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Thar Coal Locking Pakistan Into Unsustainable Capacity Payments

Sindh Province Illustrates the Nation's Renewable Energy Potential

Executive Summary

Two more Thar coal power projects have reached financial close so far in 2020 as the high capacity payments of such fossil fuel-based plants threaten to become financially unsustainable. Meanwhile, the economic downturn caused by COVID-19 is now increasing the risk of Pakistan being burdened by overcapacity which will make the financial issues within the power sector even worse.

Further Coal Projects Are Unaffordable and Increasing Overcapacity Risk

The two coal-fired power proposals to reach financial close so far this year are Thar Energy Ltd's US$500m, 330 megawatt (MW) coal power project and Shanghai Electric's US$2bn, 1,320MW Thar Coal Block-1 (TCB-1) proposal. Both will receive large capacity payments according to their approved tariffs.

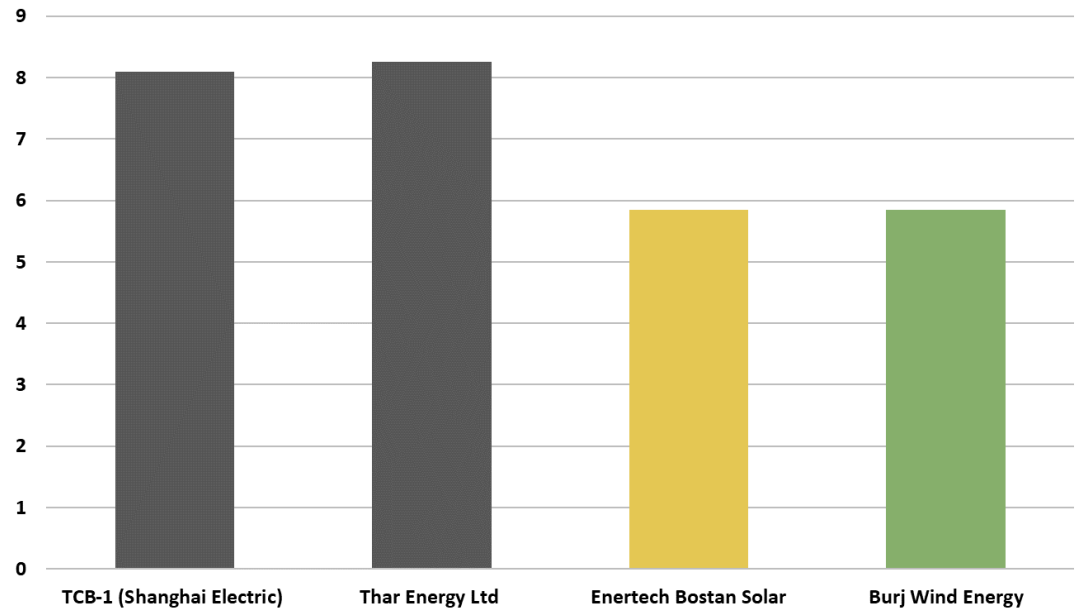
Meanwhile, Prime Minister Imran Khan noted in April 2020 that total capacity payments to public, private and CPEC power generators could reach an entirely unsustainable Rs1.5 trillion (US$9bn) in the next few years as more of such capacity is added.

The government of Pakistan has now asked China for easier repayment terms on 12 gigawatts (GW) of CPEC power projects totalling US$30bn of investment, hoping that a lower interest rate and longer repayment schedule can reduce the capacity payments needed to cover the generators' fixed costs. Servicing of Pakistan's total debt will take up 41% of the entire FY2020-21 budget of Rs7.1 trillion (US$43.2 billion).

The rising issue of overcapacity in Pakistan means that large capacity payments are even more of a financial burden as they must be paid to the generators even if there is not sufficient power demand for the power plants to produce electricity.

Overcapacity was an issue in Pakistan before the coronavirus pandemic. Slow economic growth in Pakistan prior to COVID-19 meant that power demand growth was lower than expected. Electricity consumption for fiscal year 2018-19 rose only 2.3% around the country and only 0.8% in Sindh province (including K-Electric) according to NEPRA data. If K-Electric is excluded, power consumption actually declined in Sindh province in FY2018-19.

Figure I: Recent Determined Levelized Power Tariffs for Domestic Coal, Wind and Solar Power in Pakistan (Rs/kWh)



Source: NEPRA.

Other nations planning to construct Chinese built and financed coal plants have been facing overcapacity issues. Bangladesh already has excess capacity that has required significant capacity payments to plants lying idle much of the time. Overall power capacity utilisation in Bangladesh for 2018-19 was just 43%, while capacity payments to idle plants reached Tk90bn (US$1.1bn) in 2018-19 and are expected to continue to rise.

Egypt recently shelved plans for a huge 6.6GW China-backed coal-fired power plant due to concerns about overcapacity and a preference for renewable energy.

The COVID-19 pandemic is now raising the risk that Pakistan will lock in long term overcapacity given its plans to continue rolling out large coal-fired and hydro power stations. A switch of focus towards smaller, modular renewable energy additions, grid improvements and energy efficiency can help reduce the risk of overcapacity whilst avoiding the further burden of capacity payments.

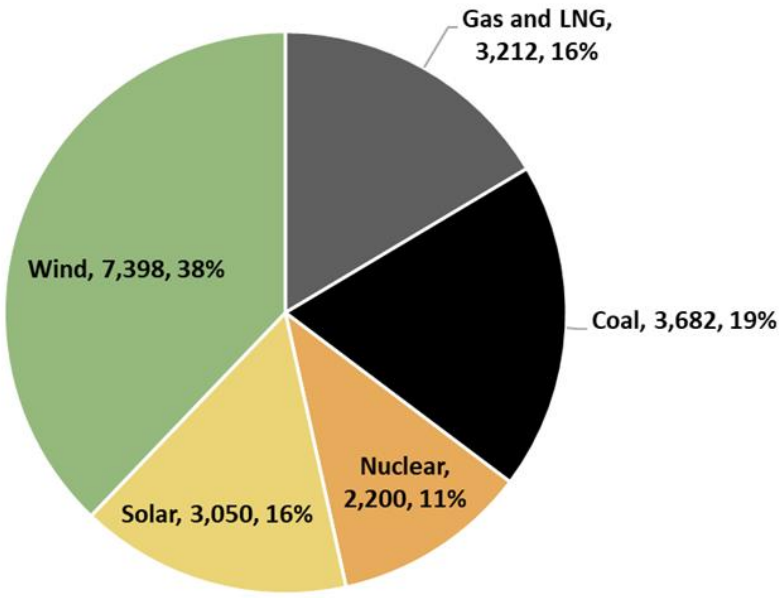
In addition to being the cheapest source of new power generation Pakistan (Figure I), renewable energy also has the advantage of being able to attract a wider range of potential investors to Pakistan who would not want to invest in coal. With Chinese finance increasingly becoming the only funding source available for coal power, Pakistan faces the prospect of further power system debt to just one nation if it continues its plan to exploit Thar coal reserves.

Sindh Highlights Pakistan's Renewable Energy Potential

Much of the overcapacity in thermal power is set to be built in Sindh province. Sindh is also the country's renewable energy leader thanks to its existing wind power capacity within the Gharo-Jhimpir wind corridor.

The province demonstrates the potential for a significant increase in Pakistan's renewable energy ambition, bringing with it a reduced cost of power generation, reduced emphasis on capacity payments and improved energy security.

Figure II: Modelled Power Capacity Potential for Sindh 2029/30 (MW)



Source: NEPRA, IEEFA calculations.

Three new developments demonstrate the provinces' renewable energy ambition:

1. Amongst the new renewable energy projects in Sindh's pipeline are the "Super Six" wind projects. These projects total 310MW of capacity to be built within the Gharo-Jhimpir wind corridor by local companies. They will provide the lowest cost electricity yet seen in Pakistan.

2. Renewable energy tariffs look set to decline further with the province's stated intention of introducing competitive bidding reverse auctions. Transparent competitive bidding for renewable energy projects has driven wind and solar tariffs down across the world. Reverse auctions also avoid much of the non-competitive bidding evident in thermal power projects.

3. The government of Sindh has been granted a licence for a provincial grid company that will complement the National Transmission and Despatch Company (NTDC) and link the Gharo-Jhimpir wind corridor to power

consumers around the province. Sindh is the first province to take such a step.

IEEFA's model for an alternative power future for Sindh province envisages increased ambition to capitalise on the domestic renewable energy potential of the province. In the model, renewable energy reaches over 50% of capacity by 2030 within the province (Figure II), well in excess of the Pakistan government's draft target of 30% across the whole nation by that date. Yearly additions of 270MW of solar and 550MW wind out to 2030 to achieve this are highly achievable given the international context.

By following this alternative path, Sindh would benefit from the declining cost of renewable energy more than any other province in Pakistan. Driving deflationary electricity generation provides a strong boost to the global competitiveness of downstream industry activity.

Renewable energy tariffs do not include capacity payments to generators so an increased focus on wind and solar also helps avoid the high capacity payments that are already an issue in the power system and threaten to become totally unsustainable.

The International Energy Agency (IEA) has called for clean energy investment to be central to stimulus packages aimed at economic recovery post-coronavirus. As Pakistan shortly begins to emerge from the COVID-19-induced economic downtown, it faces an opportunity to overhaul its power capacity addition plans and avoid the financial burden of large, expensive power plants with their unsustainable capacity payments.

Increased focus on modular renewable energy additions and transmission and distribution improvements can help Pakistan reduce overcapacity risk whilst benefitting from the lowest-cost source of power generation.

Table of Contents

Two More Thar Coal Projects Reach Financial Close

Despite the introduction of a draft renewable energy policy with a target of reaching 30% renewable energy capacity by 2030, the focus of Pakistan's capacity power additions remains on coal-fired power. Two more domestic coal-fired power proposals at Thar, Sindh province have reached financial close so far in 2020.

In January, Thar Energy Ltd reached financial close on its US$500m, 330MW coal power project. Thar Energy is owned by a consortium of Hubco Power Company Ltd, Fauji Fertiliser Ltd and China Machinery Engineering Corporation (CMEC) within the China-Pakistan Economic Corridor Project (CPEC). The lead financiers are China Development Bank and Habib Bank.

In March, another CPEC project – Shanghai Electric's US$2bn, 1,320MW Thar Coal Block-1 (TCB-1) – reached financial close. Shanghai Electric is a subsidiary of one of China's major power utilities – State Power Investment Corporation.

Coal Plants are an Expensive Burden

Renewable energy is the cheapest source of new power generation in Pakistan. Despite this, more coal-fired power plants are being built and planned with power tariffs significantly more expensive than new wind and solar tariffs (Figure 1).

Furthermore, the capacity payments that make up around half of the overall tariff of coal-fired power plants for the first ten years of operation are becoming a major burden on the nation's power system. Prime Minister Imran Khan has noted that total capacity payments to public, private and CPEC power generators could reach an entirely unsustainable Rs1.5 trillion (US$9bn) in the next few years as more capacity is added.[1]

In the case of CPEC coal projects, capacity payments are higher in the first ten years of operation as they cover principal and interest payments to be paid over that period. The government of Pakistan has now asked China for easier repayment terms on 12GW of CPEC power projects totalling US$30bn of investment, hoping that a lower interest rate and longer repayment schedule can reduce the capacity payments needed to cover the generators' fixed costs.

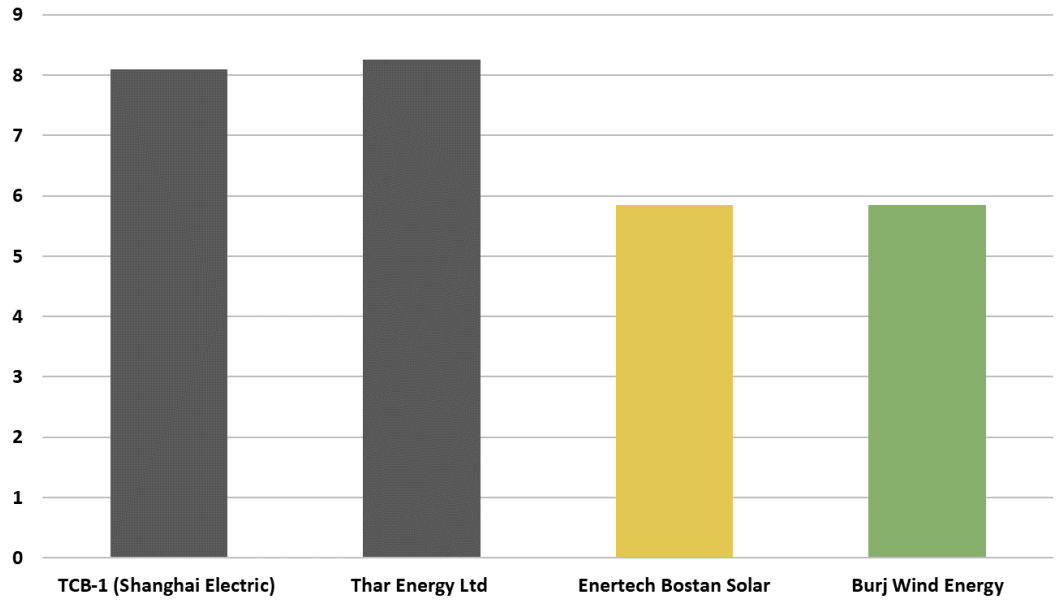
Renewable energy is the cheapest source of new power generation in Pakistan

In the hope that it can get foreign debt repayments rescheduled, the Pakistan government did not allocate any amount for repayment of foreign loans in its recent 2020-21 budget announcement. For 2019-20, Rs1.2 trillion (US$7.3 billion) was allocated for foreign debt repayments.

[1] Dawn. Pakistan urges China to soften terms for power deals. 15 April 2020.

However, the 2020-21 budget did allocate increased amounts for interest payments on domestic and foreign debt. For the coming fiscal year, debt servicing will amount to Rs2.95 trillion (US$17.9 billion), up 9% on the revised 2019-20 figure of Rs2.7 trillion (US$16.4 billion). Debt servicing will take up 41% of the entire FY2020-21 budget of Rs7.1 trillion (US$43.2 billion).[2]

Figure 1: Recent Determined Levelized Power Tariffs for Domestic Coal, Wind and Solar Power in Pakistan (Rs/kWh)



Source: NEPRA.

High Coal-power Capacity Payments

The coal-power tariff issues outlined above also apply to the Thar Energy Ltd and Shanghai Electric coal-fired power projects that have reached financial close this year. Figure 1 compares the NEPRA-determined levelized tariffs for these projects with the significantly lower tariffs of two recent renewable energy projects.

Like other CPEC coal power projects, the Thar Energy and Shanghai Electric projects have loan repayment terms over ten years. This means that capacity payments to the plants over that period will be high, adding to the growing financial burden within the power system. According to the NEPRA determined tariffs, the Thar Energy ad Shanghai Electric plants will both receive a Rs4.32/kWh capacity payment based on an assumed plant utilisation rate of 85%.

An assumed utilisation rate of 85% looks highly optimistic. Experience in other developing nations shows that, when coal-fired power plants are built in excess of demand growth – as Pakistan is on course to do – the utilisation of those plants is significantly lower than expected. China has experienced coal plant utilisation rates

[2] Express Tribune. Budget 2020-21.

under 50% due to its excessive coal power build out whilst India's coal power fleet was suffering with utilisation of only 55% even prior to the worst impacts of COVID-19.[3]

Circular Debt

Unsustainable capacity payments are making electricity more expensive and contributing to Pakistan's major issue with circular debt – the accumulated debt within the power system that has now reached around Rs2 trillion (US$12 billion).

A major component of the power system's circular debt is unpaid subsidies. These are meant to compensate distribution companies for selling electricity to consumers below the rate that they pay power generators for it. As a result, the distribution companies are often unable to pay power generators, who in turn cannot pay for fuel and are forced to keep power plants idle. Pakistan suffers power blackouts despite having enough capacity to cover present demand.

In addition, very significant transmission and distribution (T&D) losses mean that around a quarter of all power generated never reaches consumers. Even when it does, collection rates for power bills are often low.

As well as addressing T&D losses and power theft, the government's plan to tackle circular debt is to raise power tariffs to more accurately reflect the cost of generation. This is far from ideal in an economy with sluggish growth made worse by COVID-19.

Prioritising the lowest cost power generation should be part of Pakistan's response to its growing circular debt problem

Prioritising the lowest cost power generation (wind and solar) should be part of Pakistan's response to its growing circular debt problem.

COVID-19 Increases Growing Overcapacity Risk

The rising issue of overcapacity in Pakistan means that large capacity payments are even more of a financial burden as they must be paid to the generators even if there is not sufficient power demand for the power plants to produce electricity.

Overcapacity was an issue in Pakistan before the coronavirus pandemic. Slow economic growth in Pakistan prior to COVID-19 meant that power demand growth was lower than expected. Electricity consumption for fiscal year 2018-19 rose only 2.3% around the country and only 0.8% in Sindh province (including K-Electric)

[3] IEEFA. Who Would Still Fund a New Coal Plant in India? Stranded Asset Risks Continue to Rise as Solar Deflation Continues. May 2020.

according to NEPRA data.[4] If K-Electric is excluded, power consumption actually declined in Sindh province in FY2018-19.

Across Pakistan as a whole, the utilisation rate of gas-, oil- and LNG-fired power plants declined to 39% in FY2018-19, down from 43% in the prior year, despite no more capacity additions of this type during the year. The overall thermal power capacity utilisation (including coal plants) was just 40% in FY2018-19 according to NEPRA data.

In December 2019 wind-power installations, which do not receive capacity payments, were curtailed in favour of coal and gas generation due to insufficient demand. This was despite wind power's supposed "must run" status.[5]

As has been seen in other developing Asian nations, overestimated demand growth projections are putting the nation on the path towards building more expensive power capacity than it needs.

COVID-19 is now making the situation worse; power demand growth is slowing globally thereby falling even further behind expectations. At the same time, capacity payments will still have to be made to power plants that may increasingly be sitting idle amidst lower-than-expected demand. During FY2020-21, it is expected that another 4GW of power capacity will be added nationally.[6] Where these new plants have capacity payments due according to their tariff agreements, they will become further financial burdens on the power system.

COVID-19 is now making the situation worse; power demand growth is slowing globally

The pandemic is raising the risk that Pakistan is locking in long term overcapacity given its plans to continue rolling out large coal-fired and hydro power stations. It is not the only country facing increased overcapacity risk.

Overcapacity Along China's Belt and Road

Bangladesh already has significant excess capacity that has required capacity payments to plants lying idle much of the time. Overall power capacity utilisation in Bangladesh for 2018-19 was just 43%, while capacity payments to idle plants reached Tk90bn (US$1.1bn) in 2018-19.[7]

Bangladesh's current power capacity addition plan is based around the addition of significant amounts of coal- and LNG-fired power plants and looks certain to lock in

[4] NEPRA. State of the Industry Report 2019.
[5] Dawn. Alarm mounts as wind power turbines halt after government stops purchases. 8 December 2019.
[6] Express Tribune. Pakistan's installed capacity soars. 14 June 2020.
[7] IEEFA. Bangladesh Power Review: Overcapacity, Capacity Payments, Subsidies and Tariffs Are Set to Rise Even Faster. May 2020.

an extremely high level of overcapacity out to at least 2030. This suggests that there will be capacity payments to idle plants for the long term if the planned coal- and LNG-fired power plants come online.

In an indication of what lies ahead, the first of many China-backed Belt and Road Initiative (BRI) coal plants to be built in Bangladesh at Payra has reportedly been receiving capacity payments of US$19m a month whilst half its capacity is idle due to a delayed transmission line connection. The Bangladesh Power Development Board's chairman has stated: "In that case the Payra power plant is going to be a burden and would only increase the government's power subsidy". Since then, the one operating unit at the Payra coal plant has gone offline but is continuing to receive capacity payments whilst standing idle.[8]

There are now some early indications of a possible change of emphasis for China's BRI power investments in Bangladesh. In March 2020, is was revealed that the 350MW Gazaria BRI coal-fired power plant had been cancelled and replaced with plans for grid upgrades to reduce system losses in the rural electricity system.[9] In June 2020, Bangladesh's cabinet committee approved a plan for a joint venture with China for the acceleration of renewable energy investment with a US$500m investment in 500MW of solar and wind power.[10]

Bangladesh already has significant excess capacity that has required capacity payments to plants lying idle much of the time

PLN, Indonesia's state-owned power utility, has seen its misguided reliance on new coal-fired independent power plants (IPPs) lead to the need for rapidly escalating government subsidies. PLN's delayed 2018 financial results revealed that increased IPP payments, along with higher fuel costs had led to the need for a 75% increase in subsidy from the government. The subsidy reached an enormous US$5bn in 2018.[11] COVID-19 is now adding to the financial pressure on PLN as it is required to make capacity payments to IPPs even as power demand drops amid the global economic downturn.[12]

PLN simply cannot afford its current strategy of relying on more coal IPPs. With more of these projects set to come online, PLN's IPP payments are set to increase further still. IEEFA has forecast that government subsidy payments to PLN may reach US$7.2bn in 2021.[13]

Meanwhile, Egypt recently shelved plans for a huge 6.6GW China-backed coal-fired power plant due to concerns about overcapacity and a preference for renewable

[8] Financial Express. Country's biggest Payra coal-fired power plant remains shut. 31 May 2020.
[9] Financial Express. Chinese loans: Govt to drop coal plant project. 20 March 2020.
[10] PV Magazine. Bangladesh looks to Beijing to speed its solar ambition. 9 June 2020.
[11] IEEFA. PLN's fractured finances require real leadership, 30 May 2019
[12] Jakarta Post. PLN books $2.8b loss in Q1 amid weakening rupiah, 16 June 2020
[13] IEEFA, PLN in Crisis – Time for Independent Power Producers to Share the Pain?, April 2020

energy.[14] Egypt is now moving ahead with a plan to implement wind and solar projects totalling 3,170MW.[15]

China on Course to Becoming the Last Financier of Coal

A determination to expand power generation via coal-fired plants means Pakistan is becoming more indebted to just one nation for power projects. With international finance for coal power rapidly drying up, China is rapidly becoming the last source of coal power largesse.

An ever lengthening list of banks have announced policies that distance them from thermal coal.[16] Now major investors are increasingly associating carbon risk with financial risk. BlackRock, the world's largest asset manager with US$7 trillion under management, recently raised concerns with South Korean state-owned power utility KEPCO over its overseas coal projects.[17]

State-backed finance for coal is also declining. Partly in response to South Korea's major air pollution problem, its government is now initiating a "Green New Deal" to refocus its economy and move it away from coal and towards renewables.[18] This looks set to also reduce South Korean export credit agency (ECA) support for South Korean-built coal power projects around the developing world. South Korea has historically been one of the key enablers of coal power in developing countries along with China.

The other key state financier of coal power across Asia has been Japan. The Japan Bank for International Cooperation (JBIC) is under increasing pressure to end coal finance.[19]

With Chinese finance becoming the only funding source available for coal power, Pakistan faces the prospect of increasing debt to China if it continues its plan to exploit the Thar coal reserve. Debts owed to China for power plants are already a financial difficulty for Pakistan, made worse by the COVID-19 economic downturn, evidenced by Pakistan recently asking China for debt relief on US$30bn of debt for 12,000MW of power plants.[20] The Paris Club of creditor nations has recently provided debt relief to Pakistan but it is not yet clear what relief China will provide.[21]

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[14] ChinaDialogue. Shelving of huge BRI coal plant highlights overcapacity risk in Pakistan and Bangladesh. 1 May 2020.
[15] ESI Africa. Egypt: New and Renewable Energy Authority form on growth plan. 4 June 2020.
[16] IEEFA. Financial institutions are restricting thermal coal funding.
[17] Bloomberg. BlackRock Warns Korean Utility on Overseas Coal Plant Push. 29 May 2020.
[18] Forbes. South Korea Embraces EU-Style Green Deal For COVID-19 Recovery. 16 April 2020.
[19] Reuters. JBIC muddies comments from chief on ending coal finance. 1 May 2020.
[20] Dawn. Pakistan urges China to soften terms for power deals. 15 April 2020.
[21] Reuters, Ethiopia. Pakistan among latest countries to get Paris Club debt relief. 10 June 2020.

Amongst the many advantages in prioritising renewable energy is the much wider range of potential investors the new technology can attract to Pakistan. Whilst the number of financiers for coal is declining fast, the world's major banks, power technology firms and investors are increasingly keen to take part in opportunities in renewable energy. Global wind power technology leader Vestas has shown an interest in Pakistan renewable energy opportunities.[22]

A switch in focus from coal to renewables would attract far more diverse sources of power finance and investment whilst reducing debt reliance on a single nation.

A switch in focus from coal to renewables would attract far more diverse sources of power finance and investment

Renewables Beat Domestic Coal on Energy Security and Economics

Pakistan is continuing to turn away from planning more coal-fired power plants that use imported coal. Domestic coal fuelled plants are currently seen as a better alternative on energy security and economic grounds due to the avoidance of fossil fuel imports made more expensive by a weakened Pakistan Rupee.

However, in addition to being the cheapest source of new power generation in the country, renewable energy provides a better solution on both economic and energy security grounds, in addition to the avoidance of many other issues afflicting Pakistan's power system.

Not only do wind and solar not have any fuel cost at all, renewable energy tariffs do not include capacity payments which are currently becoming an unsustainable financial burden on the nations power system. Pakistan's post-pandemic economic growth and prosperity will be better enabled by further reliance on wind and solar than on fossil fuel-based plants dependent on large loans that are required to be repaid quickly.

Domestic coal-fired power cannot beat renewables on energy security either. A power system with higher reliance on smaller, modular, distributed power generators is likely to be more energy secure in the long run than one reliant on fewer, larger, more complicated power stations. As well as being the cheapest source of power generation, renewable energy is also the most energy secure form of power generation in Pakistan.

[22] The Nation. Wind turbines manufacturer Vestas keen to establish factory in Pakistan. 7 February 2020.

Pakistan's Draft Renewable Energy Policy

The various advantages of renewables have been recognised to some extent in a new draft renewable energy policy targeting 20% renewable energy capacity by 2025 and 30% by 2030. This is below the level modelled by IEEFA as being well within reach in our December 2018 report on Pakistan's power system.[23] Our model suggested the nation could approach 30% of power *generation* coming from renewables by 2030 with renewable power technology making up 36% of *capacity* by that time. Nevertheless, the new draft policy represents a significant step forward for increased renewable energy ambition in Pakistan.

Furthermore, the government is now correctly identifying that increased reliance on renewable energy will help reduce power tariffs[24] in an electricity system that is becoming too reliant on expensive fossil fuel-based power tariffs.

In February 2020, a NEPRA determination for a 50MW solar project by Enertech Bostan Solar Ltd confirmed a levelized tariff of Rs5.84/kWh, further reinforcing the fact that renewables are the cheapest source of new power generation in Pakistan.

The new draft policy represents a significant step forward for increased renewable energy ambition in Pakistan

Renewable energy tariffs in Pakistan look set to decline further with the first competitive bidding reverse auction for solar power.[25] Sindh province is set to auction the first 50MW of a 400MW solar program receiving funding from the World Bank. Competitive bidding for renewable energy projects has driven wind and solar tariffs down across the world.

Amongst the new renewable projects in the pipeline are the so-called "Super Six" wind projects. The Super Six total 310MW of capacity to be built within the Gharo-Jhimpir wind corridor in Sindh province by local companies and will provide the lowest cost electricity yet seen in Pakistan.[26] With a total investment of US$450m, the International Finance Corporation (IFC), part of the World Bank Group, will provide US$320m including US$86m from its own account and US$234m through intermediary lenders.

On the downside, existing wind power generators in the Gharo-Jhimpir wind corridor have reported financial difficulties due to curtailment of their output,

[23] IEEFA. Pakistan's Power Future: Renewable Energy Provides a More Diverse, Secure and Cost-Effective Alternative. December 2018.
[24] Express Tribune. $700m investment in Pakistan's power sector underway. 20 November 2019.
[25] Express Tribune. In a first, Sindh to auction solar power project. 7 December 2019.
[26] IFC. IFC Supports Super Six Wind Projects to Spur Renewable Energy and Help Meet Power Needs. 15 November 2019.

despite their "must run" status. The Central Power Purchasing Agency (CPPA) has reportedly curtailed zero marginal cost wind generation whilst illogically accepting offtake from coal and gas generators reliant on expensive fossil fuel imports.[27]

Meanwhile, another 2019 renewable energy project in Pakistan demonstrated the speed with which such installations could be built. Italian oil and gas company Eni announced a 10MW off-grid solar power project at its Pakistan gas field in March. The plant was completed within just six months[28] in great contrast to the length of time it takes to build fossil fuel-based and hydro plants.

The speed with which renewable energy can be installed was also clearly exhibited elsewhere in Asia during 2019. Vietnam expanded its solar capacity tenfold to 4.6GW of capacity in the 12 months through to June 2019.[29] This puts the Pakistan government's target of adding 8GW of renewable energy by 2025 into context. Spurred on by a feed-in-tariff deadline, the average time taken to complete and commission the new Vietnamese projects was just 275 days. From less than 10MW of operating solar power capacity two years ago, Vietnam now has more operational utility-scale solar power than Australia.

There is significant renewable energy potential right across Pakistan. However, much of the installed renewable capacity so far has been constructed in Sindh province which has the potential to significantly scale up wind and solar ambition, reinforcing its position as Pakistan's renewable energy leader.

Sindh's Renewable Energy Potential

Sindh is the most advanced province in Pakistan in terms of renewable energy development. It is also home to the Thar coal fields and the coal-fired power projects and proposals intended to exploit them, as well as imported coal-fired power projects. Although Pakistan's major hydro power proposals are upstream of Sindh, the province could potentially be significantly impacted by further damming of rivers in the north of the country.

Sindh's leadership position within Pakistan and its contrasting coal development proposals make it an ideal case study into how renewables in Pakistan can develop whilst avoiding the mistake of constructing too much out-of-date fossil fuelled power technology and the financial burden they entail.

Sindh is Pakistan's Renewables Leader

Most of Pakistan's renewable energy development so far has been concentrated on the Gharo-Jhimpir wind corridor in Sindh province. Further wind power projects within the corridor are under development including the "Super Six" wind projects - 310MW of wind power capacity that will provide the lowest cost electricity yet seen

[27] Dawn. Alarm mounts as wind power turbines halt after government stops purchases. 8 December 2019.
[28] PV Magazine. Pakistan gas field powered by 10MW off-grid solar system. 22 November 2019.
[29] Rystad Energy. Vietnam overtakes Australia in commissioned utility PV. 4 July 2019.

in Pakistan.[30]

Sindh is also moving forward with solar power development with a plan to install 400MW of solar by 2021. The province is also set to be the first in Pakistan to move towards competitive bidding for renewable energy projects – a move that is set to drive down the cost of renewable energy even further, as has been seen in other nations that adopted this bidding process.

The provincial government of Sindh has been granted a licence for a provincial grid company that will complement the National Transmission and Despatch Company (NTDC) and link the Gharo-Jhimpir wind corridor to power consumers around the province.[31] Sindh is the first province to take this step. This plan is designed to reduce congestion of power evacuation from the corridor which has led to curtailment of wind power despite the fact that it is the cheapest form of power generation.

These positive steps forward by Sindh province make the possibility of increased renewable energy ambition highly achievable.

Sindh Electricity Model

IEEFA has modelled an alternative power expansion scenario for Sindh province to highlight its renewable energy potential. Assumed rates of power demand growth, T&D losses, and future improvements in energy efficiency and reduced line losses are the same as those assumed for the nation as a whole (Annexure I).

Table 1: Sindh Power Capacity and Generation 2018/19

Source	Electricity Market Composition 2018/19				
	Capacity		Generation		Capacity
	MW	% of Total	GWh	% of Total	Utilisation
Oil, Gas, LNG	6,762	66.3%	27,296	70.0%	46%
Coal	1,852	18.2%	8,245	21.2%	51%
Nuclear	137	1.3%	130	0.3%	11%
Solar	50	0.5%	57	0.1%	13%
Wind	1,398	13.7%	3,252	8.3%	27%
Total	**10,199**	**100.0%**	**38,980**	**100.0%**	

Source: NEPRA, IEEFA calculations.

Despite Sindh's renewable energy leadership within Pakistan, renewable energy made up just 14% of power capacity in FY2018-19 and only 8% of electricity generation. The province's power system is dominated by fossil fuels with the prevalence of coal having increased in recent years, with much more planned.

[30] IFC. IFC Supports Super Six Wind Projects to Spur Renewable Energy and Help Meet Power Needs. 15 November 2019.
[31] NEPRA. Grant of Transmission Licence to act as a Provincial Grid Company. 5 November 2019.

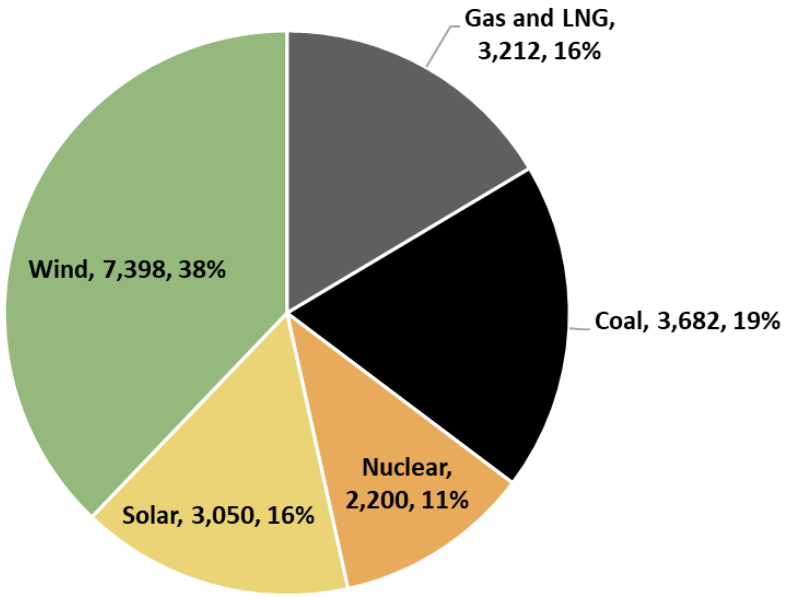
IEEFA's alternative power scenario is based on an increase in the province's already nation-leading ambition in renewable energy. We assume that Pakistan as a whole could add 12GW of wind power out to 2030, a rate of 1GW per year. For Sindh, we assume that half (6GW) will be located within the province given its already well-identified wind energy resources and moves made by the Sindh government to increase transmission capacity from the wind corridor.

For solar, we assume 3GW of utility-scale solar can be installed in Sindh by FY2029-30 – a highly achievable rate of just 270MW per year given the Sindh government currently plans to add the first 400MW of solar by 2021.

The addition of 9GW of progressively cheaper renewable energy means that much of the planned future build of coal-fired power is not required to meet electricity demand growth in Sindh. Several coal and LNG-based power plants are under construction and these are included in our model. IEEFA's model also includes 2.2GW of under-construction nuclear power units to be added by 2021-22.

However, beyond these fossil fuel-based and nuclear additions, the increase in renewable energy ambition means that no further coal-fired power developments are required to meet forecast demand growth in Sindh.

Figure 2: Sindh Modelled Power Capacity 2029/30 (MW)



Source: NEPRA, IEEFA calculations.

In our model for Sindh, electricity consumption in the province increases 50% over the period to 2029-30 to reach 46TWh (Annexure I). We assume energy efficiency gains of 1% per annum and for T&D losses to reduce 0.2% per annum. However, due to the increase of the province's power generation over the period, total T&D losses are higher by 2029-30. As a result, an increase in electricity consumption of 15TWh

by 2029-30 needs to be met with an increase in generation of 18TWh to allow for T&D losses (Table 2).

Our model sees this additional 18TWh of power generation being met with a significant increase in renewable power installations in addition to the completion of coal-fired, LNG-fired and nuclear plants that are already under construction. Wind and solar power capacity reach 3.1GW and 7.4GW by 2029-30 respectively, making up more than half of the total power capacity of the province by that time (Figure 2). With no need to build new coal-fired plants beyond what is already under construction, total coal power capacity reaches 3.7GW in 2029-30, up from 1.9GW in 2018-19 (Table 2).

Table 2: Increased Renewable Energy Ambition Meets Sindh's Power Demand Growth

Sindh Waterfall Chart				
Net Electricity consumed in Sindh in 2018/19 (TWh)			31	
Real GDP Growth	4.0%	pa		
Electricity to GDP multiplier	1.35	times		
Gross Electricity Demand Growth	5.4%	pa	18	
Energy Efficiency	-1.0%	pa	-2	
Net Electricity consumed in Sindh in 2029/30 (TWh)			46	
Net expansion in electricity demand 2029/30 (TWh)			**15**	
Growth: gross production losses			4	
Reduced grid T&D losses	-0.20%	pa grid efficiency gain	-1	
Gross expansion in electricity production required (TWh)			**18**	

The Increase in Electricity Production is met by (TWh)	TWh	Uplift	Capacity 2018/19 (GW)	Capacity 2029/30 (GW)
Solar expansion	6	31%	0.1	3.1
Onshore wind expansion	16	90%	1.4	7.4
Increase in nuclear generation	15	84%	0.1	2.2
Increase in coal-fired electricity	8	44%	1.9	3.7
Change in other thermal generation (oil, gas, LNG)	-27	-149%	6.8	3.2
Expansion in Electricity Production by 2029/30 (TWh)	**18**	**100%**	**10.2**	**19.5**

Source: IEEFA calculations.

This build out of new capacity means much of the existing thermal power fleet is no longer required to meet electricity demand in Sindh, and so can be used to meet demand in other provinces or otherwise shut down. Expensive oil-fired plants should be the first to be phased out. A proportion of Sindh's existing thermal power fleet will be due to close down by 2030 anyway.

Table 3: Sindh Modelled Power Capacity and Generation 2029-30

Source	Electricity Market Composition 2029/30				
	Capacity		Generation		Capacity Utilisation
	MW	% of Total	GWh	% of Total	
Gas and LNG	3,212	16.4%	441	0.8%	2%
Coal	3,682	18.8%	16,127	28.3%	50%
Nuclear	2,200	11.3%	15,242	26.8%	79%
Solar	3,050	15.6%	5,716	10.0%	21%
Wind	7,398	37.9%	19,430	34.1%	30%
Total	**19,542**	**100.0%**	**56,956**	**100.0%**	

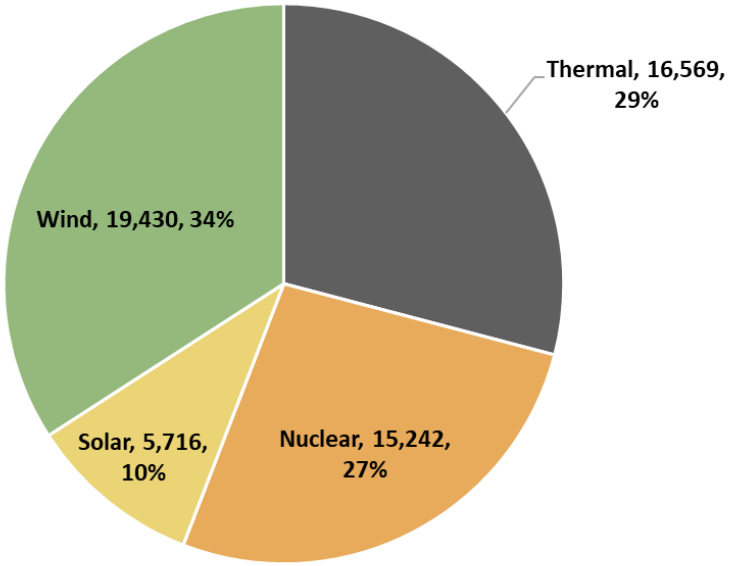
Source: NEPRA, IEEFA calculations.

This still leaves 3.2GW of non-cal thermal power plants serving Sindh power demand at 2029-30, including the K-Electric Bin Qasim III 900MW LNG-fired plant. Given that renewables, coal and nuclear power cover most of the provinces' power needs by 2029-30, only very low utilisation of other thermal plants in Sindh is required to meet demand, according to our model. Importantly, this gives flexibility to the provincial power system as there is capacity to increase thermal power utilisation during periods of low wind or solar radiation and / or peak power demand. Lower gas utilisation within the power system also helps address winter gas shortages.

Our model for Sindh province sees renewable energy reaching over 50% of capacity by 2030 which is well in excess of the Pakistan government's draft target of 30% across the whole nation by that date. However, in comparison to the rates of renewable energy installation in other Asian nations, yearly additions of 270MW of solar and 550MW wind in Sindh are highly achievable. This is even more true because Sindh has already begun its renewable energy planning and installation and is ahead of other provinces in Pakistan.

The lower utilisation rates of wind and solar mean renewable energy's contribution to power generation is below 50% (Figure 3). However, renewables are the largest overall contributor to the power generation mix by 2030, allowing Sindh to benefit from the declining cost of renewable energy more than any other province in Pakistan. Renewable energy tariffs do not include capacity payments to generators so increased focus on wind and solar also helps avoid the high capacity payments that are already an issue in the power system and threaten to become totally unsustainable.

Figure 3: Sindh Modelled Power Generation 2029/30 (GWh)



Source: NEPRA, IEEFA calculations.

Greater reliance on wind and solar along with reduced dependence on fossil fuel imports would also give Sindh the highest long-term energy security of any province in the country. In addition to energy security, water security is also an issue in Sindh, with the province suffering a major water crisis during 2019.[32] Availability of fresh water is an ongoing issue and set to grow worse into the future due to a changing climate and the possibility of a number of ill-conceived Indus basin hydro power projects planned upstream. Under these circumstances, it is not advisable to increase reliance on coal-fired power – a technology that requires large quantities of water to operate. A better outcome for the energy and water security nexus is renewable energy with its low operational water requirement.

If Sindh was to adopt a power buildout along the lines suggested in our model, the province will have harnessed the modular and quick-to-build nature of renewable energy capacity, and avoided the stranded asset risk that comes with building too many large, fossil fuel-based power stations based on over-estimated electricity demand growth forecasts.

Sindh will be key to the national government meeting its national 2030 renewable energy targets

Due to its excellent renewable energy resources, Sindh will be key to the national government meeting its national 2030 renewable energy targets and as such, Sindh should receive good federal government support and coordination to assist the province's renewable energy expansion. Issues such as the curtailment of wind

[32] Dawn. Sindh's water woes. 11 July 2019.

power seen recently in the province will need to be addressed in order to provide the investment confidence required to enable the next phase of renewable build out.

The International Energy Agency has noted that the COVID-19 pandemic and subsequent global economic downturn is a test for nations' commitment to the energy transition. It has also called for clean energy investment to be central to stimulus packages aimed at economic recovery.[33] Greater focus on wind and solar power can help Sindh province - and the whole of Pakistan – recover from economic slowdown and build a more financially sustainable power system.

Pakistan's Power Future is Inevitably Renewables-based

As will be seen around the world, Pakistan's long-term power future will inevitably be dominated by renewable energy due to its numerous advantages which include its ever-lower cost.

Although we only include simple wind and solar installations in our Sindh model, of the type already operating in Pakistan, further renewable energy developments such as wind and solar hybrid installations - which can reduce the intermittency of renewables[34], battery storage and even offshore wind[35] will play a role in the nation's power system in the future. These technologies will lead to renewable energy providing well in excess of 50% of Pakistan's electricity generation in the longer term.

The inevitability of renewable energy's rise is another reason to limit any further construction of power technologies like coal-fired and nuclear power. The inflexibility of coal and nuclear mean that they are not a good match with large scale renewable energy capacity – they are not easily ramped up or down to compliment the intermittent nature of wind and solar power.

Pakistan's long-term power future will inevitably be dominated by renewable energy

Nations that have large capacities of both coal-fired and renewable energy in the future will face technical difficulties in making the two complementary. India has a large coal-fired power capacity and is rapidly building out renewable energy. In the near future, it will have to get to grips with trying to make its large coal capacity more flexible so it can match its large wind and solar capacity. Operating its coal fleet more flexibly will be technically challenging for India, and will place extra strain and wear on its coal plants, shortening their operating lives.

[33] IEA. Put clean energy at the heart of stimulus plans to counter the coronavirus crisis. 14 March 2020.
[34] PV Magazine. Hybrid power plants, and the move beyond LCOE. 28 November 2019.
[35] IEEFA. Offshore wind emerging as viable new source of clean energy in Asia. 21 October 2019.

The nation's existing gas- and LNG-fired power stations are better placed to complement its growing wind and solar capacity due to their ability to operate more flexibly. Over time, this flexible capacity can be replaced with renewable energy storage as the cost of that technology inevitably declines.

As Pakistan shortly begins to emerge from the COVID-19-induced economic downtown, it faces an opportunity to overhaul its power capacity addition plans and avoid the financial burden of large, expensive power plants with their unsustainable capacity payments.

An increased focus on modular renewable energy additions and grid improvements can help Pakistan reduce overcapacity risk whilst benefitting from the lowest-cost source of power generation.

Annexure I

IEEFA Modelled Sindh Electricity Demand Growth

GDP Growth (%)	4.0%
Electricity to GDP multiplier pre-EE	1.35
Electricity Demand Growth (%)	5.4%
Energy Efficiency (%)	-1.0%
Electricity to GDP multiplier	1.10
Reduced grid T&D losses	-0.2%

Year ended June	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
Gross Production (TWh)	33.4	39.0	39.0	39.6	41.2	42.9	44.7	46.5	48.4	50.4	52.5	54.7	57.0
Gross Production Growth (%)		16.9%	0.1%	1.4%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%
T&D Losses (TWh)	7.0	8.2	8.1	8.2	8.4	8.7	9.0	9.2	9.5	9.8	10.1	10.4	10.7
T&D Losses (%)	20.9%	21.0%	20.8%	20.6%	20.4%	20.2%	20.0%	19.8%	19.6%	19.4%	19.2%	19.0%	18.8%
Reduced Grid losses			-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Real GDP Growth (%)	5.5%	3.3%	1.0%	2.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Electricity Multiplier (x)			1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
Electricity Growth (%)			1.3%	2.7%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
Energy Efficiency			-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%
Net Demand Growth (TWh)	26.4	30.8	30.9	31.4	32.8	34.2	35.7	37.3	38.9	40.6	42.4	44.3	46.2
Net Demand Growth (%)		16.6%	0.3%	1.7%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%

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. http://ieefa.org

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