generated electricity for a power plant over its book or assumed useful lifetime. The greater the amount of electricity produced, the lower the per capita cost of one 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).⁴ This means that an investor, on average, would incur US\$72 per MWh of electricity produced by this type of power plant over its lifetime in today's dollar terms (ie. the real price).

An estimation of electricity production over a plant's life relative to the plant's maximum capacity of electricity production, which is called capacity factor, is a critical factor affecting LCOE and the financial valuation of power plants. However, there are historically misleading assumptions using an inflated capacity factor and therefore an inflated assumption of the amount of electricity produced by gas- and coal-fired power plants over their lifetime.

Capacity Factor Is a Key Element

The capacity factor⁵ 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 all 8,760 hours of the year (24 hours per day, 365 days annually).

The capacity factor for gas-fired power plants is also forecast to decline.

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.** Historical evidence and forward-looking reputable research show however that the

⁴ EIA. [Levelized Costs of New Generation Resources in the Annual Energy Outlook 2021](#). February 2021.

⁵ Sometimes capacity factor and utilization 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. 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 5-10% of the year due to circumstances outside of its direct control, and coal plant owners can charge the customers for this lost generation opportunity.

capacity factor for coal-fired power plants has been declining globally since the beginning of last decade, and that gas-fired power plants are also forecast to decline.

IEEFA notes the assumption of a constant capacity factor based on the optimal operating rate, rather than the likely outcome, should be revised in order to avoid financial overvaluation of fossil-based energy assets.

Australia

The capacity factor of coal-fired power plants operating in Australia's National Electricity Market (NEM) has declined by about one quarter since 2008. Figure 1 demonstrates the sharply negative trend over the last 12 years; a drop from 88% in 2008 to 67% in 2020.

Figure 1: Coal-fired Power Plant's Capacity Factor Trend in Australia's National Electricity Market (2008-2020)



Source: IEEFA Calculation Data: [OPENNEM.org](https://opennem.org).⁶

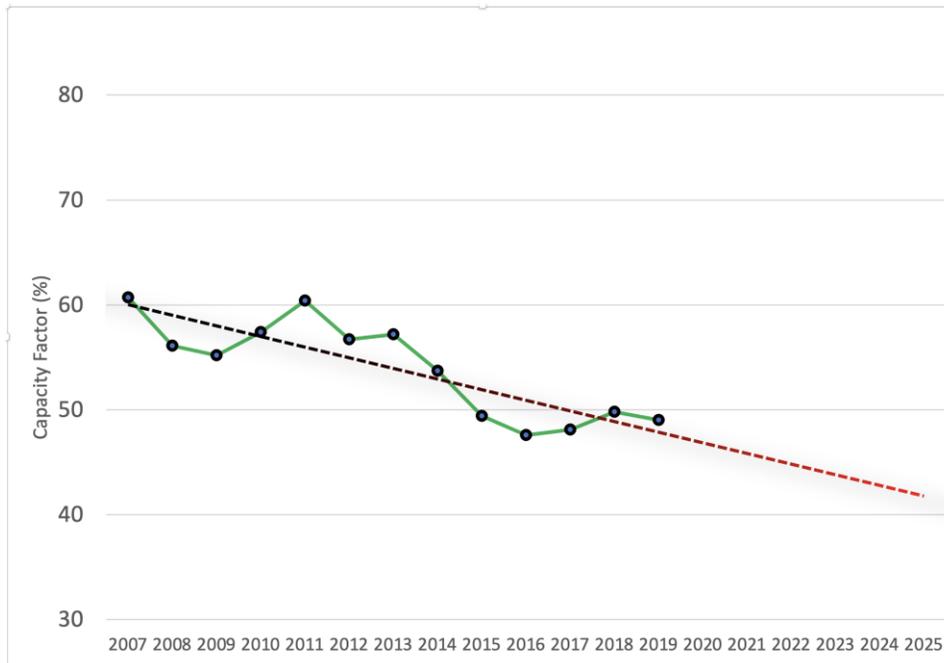
China

The capacity factor of China's coal-fired power plants has declined from 61% in 2007 to 49% in 2019 (Figure 2), with a similar outcome evidenced in 2020. This 20% decline rate in one of the most coal-dependent economies in the world is alarming. Linear extrapolation shows the capacity factor could fall to 40% in the next 4 years, particularly if China fails to learn from the evidence of the last 5 years

⁶ OpenNEM.

and continues to build an idle new coal power plant every two weeks.⁷

Figure 1: Coal-fired Power Plant's Capacity Factor Trend in China (2007-2019)



Source: China Electricity Commission (CEC), [Carbonbrief.org](https://www.carbonbrief.org)⁸

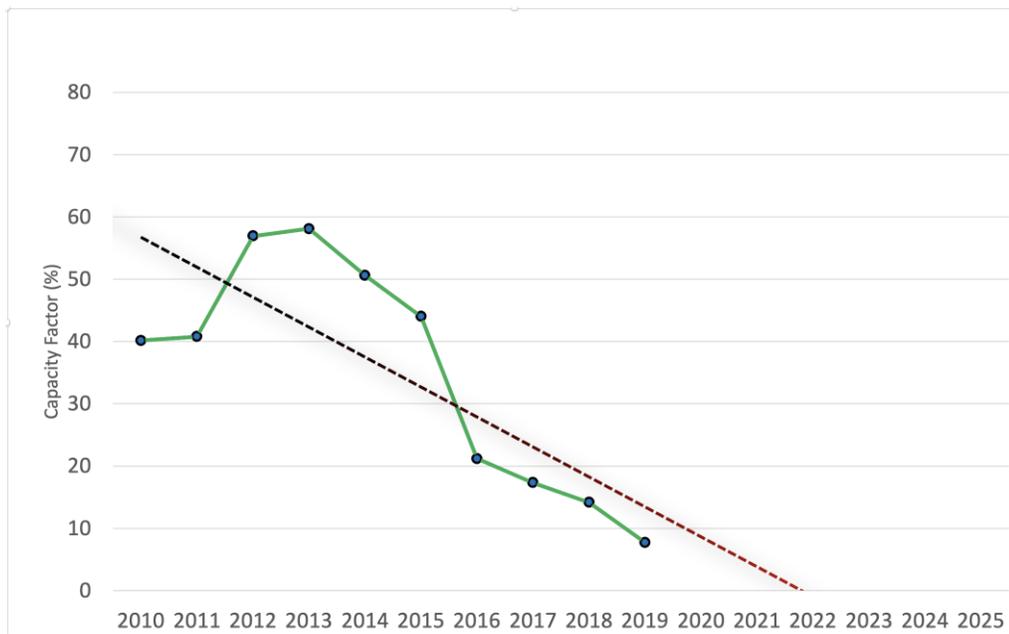
UK

More severe trends can be seen in the UK with Figure 3 demonstrating the collapse in the capacity factor of its' coal-fired power plants. The drastic falls account for numerous stranded assets in the UK's coal sector in the last five years.

The linear forecast trend shows the UK's coal era will end in 2022. There is no financial rationale for investing in this collapsing energy asset. The introduction of capacity market payments (a term used for yet another fossil fuel subsidy) failed to prevent the unexpected early closure of the entire UK fleet of coal plants.

⁷ 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.

⁸ Carbon Brief. [Analysis: Will China build hundreds of new coal plants in the 2020s?](https://www.carbonbrief.org/analysis-will-china-build-hundreds-of-new-coal-plants-in-the-2020s) March 2020.

Figure 2: UK Coal-fired Power Plant's Capacity Factor Trend (2010-2019)

Source: IEEFA Calculations, Data: *Digest of UK Energy Statistics (DUKES): Electricity*.⁹

United States

The downturn in the capacity factor of U.S. coal-fired power plants is clear-cut as well. Despite this, the EIA continues to consider a constant (and sometimes increasing) capacity factor and consequently a constant amount of yearly electricity production from these power plants.

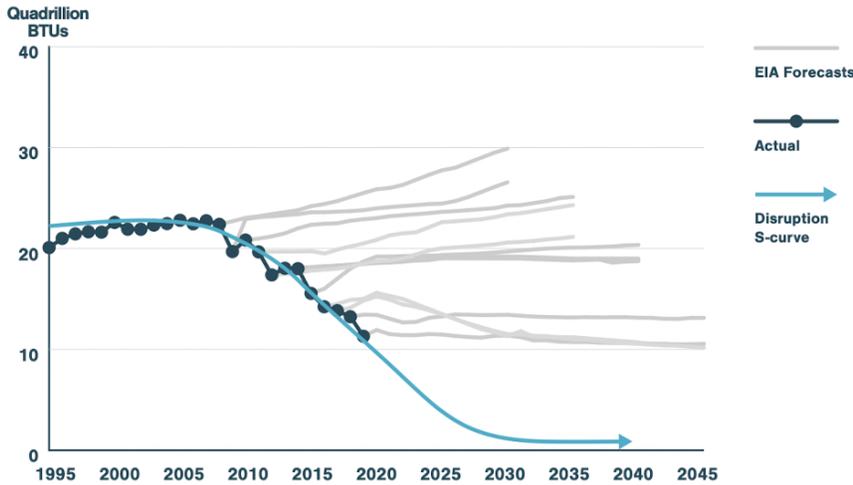
Figure 4 shows how optimistic the EIA is about the future of coal-fired power generation in the U.S.¹⁰ The grey lines are the EIA's forecast for coal-fired power generation over the coming decades. However, as thinktank RethinkX forecasts¹¹, the blue S-curve is the more realistic forecast of U.S. coal-fired power plants based on historical data and the huge impact of disruptive new technologies including solar, wind and batteries.

⁹ UK Government. *Digest of UK Energy Statistics (DUKES): Electricity*. July 2020.

¹⁰ EIA's 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].

¹¹ RethinkX. *Rethinking Energy*. February 2021.

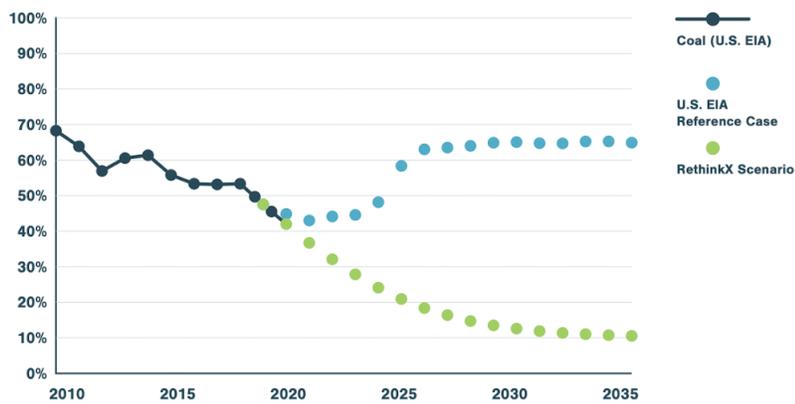
Figure 4: Coal-fired Power Plants' Generation in the U.S: Disruption Forecast (RethinkX) vs EIA Forecast



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 5 (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, particularly in light of President Biden's June 2021 pledge to make the U.S. electricity sector carbon free by 2035.¹²

Figure 5: Coal-fired Power Plants' Capacity Factor in the U.S: RethinkX 's Forecast vs EIA's Forecast



Source: RethinkX, U.S. EIA Annual Energy Outlook, 2021.¹³

¹² Whitehouse Fact Sheet. G7 to Announce Joint Actions to End Public Support for Overseas Unabated Coal Generation by End of 2021. 12 June 2021.

¹³ EIA. Annual Energy Outlook 2021.

Capacity Factor Overestimation Leads to Financial Bubble

Using a constant rather than declining capacity factor over the lifetime of a gas- or coal-fired power plants' life brings about an unrealistically low cost figure for generating one unit of energy from that fossil-fuelled power plants. This results in the fossil-based energy asset looking like a low-cost project and makes it artificially more financially attractive relative to its competitors (ie. renewable energy and battery technologies), thereby misleading potential investors.

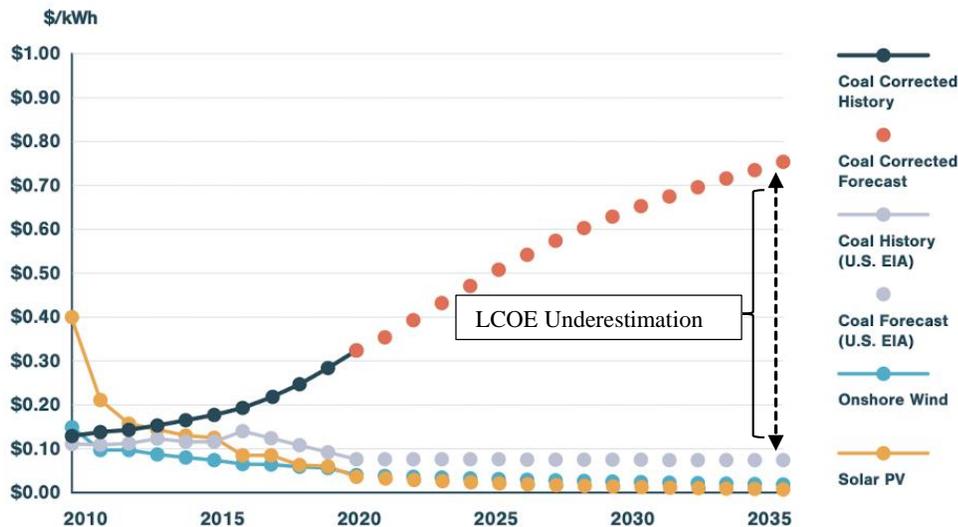
The underestimation of cost for generating energy from fossil-based power plants, rooted in the assumption of a constant capacity factor, in turn creates a financial bubble, meaning those assets are overvalued.

Figure 6 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 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.

The underestimation of the cost of generating energy from fossil fuel power plants creates a financial bubble, meaning those assets are overvalued.

Figure 6: U.S. Coal Power Plants' LCOE: Corrected History vs EIA's Forecast



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

The Dying Coal Story Has Implications for Gas

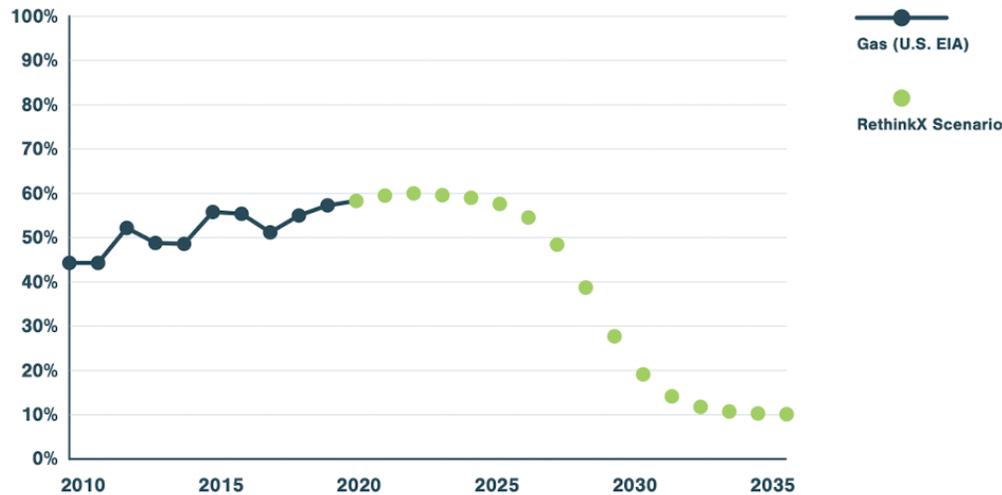
After thermal coal, 'natural' gas is the next victim in the tsunami of the global energy transition led by the technology and scale driven deflation evident in wind, solar, batteries and electric vehicles.

Renewables are aggressively penetrating energy systems with two important implications for fossil-fuelled power plants. First, the share of coal and gas will continue to shrink in electricity generation; the merit order dispatch system means fossil-fuel power plants need to be used less often which means a lower capacity factor in coming years, which in turn challenges their useful life assumption.

Gas is the next victim in the tsunami of the global energy transition.

The second consequence is plunging wholesale electricity prices due to the near zero short run marginal cost of renewables in electricity production, as evidenced by the 50-60% collapse in prices in Australia's NEM (at least until May 2021 with the unexpected explosion at one coal plant in Queensland, followed in June 2021 by flooding outages at a second coal plant in Victoria). Renewables can provide very cheap electricity (sometimes at a negative price) to wholesale electricity markets, and this so-called merit order effect smashes gas peakers not able to cover their huge variable cost of production. Even if gas peakers had zero investment costs they would be beaten by solar and wind because of their fuel costs compared to the near zero operational costs of renewables and batteries.

Figure 7: U.S. Gas-fired Power Plants' Capacity Factor Trend in the U.S: RethinkX 's Forecast



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

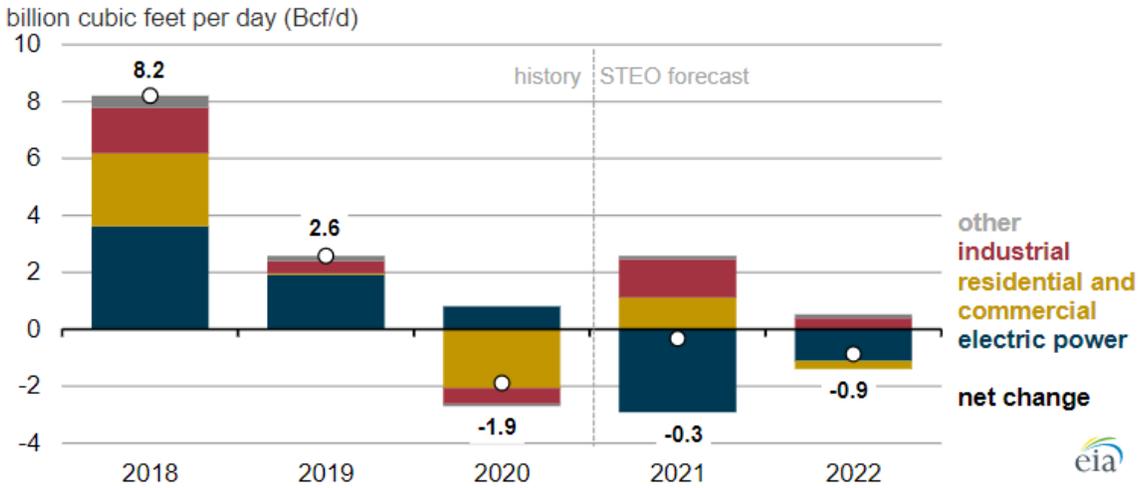
Figure 7 shows a slight increase since 2010 in the capacity factor of U.S. gas-fired power plants (basically Combined Cycle Power Plants) due to the shale boom 'ponzi scheme'¹⁴ that artificially collapsed Henry Hub gas prices. However, this is not stable growth and as RethinkX forecasts, a huge drop is likely to begin from 2022, driven by the sustained reduction in drill rig deployment rates.¹⁵

RethinkX's prediction aligns with the EIA's Short-Term Energy Outlook showing a considerable decline in gas consumption in the U.S. electric power sector during 2021 and 2022. (Figure 8)

¹⁴ CNBC. Shale oil industry a 'Ponzi scheme' or can it boom again? 17 May 2016.

¹⁵ Reuters. U.S. oil & gas rig count falls for first time in six weeks -Baker Hughes. 5 June 2021.

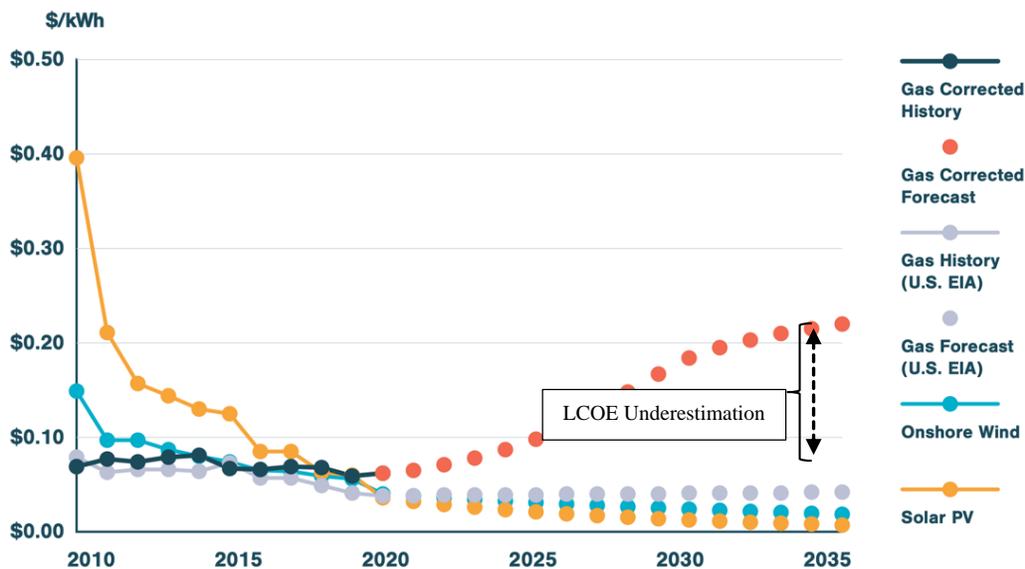
Figure 8: U.S. Natural Gas Consumption by Sector, Net Change from Previous Year (2018-2022)



Source: U.S. EIA, Short-Term Energy Outlook (STEO)

Similar to the coal industry, **capacity factor overestimation and consequently the underestimation of LCOE is creating a financial bubble in the gas industry**, as depicted in Figure 9.

Figure 9: U.S. Gas-fired Power Plant LCOE Corrected History vs EIA's Forecasts

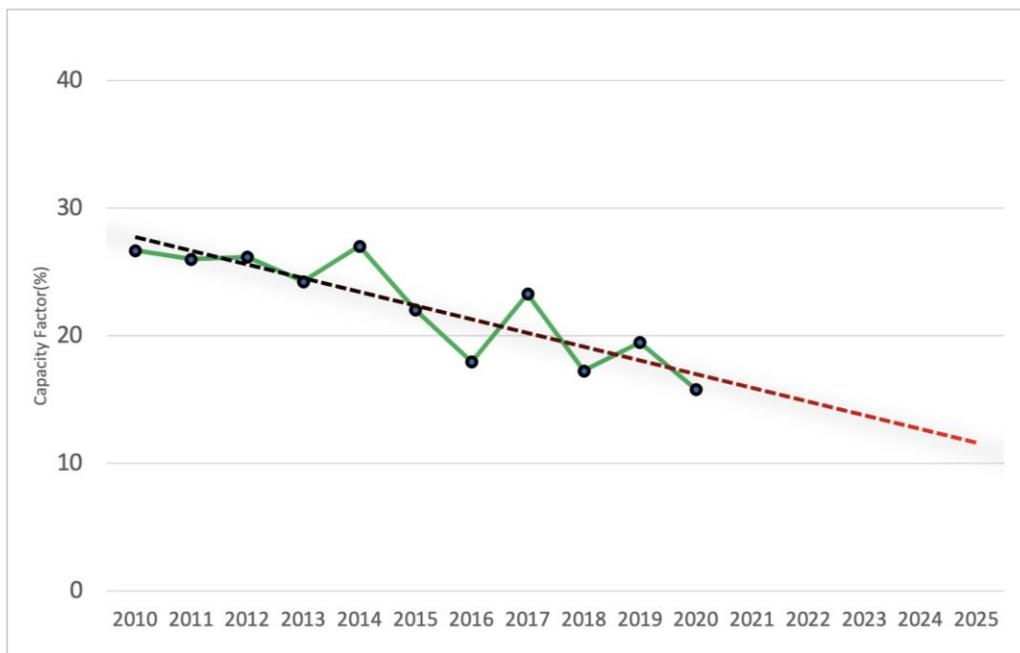


Source: RethinkX, EIA Annual Energy Outlook, 2021.

Gas-fired Power in Australia

Australia's NEM data shows an even more severe story than that occurring in the U.S. The average capacity factor of all domestic gas-fired power plants¹⁶ across the NEM has fallen by 41% in the last decade from 27% to a decade low of just 16% (Figure 10).

Figure 10: Gas-fired Power Plants' Capacity Factor in Australia's National Electricity Market (2010-2020)



Source: IEEFA Calculations, Data: AEMO, OPENNEM, Global Energy Observatory.

The Australian government recently announced¹⁷ A\$600 million in funding through the governmental-owned company Snowy Hydro for a new gas peaker or dispatchable gas power plant - the Kurri Kurri Open Cycle Gas Turbine (OCGT)¹⁸, claiming the plant was necessary to maintain the reliability and security of the grid after the closure of the Liddell coal-fired power station in 2023. In direct contradiction of this claim, the Australian Energy Market Operator while (AEMO) has forecasted only around 150MW would be needed to compensate that shortfall.¹⁹

¹⁶ Including CCGT, OCGT, Reciprocating, Steam and Waste Coal Mine.

¹⁷ ABC. [Federal government will spend \\$600 million on new Kurri Kurri gas plant in the NSW Hunter Valley](#). 18 May 2021.

¹⁸ Snowy Hydro. [Hunter Power Project](#).

¹⁹ ABC. [The Government's backing of a new power plant is a gas-fired distraction](#). 19 September 2020.

Exclusively analysing the capacity factor trend of gas peakers²⁰ in the NEM, IEEFA notes they have been experiencing falls since 2010 as well (Figure 11).

Figure 11: Gas Peakers' Capacity Factor in Australia's NEM (2010-2020)



Source: IEEFA Calculations, Data: Australian Energy Market Operator (AEMO), OpenNEM, Global Energy Observatory.²¹

The capacity factor of high marginal cost gas-fired power plants is falling under the aggressive ongoing cost-down pressure of renewables and batteries. The 41% drop since 2010 shows gas-fired power plants in Australia are likely to be stranded assets into the future.

As such, recent announcements of massive new government subsidies for new gas-fired power plants in New South Wales including Tallawarra B²², Kurri Kurri²³ and Port Kembla²⁴ will likely mislead investors,

**Gas-fired power plants
in Australia are likely
to be stranded assets
into the future.**

²⁰ Open Cycle Gas Turbine (OCGT) and Reciprocating plants.

²¹ Global Energy Observatory.

²² SMH. Government intervention is complicating renewable energy revolution. 4 May 2021.

²³ ABC. Federal government will spend \$600 million on new Kurri Kurri gas plant in the NSW Hunter Valley. 18 May 2021.

²⁴ AFR. Forrest willing to fund \$1b green power station in NSW. 16 March 2021.

bankers, and asset managers in directing financial flows towards similar gas energy assets into the future.

IEEFA notes, investors beware. The capacity factor and LCOE analysis shows that investing in new fossil gas projects does not make financial sense, particularly in light of the growing global investor and political focus on net zero emissions by 2050. Capital flight on high emissions fossil fuel projects is accelerating, consistent with the International Energy Agency (IEA) Net Zero Emissions by 2050 Roadmap that calls for no new unabated coal, oil or gas projects globally.²⁵

Investing in new fossil gas projects does not make financial sense.

The Australian government is challenging the growing global consensus on the urgent need to address the financial costs of the science of climate change, and the resulting financial bubble surrounding gas assets by backing a 'gas-fired recovery'. That financial bubble is about to burst and will likely ignite negative financial consequences for investors.

²⁵ IEA. [Net Zero by 2050: A Roadmap for the Global Energy Sector](#). 17 May 2021.

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

About the Authors

Bruce Robertson

Bruce Robertson has been a fund manager and professional investor for over 32 years. He has worked with Perpetual Trustees, UBS, Nippon Life Insurance and BT and is an active participant in the national debate on energy issues in Australia. brobertson@ieefa.org

Milad Mousavian

Energy Analyst for Australian energy sector, Milad Mousavian has worked as a consultant in the public and private sector and has been conducting research in the fields of energy transition, sustainability and climate change economics. He has a Masters in Economics from the University of Melbourne and in Energy Systems Planning from the University of Tehran. mmousavian@ieefa.org

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