Rural Development Policy Institute
Quarterly Energy Monitor (Mar-June 2020)

This yearly quarter (Mar-June) saw two major developments in the energy and power regime in Pakistan; the release and a subsequent repudiation of the National Transmission and Dispatch Company's Annual Indicative Generation Capacity Expansion Report (IGCEP 2047) and a rousing scandal for the Independent Power Production (IPP) sector in Pakistan in the form of an inquiry commission report highlighting financial irregularities in the sector. Like the rest of the world Pakistan also faced crippling economic challenges due to the COVID-19 pandemic. A nation-wide lockdown was imposed at the end of March lasted for 5 weeks[1], during which all commercial and Industrial activity within the country came to a grinding halt. This shutting down of economic activity had severe consequences for the energy sector as well, which saw consumer demand dropping down by almost 30%[2] putting the national electric utilities and distribution companies (DISCOs) under severe financial distress.
Keeping in line with these progressions within the sector, this quarterly energy monitor reflects two overarching themes:

1. The new Integrated Generation Capacity Expansion Plan (2047) and the response it received
2. The findings and implications of the 'Report on the Power Sector' produced by the Committee for power sector audit, circular debt resolution & future roadmap

In addition, the energy monitor also relays any updates within the energy market in the country such as the shelving of Datang Coal power plant and the initiation of construction for Diamer-Bhasha Hydro Power dam.

Section 1: Indicative Generation Capacity Expansion Plan 2047

Released in April 2020 by the Power system planning division of the National Transmission and Despatch company (NTDC), the Indicative Generation Capacity Expansion Plan 2047 is the second in the series of such interventions and was prepared in accordance with the provisions of the Planning Code/Grid code for NTDC. After approval from NEPRA, the plan is to serve as the blue print for capacity additions to the country's national grid on a least-cost of generation basis.

The Indicative Generation Capacity Expansion Plan has broadly two outputs upon which a capacity addition plan is presented to the national regulator (NEPRA) for long term power planning.

- A long term forecast for electricity demand projection based on a low, medium and high GDP growth rate
- A yearly capacity addition plan developed after accounting for local constraints, existing policies, reliability criteria and economic parameters for various generation options

[1] https://gandhara.rferl.org/a/pakistan-to-lift-virus-lockdown-on-may-10-despite-spike-in-cases/30599418.html
[2] https://www.dawn.com/news/1545449

This year's iteration of the IGCEP has been carried out using the PLEXOS tool, which is an improvement over the WASP-IV model last year, however the software still has its limitations which are evident in the outputs the plan generates.

After its release in April, the plan was met with a huge number of objections from a variety of stakeholders including provincial governments which criticized the plan for prioritizing certain forms of generation over others. The Azaad Jammu and Kashmir and the Khyber Pakhtunwa Governments were particularly critical of the fact that many hydropower projects in various stages of development had been pushed as far back as 2043, which would reverse the progress already made on these projects and possibly cause investors to back out of future developments in Pakistan. Upon receipt of such widespread critique, NEPRA decided to hold off approval for the plan and instituted a committee to revise the plan and address its shortcomings by August, 2020[3].

A public hearing was held on 15th July, to solicit input from the multitude of stakeholders which had given feedback on the plan so that advancements could be made on the revision of the plan[4].

Components of the IGCEP 2047 and their critique

Pakistan's power sector at present

As of December 2019, the national grid in Pakistan had an installed capacity of 35,344 MW, with a majority of this capacity being contributed by fossil-fuel based resources (14% coal and 46% Furnace Oil, Re-liquified Natural Gas (RLNG) and Natural Gas)[5].
Power generation for the year corresponded with these proportions as well. A total of 122,542 GWh was produced in FY 2018-19, out of which 62% was contributed by thermal sources, 4% by renewable energy including biomass, 26.5% by hydro power and 7.4 % by nuclear power[6].

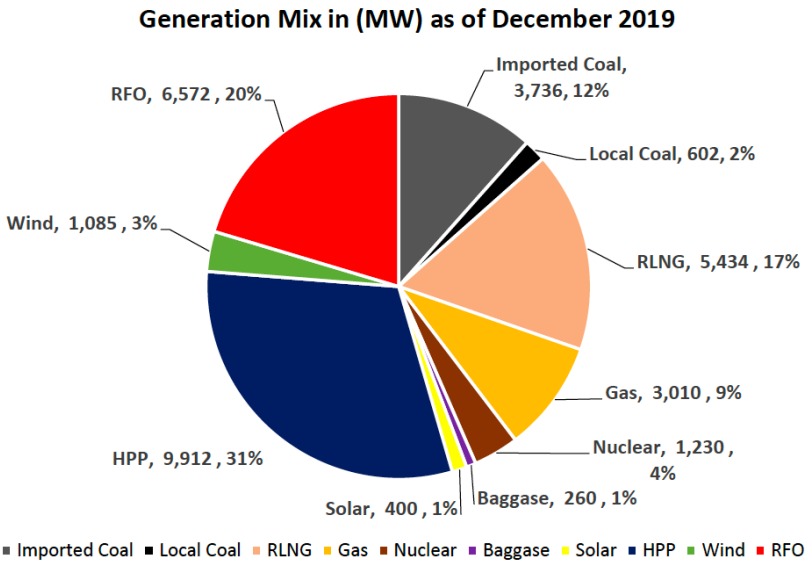

Figure 1 Pakistan's power generation mix as of December 2019. Source: IGCEP 2047

[3] https://www.thenews.com.pk/amp/687550-nepra-forms-body-to-modify-proposed-igcep-2047
[4] https://nepra.org.pk/Admission%20Notices/2020/06%20Jun/Public-Notice-for-Hearing-June-29-2020.pdf
[5] IGCEP 2047
[6] IGCEP 2047

Heavy reliance on imported fuel such as re-liquified natural gas and furnace oil has led to Pakistan having one of the highest electricity consumer tariffs within its neighboring region[7]. Residents businesses and industries in India's Capital Delhi were all paying around 11 cents for a unit of electricity in 2019[8], whereas in Iran electricity was being sold at 0.7 cents/KWh in 2019[9]. In Pakistan on the other hand, electricity for residential consumers is heavily subsidized and was being sold at 7.2 cents/KWh in 2019. For Industrial consumers the tariff was 10 cents a unit on average and for commercial customers the tariff was 13 cents/KWh[10].

Long term energy forecasts and the horizon of IGCEP 2047

Pakistan's planning code mandates preparation of a 10-year Indicative Generative Capacity Expansion Plan based on 20-year energy demand forecasts. The plan also needs a loss of load probability (LOLP) of less than 1% as a measure of reliability for electrical supply. In accordance with these stipulations the NTDC has prepared this year's Indicative Generation Capacity Expansion Plan (IGCEP). The IGCEP model employs a multiple regression-based modeling exercise for projecting energy demand into the future. Demands are projected individually for four consumer sectors i.e. Domestic, Agricultural, Industrial and commercial based upon GDP growth in each sector, tariff rates for each category, number of consumers and price indices. Individually projected demands are then aggregated into a country-wise figure. In accordance with the planning code three scenarios for GDP growth are used in the demand projections; a high, medium and low growth scenario to provide a sensitivity analysis against variable economic growth in the country. Forecasts are made for annual peaks at first and then converted to hourly projections using hourly conversion factors obtained from historical analysis. Provisions have also been made for T&D losses possible increases in demand due to Pakistan's new Electric Vehicle policy and a 5 million new and affordable housing scheme.

Electricity demand projection for peak demand under a medium growth scenario of 5.5% is anticipated to grow to levels of 43,820 MW or 237,996 GWh by 2030 and 103,065 MW or 559,765 GWh by 2047.

Since these calculations were carried out before the COVID-19 pandemic struck Pakistan, the projections do not account for the consequences of the resulting economic crisis and drop in GDP growth within the country. The nation-wide lockdown in March, led to a 30-40% reduction in energy demand within the country, with industrial and commercial demand dropping down by

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[7] https://tribune.com.pk/story/1774186/price-pakistan-pay-power-generation

[8] https://www.indiatoday.in/india/story/derc-announces-new-power-tariff-domestic-consumers-to-benefit-1575786-2019-07-31

[9] https://financialtribune.com/articles/energy/97278/rise-in-electricity-and-water-tariffs-in-iran#:~:text=Electricity%20is%20presently%20sold%20at,10.7%20cents)%20per%20cubic%20meters.

[10] Nominal Tariff Weighted Average for Pakistan (NTDC and KE)-IGCEP 2047

65% and 75% respectively[11]. The lock down was lifted in May, but 'work from home' continues for most of the offices within the country, and commercial and industrial activity hasn't fully resumed as well. Economists predict these effects are to likely spillover into the coming years, as has been the pattern with pandemics worldwide. IMF in fact has recently revised its GDP projections for Pakistan to -0.4% for 2020 and 1% for 2021[12].

It is understandable that NTDC couldn't have predicted this fall in demand and economic growth, however pandemic aside, the demand projections done for the IGCEP report are not realistic. A simple trend analysis done for growth in computed electricity demand from 2015 to 2019, revealed a compounded annual growth of just 2.2.%[13]. This indicates that a better, more realistic model for demand projections is indeed needed.

In addition, the horizon for which these projections and subsequent capacity additions are being made is questionable itself. As mentioned earlier, the planning grid code calls for a 10-year capacity addition plan. For this iteration however, a planning period of 28 years is taken into account. As has been pointed out by many experts in their criticism of the report, 28 years is too long a period to project for, given the fact that the availability and economic feasibility of technology is rapidly changing. This planning exercise is also a yearly endeavor which makes one wonder at the futility of recommending capacity additions so far into the future[14].

IGCEP outputs, neglect of hydropower and prioritization of unsustainable forms of energy

The base case scenario under the IGCEP 2047 incorporates renewable energy (RE) targets from the draft ARE 2019 policy (RE should be 20% of the installed capacity by 2025 and 30% by 2030), the medium/normal demand growth scenario of 5.5.% GDP growth, retirement of power plants at the end of their power purchase agreements, prioritization of committed power plants, and optimization of hydro power projects within the defined horizon. Based on these assumptions, the model churns out its output for two time periods:

- 2020-2030
- 2030-2047

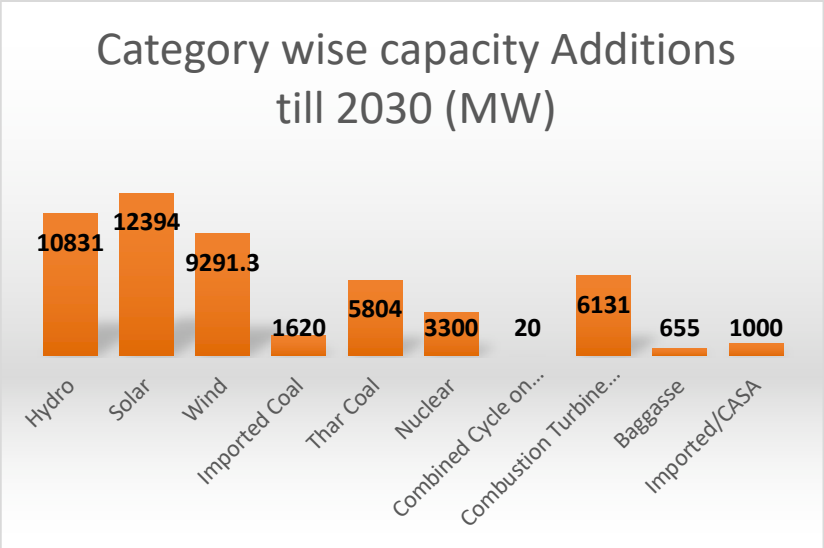

Figure 2 Category wise capacity additions according to IGCEP 2047 (2020-2030)

[11] https://www.linkedin.com/posts/women-in-energy-pakistan_policy-brief-impact-of-covid19-on-energy-activity-6661289878505959426-XXPT/

[12] https://www.dawn.com/news/1565089/imf-lowers-countrys-growth-forecast-to-1pc

[13] Author Analysis and calculations carried out using NEPRA State of the Industry report 2018.

[14] https://nepra.org.pk/IGCEP-2047/Comments%20of%20Stakeholders%20on%20IGCEP.pdf

By 2030, 43820 MW of peak demand is met by 76,931 MW of installed capacity, whereby 51046 MW of new capacity additions are proposed including 9291 MW of wind and 12394 MW of solar energy. This corresponds to solar and wind comprising of 23% of the generation mix in a bid to meet the 30% by 2030 target. It seems as if the model took this target to the letter, and no efforts are made by the model to even maintain this level of renewable energy in the mix, as capacity addition patterns radically change after 2030. From 2030-2047 the model proposes an addition of almost 27000 MW of Thar coal and 21000 MW of Open Cycle Gas Turbines (OCGTs) which would operate on RLNG. Despite the economic feasibility and high production potential of wind resources in Pakistan, no wind power plants are prioritized after 2030. Solar fared better as 14000 MW of solar capacity are included in the capacity additions.

35000 MW of Hydro power is also added to the mix, but only from 2041 onwards. Some of the biggest hydro power projects including Diamer Bhasha Dam do not get prioritized until 2043 leading to a lot of reservations from the province of Khyber Pakhtunkwah and the Azaad Jammu and Kashmir region where most of these hydro power projects are based[15]. The IGCEP report itself mentions that these Hydro power plants had been pushed to such a late timeline because of their high costs and their addition into the generation mix is horizon bound i.e. these plants had to come online by the end of the planning period.

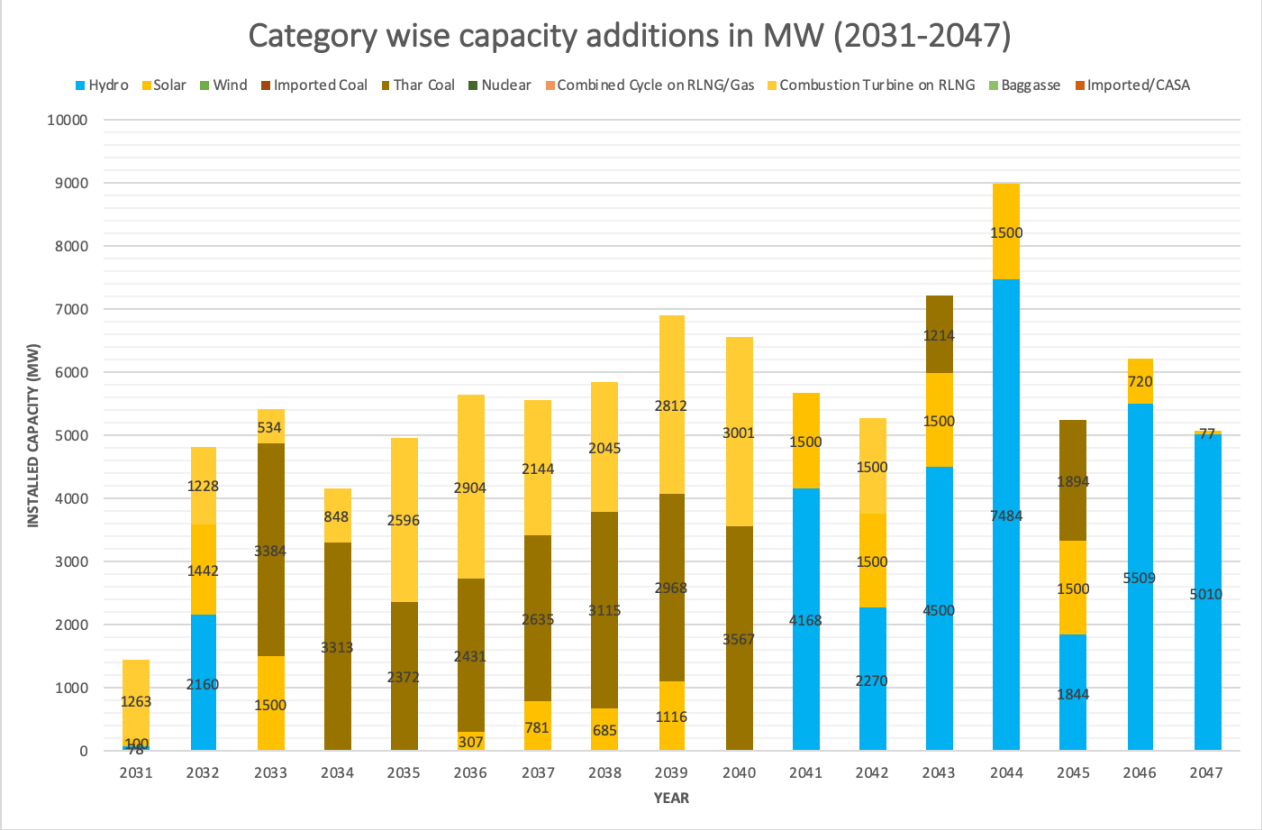

Figure 3 Category wise capacity additions on a yearly basis by IGCEP 2047 (2030-2047)

[15] https://www.dawn.com/news/1567268

It is also strange that despite the government's rhetoric of indigenization of generation fuels, 25,828 MW of candidate OCGT's are added to generation mix by 2047 which would operate on imported RLNG. The report justifies these additions by stating that these plants have been selected by the model to counter for the intermittency of 26,921 MW candidate solar and 10,327 MW candidate wind power plants which have been optimized by the model. Since they're only going to serve as a contingent reserve for solar and wind, these plants have extremely low utilization factors (<1%) until their retirement period.

This is unlike the behavior displayed by existing RLNG power plants already under operation such as Balloki, Haveli Bahadur Shah, and Bhikki, which have an annual capacity factor of 67% till 2032 due to a 66% off take requirement under a 'take or pay' clause in their Power Purchase Agreements. Similarly, for the Trimmu RLNG power project utilization is up to 94% in the initial two years which drops to 20% in 2023 and then flat lines after that. This could also be because of a minimum 66% off take requirement till 2025 for Trimmu RLNG power plant[16].

It is evident, that RLNG is an unsustainable source of power generation due to its high operational costs, yet the system chose this as a form of reserve for renewable energy. A historical analysis of generation various power sources in Pakistan reveals that Thermal IPPs and State-owned generation companies (GENCOs) have very low capacity factors throughout the year, with Thermal IPPs having a capacity factor of 55% and GENCOs being utilized only 33% of the time. Installed capacity for Nuclear energy seems to be under-utilized too with a 69% average capacity factor from 2013-2018[17]. Instead of opting for more RLNG based power plants which would sit idle almost entirely during their lifetime, the existing underutilized capacity be it Nuclear or thermal should be brought online to serve as a back-up for intermittent solar and wind. It is also unclear how the IGCEP model is dispatching various technologies; it is appreciated that hourly projections for electricity demand have been made but the same should be done for the supply side scenario.

The complementary nature for solar and wind is widely known, perhaps if an hour by hour dispatch system had been modeled taking into consideration daily production curves for both technologies, such a huge amount of fossil fuel-based reserves wouldn't have been optimized in the output.

Faulty Assumptions and Inputs for the model

The IGCEP model didn't produce these outputs in isolation, the PLEXOS based model fed certain inputs which yielded these results. Taking a deeper look at some of these inputs might reveal why these choices were made:

1. **Selection criteria takes annualized cost of energy:**
   The annualized cost of capital taken as an input by the model to select the least cost option for generation comprises of a fixed ($/KW/Yr) and variable (c/KWh or $/MWh)

[16] https://tribune.com.pk/story/2150319/1263mw-lng-plant-cause-losses-worth-rs202b

[17] Electricity generation figures were taken from NEPRA's state of the Industry reports (2013-2018). The actual generation taken from these reports was divided by possible theoretical generation from each power plant to arrive at the capacity factor. Calculations for each individual year from 2013-2018 were then averaged out to get a single value to be used in our analysis

component. Technologies such as hydro power, though having virtually negligible costs of operation are capital intensive due to the high cost of civil works needed for construction of the dams, spillways and power plants. This leads to a higher fixed cost for hydro power plants in comparison to coal and RLNG. The same logic could apply to solar in its prioritization over wind power. Wind power has a higher cost of capital than solar and thus results in higher fixed costs. Since the model seems to be considering both variable and fixed metrics for the selection of outputs, it prefers one technology over the other. However, this is a flawed methodology as lifetime costs of generation are considered the global standard for carrying out cost comparisons between different types of technology. A levelized cost of electricity (LCOE) would've been a better metric as it takes into account both fixed and variable costs, including the costs of debt servicing and return on equity related to the construction and operation of a power project and divides it over the lifetime electricity generation to arrive at a $/KWh or $/MWh value.

LCOEs calculated for hydro power in Pakistan averaged at **$0.063/KWh** whereas Thar coal (based on calculations done for Engro Thar power plant, please see table below) had a levelized cost of generation of $ **0.09/KWh.**

Using such a metric would have made the optimization process more robust, without affording any single technology advantage over others based on faulty assumptions.

Table 1 Levelized cost of electricity generation for CPEC Coal Power Plants in Operation ($ Values Indexed to Jan 2020)

Plant Name	**LCOE ($/KWh)**	**Total CapEx($ m)**	**Fuel Costs ($/KWh)**
Sahiwal 2x660MW Coal-fired Power Plant, Punjab	0.08	1863	0.05
2×660MW Coal-fired Power Plants at Port Qasim Karachi	0.06	2054	0.03
HUBCO Coal Power Project, Hub Balochistan	0.06	2070	0.03
Engro 2x330MW Thar Coal Power Project	0.09	1077	0.05

2. **Fuel Costs and technology assumed for Local Coal in Thar may not be representative**
   The report states that variable economic parameters for candidate power plants based on local coal have been taken from latest upfront tariff determination and operational data for SSRL (1320 MW) Thar Coal Block-I power plant. It should be noted that this power plant just recently achieved its financial closure in February 2020[18], and is still under

[18] https://www.prnewswire.com/ae/news-releases/shanghai-electric-achieves-financial-close-for-coal-mine-project-of-thar-block-1-integrated-coal-mine-power-project-in-pakistan-301013456.html#:~:text=28%2C%202020%20%2FPRNewswire%2F%20%2D%2D,of%20the%20Thar%20Block%2D1

development. The first unit is expected to be completed by August 2022[19], hence operational data for this power project couldn't have been available yet. Although a coal price of $42.45/ton was recently negotiated by the Thar Coal Energy Board for mines of 7.8 million tonnes per annum[20,] a figure which is significantly lower than the $52.05/ton of coal from the Sindh Engro coal mines[21] or the $97- 118/ton figure for imported coal from South Africa[22,] the technology employed for generation also has an impact on operational and construction costs. Super critical technology is more efficient and less polluting. In comparison sub-critical power plants take in a higher amount of fuel and water requirement per unit of electricity produced and are the most polluting form of coal fired generation[23]. This could potentially lead to higher than assumed operational and environmental costs for Thar coal power plants which the model fails to consider.

3. **Economic Parameters for Candidate Power plants are based on information for a single power plant only**
   A similar methodology has been made for other candidate power plants, where a single power plant has been used for referencing economic parameters for future electricity generation. For imported coal, China Power Hub Generation Company (Hub Co 1320 MW) has been used a benchmark, while Zorlu Solar and Master Green Wind Power plants have provided financial information for solar and wind power respectively. It should be noted that a single power plant cannot be representative of the many future power plants that are to be brought on line. It may not even the least costly option available out there. Gathering information from direct sources such as manufacturers and engineering and procurement contractors (EPC) themselves would have led to more reliable estimates in this regard.

4. **No declining costs for solar and wind beyond 2030**
   The entire world has witnessed a technological revolution for solar and wind energy resulting in cheap manufacturing and declining installation costs. So much so that almost 50% of the renewable energy capacity that was brought online in 2019 was cheaper than

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[19] http://cpec.gov.pk/project-details/9
[20] Ibid 17
[21] https://nepra.org.pk/tariff/Tariff/IPPs/003%20Coal/Engro%20Powergen%20Thar/2020/TRF-301%20EPTPL%20FPA%20MAY-20%2029-06-20%2016695-99.pdf

[22] Figures obtained for coal imports for Sahiwal and HubCo coal power plant for May 2020
https://nepra.org.pk/tariff/Tariff/IPPs/003%20Coal/China%20Power%20Hub%20Generation%20Company%20(Private)%20Limited/2020/TRF-342%20CPHGCL%20FPA%20JUNE%2020%2001-07-20%2016886-90.pdf
21https://nepra.org.pk/tariff/Tariff/IPPs/003%20Coal/Huaneng%20Shandong%20Ruyi%20(Pakistan)%20Energy%20(Private)%20Limited/2020/TRF-308%20HSRPEL%20FPA%20June%202020%2006-07-2020%2016932-36.PDF
[23] https://www.smithschool.ox.ac.uk/research/sustainable-finance/publications/Stranded-Assets-and-Subcritical-Coal.pdf

new coal[24]. The IGCEP methodology recognizes this decreasing trend in RE costs and uses a 3.6% and 1% capital cost reduction trend for solar and wind power projects, however this decline doesn't go beyond 2030 and comes to an abrupt stop at the end of the year.

No explanation for how these 3.6% and 1% rates were obtained is given in the report, lending an aura of vagueness to the projections that were carried out for capacity additions for solar and wind.

Lack of coherence between internal planning agencies within the country

The objections raised by all the provinces, public departments such as Alternative Energy Development Board, Pakhtunkhwah Energy Board, Pakistan Atomic Energy Commission and numerous private project developers show how the stakeholder engagement process was lacking in preparation of this report. It also appears that there was a disconnect between the IGCEP planning process and the country's climate action goals. Pakistan ratified the Paris Agreement in 2016, pledging to a 20% reduction in the country's projected Greenhouse Gas (GHG) emissions by 2030[25]. While the IGCEP takes into account economic factors for selecting the 'least-cost' technology for electricity generation, no considerations have been made for environmental optimality within the selection process itself. Many countries have been using economic tools to internalize the environmental externalities resulting from policy choices, a carbon tax being the most prominent one. Canada has a $15/ton of CO2 tax on carbon emissions and Britain a $25/ton tax to discourage carbon intensive power generation from coal[26].

Policy makers may agree that a carbon tax may not be the most prudent carbon pricing instrument for implementation in developing countries such as Pakistan, but there are other ways factoring in environmental externalities into the model too. Along with economic factors, pollutant levels for criteria air pollutants such as Nitrous Oxides (NOx), Sulfur Oxides (SOx) particulate matter and carbon dioxide per unit of electricity produced should've been taken as a metric to measure generation suitability against.

The report boasts a reduction in carbon dioxide levels per unit of electricity from 0.406 kg-CO2/kWh in 2019-20 to 0.3 kg-CO2/kWh by 2047 but it fails to factor in the fact that cumulative carbon dioxide levels for the country would still be rising. Nor is any reference made as to how this would affect the country's performance against its Paris commitments.

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[24] https://www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019#:~:text=More%20than%20half%20of%20the,fired%20plants%2C%20the%20report%20finds.&text=Costs%20for%20CSP%2C%20still%20the,%25%20to%20USD%200.182%2FkWh.

[25] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Pakistan%20First/Pak-INDC.pdf

[26] https://www.nytimes.com/interactive/2019/04/02/climate/pricing-carbon-emissions.html

Coal Power plants under the China Pakistan Economic Corridor have the potential to add 1-7.5 million tonnes of CO2 emissions to the atmosphere annually[27]. The cumulative impact of addition of thousands of megawatts of coal-fired power producing capacity by 2047 can only be devastating to the environment.

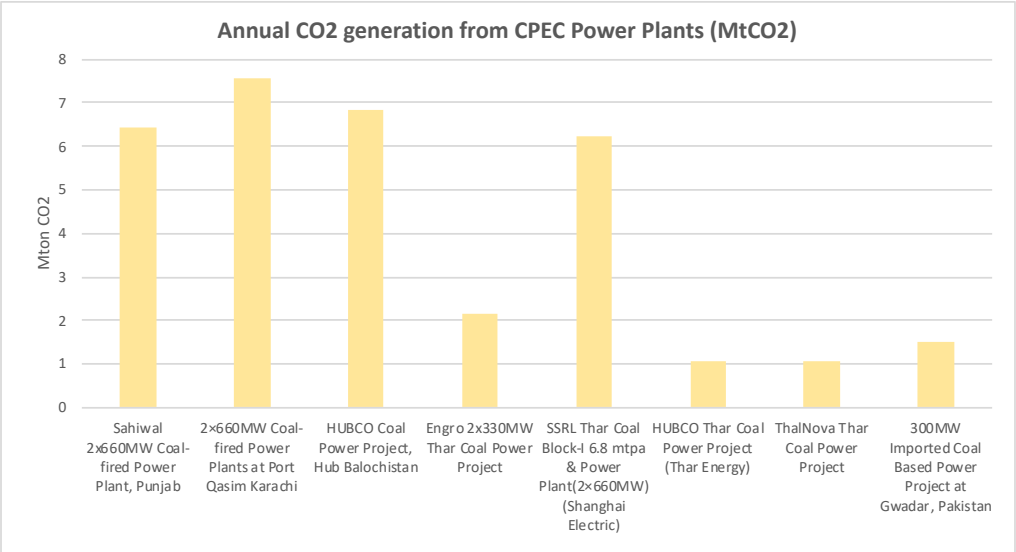

Figure 4 Potential Annual CO2 emissions from coal power plants under the CPEC- Source: Author Analysis

Conclusion

The introduction of the Competitive Trading Bilateral Contract Market Model (CTBCM) in 2019 has increased the importance of these annual Indicative Generation Capacity Expansion Plans tenfold. The CTBCM aims to de-regulate the electricity markets in Pakistan with the initiation of competitive bidding for procurement of energy projects in the country and establishment of electricity spot markets. The amount of electricity to be procured through the resulting competitive bidding is to be determined by the output of the IGCEP. It thus becomes imperative that the outcomes prioritized by the model are reliable and acceptable to all stakeholders involved. Although this year's iteration is an improvement over the last version of the report, in its current standing the IGCEP 2047 fails to deliver that. Under the mantra of 'Indigenization' IGCEP 2047, prioritizes huge amounts of local coal which will create carbon lock-in and pollution hotspots within the Thar region, endangering human lives and putting hundreds of people at the risk of social displacement. The RLNG plants selected by the model as well as the imported coal power plants instituted under the China Pakistan Economic Corridor are at high certainty to become stranded assets in the future leading to sunk investments, low dividends and unnecessary capacity payments burdening the struggling economy of Pakistan even further. Revisions and human interventions are needed at all levels of the IGCEP model, from the

[27] Based on average calculated capacity factor of 79%, each coal power plant is capable of adding around 1-7.5 million tonnes of carbon dioxide emissions to the atmosphere annually . This factor is dependent upon the installed capacity of the power plant and the type of coal it employs. Sahiwal Coal Power plant with a capacity of 1320 MW, uses imported coal and can potentially emit 6.4 Mtonnes of CO2 annually, while HubCo Thar power plant with an installed capacity of 330 MW can emit up to 1.08 million tonnes of CO2 annually

demand forecasts to model inputs and constraints. A newer version of the IGCEP expected in August[28], will hopefully consider all the feedback the report has received and upcoming versions will have a more streamlined and prudent output.

[28] https://www.dawn.com/news/1567623/ntdc-blames-policy-limitations-for-gaps-in-generation-plan

Section 2: Report on the Power Sector

Pakistan Electricity Generation Structure; A brief overview

Pakistan's electricity infrastructure is based on a partially unbundled structure where Independent Power Producers along with Generation Companies, Hydel and Nuclear Power Plants sell electricity to a federally controlled power purchaser (Central Power Purchasing Authority (CPPA)) on a cost plus regulatory return basis[29].Before these unbundling and privatization reforms (1998 to 2002) were introduced, all facets of the power sector in Pakistan including generation, transmission and distribution were controlled by two vertically integrated public electrical utilities in Water and Power Development Authority (WAPDA) and Karachi Electric Supply Company (KESC). WAPDA was responsible for electricity supply to most of the country except Karachi and some neighbouring areas of Sindh, which came under the jurisdiction of KESC. To manage the electricity crisis of the 1980s and 90s where frequent forced interruptions were observed during peak hours leading to a stagnation in industrial progress and socio-economic growth, Pakistan opened its power generation sector to private investors aka Independent Power Producers (IPPs) which added around 4500 MW through 20 IPPs and attracted almost $5 billion of investment in the process. The Private Power Infrastructure Board (PPIB) was established in 1994 to govern and attract investments from the private sector in this capital-intensive activity and the onset of unbundling efforts was further observed in 1998, as an independent regulator in the form of National Electric Power Regulatory Authority (NEPRA) was tasked to regulate prices and quality of electricity for public entities[30][31].

Unbundling reforms continued in 2002, with WAPDA being disaggregated into four thermal based generation companies (GENCOs), nine distribution companies (DISCOs) and one transmission company, National Transmission and Distribution Company (NTDC) The privatization of KESC ensued in 2005, with the formation of K-Electric which had similar jurisdictions to KESC and was a vertically integrated utility generating and supplying electricity to its service area. A further new entrant to the system was the Pakistan Electric Power Company (PEPCO), with an agenda to coordinate the unbundling efforts and ensure a smooth transition in the process[32].

The current unbundled setup has been in place ever since, with WAPDA now responsible only for Hydro Power Generation and Operation & Maintenance (O&M)[33]. Thermal generation is under the jurisdiction of state owned GENCOs and IPPs. Nuclear generation is maintained by

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[29] Cost plus regulated return, more commonly known as Cost plus tariff is a form of tariff granted by NEPRA to IPPS where the producer is paid for the actual cost of the power plant plus an agreed profit.

[30] M. M. Amjad, "Modeling of Electrical Grid Systems to Evaluate Sustainable Electricity Generation in Pakistan," p. 61

[31] K. Ullah, "Overview of Electricty Sector in Pakistan." International Journal of Energy, Information and Communications Vol. 4, Issue 3, Jun. 2013, [Online]. Available: https://www.researchgate.net/publication/304826505_Electricity_infrastructure_in_Pakistan_an_overview.

[32] A. J. Khan, "Structure and Regulation of the Electricity Networks in Pakistan," *Pak. Dev. Rev.*, vol. 53, no. 4II, pp. 505–530, Dec. 2014, doi: 10.30541/v53i4IIpp.505-530.

[33] "Introduction to WAPDA." http://www.wapda.gov.pk/index.php/about-us/present-setup-2

Pakistan Atomic Energy Generation Commission, while renewable electricity generation is mostly an IPPs based industry for now. NTDC continues to be the transmission regulator as it constructs, operates, and maintains 500/220 kV lines/grid stations. Central Power Purchase Agency (CPPA), under the NTDC is responsible for market transactions as it purchases units produced by IPPs as well as state-owned generation companies (GENCOs) and then sells them to state-owned power-distribution companies (DISCOs). CPPA remains responsible for procurement of power and all financial affairs associated with it. The National Power Control Centre (NPCC), a subset of NTDC are responsible for the generation and transmission system operations such as demand and supply management, load forecasting and setup of dispatching priorities of power. [6] The DISCOs are responsible for the construction, operation and maintenance of 132/66 kV lines & grid stations and the affiliated distribution system to ultimately supply electricity to the consumers and end users.

On the financial front, consumers pay the discos, who in turn are required to make the payment to CPPA. The CPPA then has to pay the GENCOs and IPPs as per initially agreed terms and conditions. Herein lies the biggest challenge for the electricity system of Pakistan, when bill recovery is low DISCOs often fail to pay the CPPA, which in turn fails to pay the GENCOs and IPPs. They, in turn fail to pay oil companies and suppliers, leading to shortages, price surges, power disruption, mass mismanagement and ultimately a crushing circular debt for the economy.

The Single Buyer model

One of the simpler designs for an electricity market, the single buyer model consists of a single authorized buyer where an investor (or an IPP) can enter the market through a Power Purchase Agreements (PPA) as the only entry and trading mechanism available. The IPPs ensure through legal means (contracts) that financial closure and viability is achieved, whereas an initial long-term contract usually predefines all major agendas including tariffs, plant life and investment costs. The IPP doesn't use the transmission network of the Single Buyer, but only connects with the network at an interconnection point. Transmission and distribution of the produced power, including congestion risks lie squarely on the Single Buyer who has to ensure efficient transmission and dispatch. This model allows private investors to build power plants and sell to an integrated electric utility, and usually attracts private financing of new generation more so than a model based on the construction of a competitive market with efficiency and competitiveness as the major building blocks.

The Pakistani power market also follows a single buyer model today, with the Central Power Purchasing Authority (CPPA) serving as the only buyer on a wholesale level. Wherein other countries, this model has solely been used as means to attract private investments into the power sector, Pakistan plans to use this a transition mechanism with plans to incorporate increasing competition in stages, by attracting private investment and ensuring a regulatory framework to tackle systemic inefficiencies[34].

In comparison, a competitive market opens competition at a wholesale level by allowing multiple wholesalers to enter the trading regime. This in turn leads to different disintegration models where each of the functions of generation, transmission and distribution are open to private competition and mechanisms exist for trading between multiple buyers and sellers. Again, a

[34] "CPPA." http://www.cppa.gov.pk/Home/SingleBuyer (accessed Jul. 24, 2020)

regulator can dictate the requirements for participation in the market and can ensure efficiencies and alignment towards a national agenda.

Within the Pakistani electricity market, the following participants are observed.

Generators:

This includes state owned generation companies known as GENCO's (Thermal), WAPDA controlled large hydro power plants, privately owned independent power producers developing renewable as well as thermally sourced power generation, small power producers within the industrial sector, nuclear power plants and New Captive Power Producers.

System Operator:

The NTDC remains as the sole operator of the electricity market since 1998, with NEPRA possessing a license of exclusive transmission business for 30 years in 2002. It also maintains and operates 500 and 220 KV grids and transmission lines in Pakistan.

Distributors:

There are 10 state owned distribution companies (discos) in Pakistan with K-electric as the 11th independent distribution company for the Karachi region.

Sr.No.	Name
1	Faisalabad Electric Supply Company
2	Gujranwala Electric Supply Company
3	Lahore Electric Supply Company
4	Multan Electric Supply Company
5	Peshawar Electric Supply Company
6	Quetta Electric Supply Company
7	Hyderabad Electric Supply Company
8	Sukkur Electric Supply Company
9	Islamabad Electric Supply Company
10	Tribal Areas Electric Supply Company
11	Karachi Electric Supply Company

The Circular Debt conundrum

The Pakistani electricity sector has been in crisis mode for more than a decade now with a total power sector deficit exceeding Rs. 2 trillion (almost 5% of the GDP). This circular debt is the cash shortfall faced by the Central Power Purchasing Agency (CPPA) for payments to power supply companies. A revenue shortfall of this kind effects all market players and trickles down throughout the supply chain, from generators to suppliers, refiners, and producers. This often results in supply shortages to GENCOs, and a reduction in power generated by Independent Power Producers (IPPs), leading to increased load shedding and uncertainty.

This shortfall can be attributed to various factors, but some commonly agreed causes include:

- Non-recovery of electricity sold (almost 10% of sold electricity is not recovered)
- System inefficiencies (almost 18% of electricity is lost in inefficiency and transmission deficiencies)
- Weak governance and mismanagement
- Non-collection of revenues including theft and losses
- Tariff and subsidies, most notably the Tariff Differential Subsidy (TDS)
- Insufficient payments to CPPA by the DISCOs who prioritize own cash flows etc.

TDS is the difference between the electricity tariff requested by the DISCOs for every category of consumer applied countrywide and the individual electricity tariffs determined by NEPRA for each DISCO to ensure profits for the DISCO and enough revenue generation. This revenue is ensured by NEPRA either through state subsidies or through the end consumers. A major issue with the TDS has been its delayed payments by the government to DISCOs, leading the DISCOs to taking out loans to maintain finances, or renege on payments to CPPA. This is further made worse by the fact that TDS is issued independently for each DISCO and a national tariff regime would've greatly reduced the amount payable in lieu of TDS by the government to the DISCOs[35].

The power sector's circular debt had surged to Rs. 1.9 trillion at the start of 2020, with payables and loans, both making up these figures. The implications of such astronomical figures are multifold on the economy. The incumbent government has already increased tariffs by up to 30%, passing all inefficiencies and capacity payments onto the consumers. In Pakistan law and order situations have also played an important role in recovery of tariffs and electricity bills. During periods of political instability and civil unrest, NEPRA had been allowed a 3% increase in permissible losses in recovery of electricity bills from consumers taking it up from 13.5 to 16.5%. The incumbent government has seen an improvement in the law and order situation within the country, but the ratio of permissible losses still remains the same, further pressurizing the existing compliant consumers. The dollar-rupee parity with the rupee depreciating on a daily basis also compounds the circular debt dilemma. Private investments in the power sector are indexed against the dollar, with tariff determination and capacity payments both being agreed upon in dollar values. As the rupee keeps failing against the dollar, the circular debt keeps soaring. Mandatory offtake requirements for some existing and upcoming projects as well as fixed term 'take and pay' LNG contracts with the Qatar government are also leading causes of the ever-burgeoning financial burden on the country's economy[36].

Since the late 2000s, heavy budgetary support and fiscal financing has been utilized by successive governments to address this issue. However, these measures were a stop-gap strategy at best and all these short-term measures failed to identify the root cause, resulting in ballooning

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[35] https://www.pakistantoday.com.pk/2020/04/17/poor-circular-debt-handling-cost-exchequer-rs4082bn-13-years/

[36] https://www.thenews.com.pk/print/612710-power-sector-circular-debt-surges-to-rs1-9-trillion

capacity payments, transmission constraints, pricing anomalies for gas, minimum plant factor provisions and net hydel profits. Further exacerbating the problem were the financing costs of these very circular debts. Budgetary subsidies upward of Rs. 2860 billion as well as liquidity injections were provided by successive governments to tackle the issue, yet failing to address the root causes of the same[37].

A nine-member committee was established by Prime Minister Khan in August 2019, to probe further into the Independent Power Production sector in Pakistan. After six months of proceedings, the committee released its findings in the form an inquiry report. The report contained a review of 78 independent power producers inducted into the national grid under six major IPP policies in the country. It revealed copious amounts of irregularities to a tune of Rs 4 trillion over the last 13 years. Staggering profits were earned by IPPs to a factor of 18.26 times the investment, and dividends as high as 22 times the project cost were collected. With a low level of risk for IPPs and exemplary terms on offer by the government, average annual return on equity over 50% proved to be a common occurrence for most companies. Other breaches were observed in the form of over-inflation of setting up costs, falsifying books on the amount of fuel consumed and receipt of kickbacks from fuel suppliers.

The following section presents these discrepancies in further detail:

IPPs instituted under the 1994 policy

A total of 16 IPPs were instituted under the 1994 IPP policy, introduced in 1994 to deal with an acute power shortage within the country. To attract overseas investments, internationally competitive tariff rates fixed at US cents 6.5/kWh the first 10 years and a levelized tariff worked around 5.9cents/kWh over the life of the projects (25-30 years) was offered to investors.

A review of the financial statements obtained from these IPPs revealed that these power plants had raked in dividends as high as 22 times the initial equity investment. Out of the 16, six IPPs received annual returns of more than 60% while four were allowed a 40% annual return.

IPPs instituted under the 2002 IPP policy: Thermal Power Plants

The power generation policy 2002 was issued in the wake of unbundling efforts carried out by WAPDA and had two salient features:

- A two-part tariff would be offered to the IPPs along with incentives for financial return
- Securitization of payments to the IPPs by the introduction of government guarantees

Revisions to the 2002 policy over the years allowed the return on equity component of the tariff to be converted to USD and indexed against USD/PKR rates.

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37 https://www.pakistantoday.com.pk/2020/04/17/poor-circular-debt-handling-cost-exchequer-rs4082bn-13-years/

Of the 14 IPPs amounting to 3081 MW operating under this policy within the country, 13 are thermal based power plants. A review of their financial statements revealed that these power plants had extremely short payback periods from 1-4 years and had been reaping excessive profits over the years. The IPPs had been allowed a return on of equity of 15% but received profits which were exorbitantly higher mainly owing to lesser than reported fuel and operation and maintenance (O&M) costs. These excessive gains in fuel and operation and maintenance (O&M) equaled Rs.30.51 billion and Rs.20.4 billion respectively. It is stated that there was a mismatch between power plant efficiencies submitted to NEPRA and actual heat rates observed, with plants operating at higher efficiencies than reported leading to savings in the amount of fuel consumed. The plants were also allowed a higher amount of working capital due to a discrepancy between payment schedules envisaged by NEPRA and actual payments made by CPPA.

IPP Policy 2015: Coal Based Power Plants

The power generation policy 2015 expanded its scope to outside of the private sector, by allowing public sector entities to act in an IPP mode as well. In addition, the scope of this policy included public-private partnerships. This policy also introduced a two-part tariff including a UD indexed capacity charge and energy purchase price. The policy included an exemption of income taxes and import of equipment at a concessionary rate of 5% for these power plants. The policy also allowed a return on equity as high as 20%.

Of the 14,774 MW added to the national grid under this policy 39% included imported coal, 33% RLNG, 24% Thar Coal and 4% Hydro power. By 2020, following eight plants have gone online, supplying electricity to the national grid:

- 1320 MW Imported coal based Huaneng Shandong Ruyi (Pak) Energy Pvt. Ltd.
- 1320 MW Imported Coal based Port Qasim Electric Power Company Pvt
- 1320 MW Imported Coal based China Power Hub Generation Company Pvt.
- 1230 MW RLNG based National Power Parka Management Company Pvt. Ltd. (Haveli Bahadur Shah Power Project)
- 1180 MW RLNG based Quaid-e-Azam Thermal Power Pvt. Ltd.
- 1223 MW RLNG bases National Power Parks Management Company Pvt. Ltd. (Balloki Power Project)
- 660 MW Local coal based Engro Powergen Thar (Private) Limited

Due to limitations faced by the committee, financial probes could only be made for two of imported coal-based power plants--Huaneng Shandong Ruyi Pak Energy Ltd. (HSRPEL) and Port Qasim Electric Power company (PQEPCL). The findings concluded that both IPPs had received a total of Rs. 32.46 billion in excess project costs. This excessive allowance was mainly due to a misrepresentation of the interest during construction (IDC) accrued during the project construction period for the power plants. Upfront costs allowed by NEPRA considered construction periods of 48 months whereas the projects were completed within 27-29 months. Based on these inflated set up costs, the IPPs were liable to receive a higher IRR than should be, which happened in the case of HSRPEL. The plants were also allowed additional working capital due to a mismatch between debt repayment schedules envisioned by NEPRA and actual payments made by CPPA as in

the case of IPPs under the 2002 IPP policy. Aggregating all excessive payments made to these two IPPs results in a loss of Rs. 483.64 to the national exchequer. Sahiwal power plant has recovered 71% of its initial investment in 2 years, while Port Qasim electric company has also recovered 32% of investment in just the first year of operation.

Renewable Power Plants -2006 And 2013 Policies

Pakistan's first policy for renewable energy development was introduced in 2006 setting a minimum of 9700 MW target of renewable energy deployment by 2030. The policy recognized only three sources of power generation as renewable energy;

- Small Hydro Power plants (Up to 50 MW)
- Solar Photovoltaic (PV) and thermal energy
- Wind energy

Power purchase from these sources was made mandatory by the government, and the concept of net metering was also introduced to encourage investments in renewable energy. Tariffs allowed to power plants inducted under this policy didn't include a capacity component since these renewable energy power sources cannot guarantee reliability. The tariff was thus an 'Energy based Tariff', which includes debt repayment and return on equity along with a profit margin.

The 2006 policy was upgraded in 2013 to include bagasse, biomass, waste-to-energy and bio-energy technologies within its scope. In accordance with this the Framework for Power Co-generation 2013 ("Framework") was issued as well for power generation facilities using bagasse and bio-mass for co-generation. This allowed exiting sugar mills to develop co-generation facilities on their premises. All financial incentives included in the 2006 policy were extended to these biomass/bagasse based power plants including a mandatory evacuation of all power by the power purchaser.

Wind and Solar power plants under 2006 policy

For the 7 wind power plants and 4 solar IPPs providing electricity to the national grid under the 2006 renewable energy process, no major discrepancies could be observed between the annual returns earned and the return on equity allowed by the tariff.

An issue of a mismatch between annual payments envisaged by NEPRA and actual monthly payments made by NEPRA prevailed here too. The 7 wind power plants could earn up to an excess of Rs 4.75 billion because of this error. For solar projects based on the same criteria as above, Rs.5.17 billion in total will be earned during the entire life of these projects.

IPPs set-up under Co-Generation Framework 2013 (Bagasse/Biomass)

Based upon the availability of complete financial records, 4 out of 8 Bagasse/Biomass based plants were reviewed. Discrepancies related to these plants profiting on accounts of a higher

plant factor than the allowed 45% in the tariffs approved by NEPRA were found. The four power plants have earned excess profits around Rs 6.33 billion due to this over sight[38].

In addition, these power plants will also earn an excess of Rs. 4.88 billion due to IRR related miscalculations again based on a mismatch in the timing of payments envisaged by NEPRA and the monthly schedule followed by CPPA[39].

The IPP report also sheds light on the Matiari to Lahore HVDC transmission line project. Most CPEC projects including the transmission line are Government to Government (G2G) projects and thus awarded without any competitive bidding, giving Chinese entities an advantage of getting inflated costs approved. A comparison of a similar project in India has been provided in the report carried out by a Swedish company which is cheaper by USD 360 million.

Conclusion

To tackle the issue of excessive profits and capacity payments to these independent power producers, the report suggests moving away from a USD based return system to PKR based returns and renegotiation of 'take **or** pay' contracts with IPPs to 'take **and** pay' agreements. The report provides an extensive roadmap to make this come about and following these recommendations a new committee has been formulated to negotiate with the IPPs on matters of tariff reduction, longer debt repayment schedules, heart rates, currency indexations and a shift towards take and pay contracts[40]. Since these 'take or pay' contracts are a legal instrument in implementation all over the world to attract investments from the private sector, these could be difficult negotiations to maneuver, therefore the outcome of this intervention is highly uncertain. Post COVID, declining GDP growth and rising inflation looks set to further strangle the constraints on finances for the government. Until something can be worked out between the government and these IPPS external financing may be required to ensure that the country's circular debt is not allowed to bulk up again and brought down to manageable payments.

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[38] "Payment of fixed costs, i.e. fixed O&M - local, working capital, insurance, etc., as well as debt service cost is linked with the plant factor which was determined at 45% in the tariff determination. The electricity generation in excess of 45% plant factor therefore leads to excess payment on account of fixed cost and debt service cost, which is included as a revenue of the IPPs, resulting in excess profits." Excerpt from the Audit report- Pg 72.

[39] NEPRA allows a monthly IRR return, usually 15-17%, but since CPPA makes monthly payments to these plants which include a Return on Equity component, the actual IRR turns out to be higher than what is computed in the tariff documents.

[40] https://www.dawn.com/news/1561850

Section 3: In other News

1. **700 MW Datang Coal Power Plant put on hold**
   The quarter also saw good news for the environment in the form of abandonment of K-Electric's Datang Coal Power Plant in June, 2020. The plant was supposed to operate on imported coal, however the minister for energy Omar Ayub Khan deemed it unnecessary to move ahead with the project as a ban on imported fuel would include imported coal as well. To address the energy shortages that would result due to this holding off, NTDC would work towards supplying electricity to the region from the National Grid, which currently has an over-supply.

   For further details visit: https://tribune.com.pk/story/2249796/pti-govt-abandons-k-electrics-coal-project

2. **Construction begins on Diamer Bhasha Dam Project**
   After delays of almost 14 years, construction finally began on the Diamer Bhasha Dam project. The dam is purported to be the third largest (4500 MW) in the country after Tarbela and Mangla and is expected to go online in 2028 by WAPDA's estimates.The project will both provide storage to lessen the water stress in the country as well as contributing towards electricity supply for the national grid.

   For further details visit: https://gulfnews.com/world/asia/pakistan/pakistan-begins-construction-of-diamer-bhasha-dam-1.72607867