JPRSS Vol. 10 No. 02 (December 2023) https://doi.org/10.58932/MULA0009

Revisiting Pakistan's Energy Crisis and CPEC Power Projects: Prospects, Challenges, and Remedies for Energy, Environmental, and Debt Sustainability

Dr. Arfan Mahmood[1]

Abstract

Pakistan, a country severely affected by energy crisis, is fulfilling its energy demands by a combination of fossil fuels (coal, oil, and gas), renewables, and nuclear energy. Fossil fuels such as coal, oil, and gas account for nearly one-third of energy imports are major source of Pakistan's primary energy mix. Almost 75% of energy production through CPEC power plants is through coal. Environmental and debt sustainability, two vital concerns highlighted by critics about CPEC power plants, are the major focus of this study. Considering the gap between demand and supply and environmental impacts caused by over-emphasis on fossil fuels to generate electricity, this study is structured to explore the impacts of CPEC power plants on environmental and debt sustainability in Pakistan. It further aims at exploring the factors behind new generated capacity through CPEC power projects. Exploring energy security of Pakistan, this paper utilizes 4As framework as a methodology to measure the transformations in Pakistan's energy security by mapping it onto four aspects: availability, applicability, acceptability, and affordability. Two key aspects of energy security, availability and affordability of energy, are heavily emphasized in this study. Despite substantial flows into the energy infrastructure through CPEC, Pakistan still continues to be energy insecure facing additional challenges in the shape of environmental and debt sustainability. The study recommends gradual but consistent adoption of green energy solutions and enhanced conservation efforts for mitigating energy, environmental, and debt insecurities.

Keywords: Energy security, environmental and debt sustainability, green energy, 4As framework, CPEC power projects etc.

1. Introduction

The technological revolution witnessed in the last century has triggered a huge increase in the use of energy worldwide. Thus, almost every single human activity has somewhat become energy-dependent. As far as the developing world is concerned, there is a basic need for unimpeded and affordable energy. An immense increase in the demand of energy has been witnessed owing to multitude of factors including industrial expansion, modernization in agriculture, increase in trade and up-gradation of transportation in the developing countries. Energy industry has become indispensible for world economy or economic development of any country. Pakistan has been and still remains heavily dependent on imported energy because of lacking

[1] Assistant Professor, Centre for South Asian Studies, University of the Punjab, Lahore. E-mail: arfanmahmood.csas@pu.edu.pk

of investments in local renewable and non-renewable resources of energy. In order to cater the demand for rising energy and bridge the gap between energy demand and supply, China and Pakistan launched China-Pakistan Economic Corridor (CPEC) in which power projects were given priority and significance.

Modern day national economies are highly dependent on energy. Electricity, as a highly valuable energy source, if properly utilized, may benefit every single domain of a country's economy. The current economic situation of Pakistan is partly considered the outcome of decades' long erroneous energy policies (Rehman, 2019). Three-quarters capacity generated through CPEC energy projects is through coal. If these coal-fired plants are turned into reality successfully, they would be catalyst in enhancing Pakistan's dependency on coal for power generation. Indeed, Pakistan seems to increase the share of coal from 3% to 20% in power generation from June 30, 2017 to June 30, 2025 in its primary energy mix (NEPRA, 2017). This push to emphasize coal for power generation stands in contradiction to the approach adopted by other countries in recent years.

Environmental sustainability, a vital aspect of this study, is endangered because of over-reliance of coal as power generation source under CPEC and thereby requires reconsideration to mitigate environmental threats to ensure energy security in the real sense. In addition, privatization of national energy enterprises owing to various reasons and the consequent circular debt in the energy sector is another major aspect of this study. In the face of ever-increasing energy demands, both state and private owned energy plants are engaged in producing electricity constantly. Pakistan, for its import-driven energy strategy and spike in energy prices globally, has undergone a severe fiscal sustainability challenges. The primary energy mix of the country that heavily relies upon imported furnace oil than hydropower for generating electricity is considered a major factor behind energy outages, fiscal issues and environmental sustainability. The current energy crisis in Pakistan that is traced back to late 2007 caused too much emphasis on building energy capacity and environmental and fiscal challenges were ignored by the policy-makers.

Energy security, a key aspect of a country's national security, is a multipronged concept that encompasses almost all the aspects (economic, political, geopolitical, institutional and regulatory) of a country. The elements such as import dependency, primary fuel mix diversification, utilization of indigenous energy resources and circular flow are covered in the economics of energy security. The interrelationships between fossil fuels importing and exporting nations are examined in the energy security's political economy, the second aspect of energy security. Geopolitics of energy security analyses how coalitions, cooperation, and conflicts are shaped by geopolitics. The fourth aspect of energy security deals with the institutional and regulatory mechanisms in relation to local, regional, and global context (Farhad et al, 2019). Among other aspects of energy security, climate change is a major threat that requires pragmatic solution.

An investigation into the power projects launched under CPEC provides the researcher with a chance to draw preliminary findings regarding the two vital issues that are at the epicenter of criticism leveled against the BRI. These two vital issues are environmental and debt sustainability. About the environmental sustainability, there are strong concerns that the infrastructure, particularly coal-fired power projects will have negative impact on the environment in various ways. Regarding debt sustainability, the authorities are concerned that these infrastructure projects may cause immense increases in debt while some critics argue that the borrowing nations are pushed by Chinese on purpose into debt distress for enhancing strategic leverage over them (Lagarde, 2019).

The study presents an extensive review of the relevant literature on the topic and after identifying the limitations, it strives to fill that gap by expanding its own perspective based on the analysis made in this study. The work of Malik et al (Malik et al, 2019) presents an outlook of Pakistan's energy security and makes a quantitative assessment of Pakistan energy security by employing 4As framework for sustainable energy policy. For quantitative assessment of Pakistan's energy security after the launch of CPEC power projects, the 4As framework has been adopted from this study to explore Pakistan's energy sustainability, an aspect hardly been discussed before. The works of Abdullah et al (Abdullah et al, 2022), Asim et al (Asim et al, 2022**)**, and Rehman and Cismas (Rehman et al, 2022) have provided insights into various aspects of Pakistan's environmental and energy sustainability. About debt sustainability, another significant aspect of current study, Shakeel Ahmad Ramay (Ramay, 2021) has not only explored the dynamics of "debt trap" which is leveled against China by the West for its BRI investments worldwide but also exposed the West malign agenda to disrupt BRI.

Keeping this background into consideration, the first and foremost point of investigation is to find out the rationale behind inclination towards coal-fired power plants under CPEC and their impact on environmental and debt sustainability in Pakistan. The second major aspect of this study that requires researcher's attention is to figure out the disconnection, if any, between China's green development strategy and the power generation capacity through coal-fired plants with the aid and assistance of Chinese in Pakistan under CPEC. Another query of paramount significance is related to debt distress or circular debt and this study attempts to find out whether Pakistan is deliberately pushed into debt distress by China or it's a natural outcome of policies adopted by the government of Pakistan. Last but not the least is to propose policy recommendations to mitigate the threats of environmental and debt sustainability by offering alternatives.

The major queries explored through this study are as follows:

- Why the majority of power generation through CPEC is heavily skewed towards coal-fired plants?

- How does the power generation through fossil fuels, particularly coal, affect environmental and energy sustainability in Pakistan?
- Are Chinese deliberately employing CPEC power plants to drag Pakistan into debt-trap or debt-distress causing debt sustainability issues in Pakistan?
- What are the alternatives to mitigate threats of energy, environmental, and debt sustainability in Pakistan?

Following objectives have been proposed for this study:

- To investigate the rationale behind strong inclination towards coal-fired power plants launched under CPEC power projects and their impact on the critical aspects of CPEC---environmental and debt sustainability.
- To explore the factors that lead to disconnection, if any, between China's green development strategy under BRI and the power generation capacity through coal with the aid and assistance of Chinese in Pakistan under CPEC.
- To trace out the reasons behind increasing circular debt in the energy sector of Pakistan and to figure out whether Pakistan is being deliberately pushed into debt distress by the Chinese or it's an outcome of the policies adopted by the government of Pakistan to mitigate energy crisis.
- To propose policy recommendations aimed at mitigating the challenges of environmental and debt sustainability and offering alternatives to address Pakistan's energy crisis on long-term and pragmatic grounds.

As far as the research methodology for this study is concerned, a mix method approach has been adopted for this study. In order to explore Pakistan's energy security or sustainability, quantitative method has been selected. The 4As framework (availability, accessibility, affordability, and acceptability) of energy security introduced by the Asia Pacific Energy Research Centre has been adopted for quantitative assessment of energy security of Pakistan that addresses the "paradigm shift in energy security" of the 2000s (Inthakar, 2007). This study opts for the energy security framework developed by Yao and Chang (Yao, 2014). This framework is comprised of vital 4As aspects---resources' availability (AV), technologies applicability (AP), society's acceptability (AC), and resources' affordability (AF). Each aspect contains four indicators for measuring Pakistan's energy security. This comprehensive 4As framework with all its indicators provides the researcher with a rhombus plot. This methodology helps the researcher visualizing the trends and making comparison of various dimensions to provide a holistic perspective about energy security direction of Pakistan. Qualitative content analysis is the second major aspect of research methodology of this study. Content analysis is adopted to explore the prospects and challenges of energy, environmental, and debt sustainability issues in Pakistan. Government's policy documents, media reports, publications from energy industry/institutions, corporate documents and official statements from the executives of power companies and views of experts from energy and economic sector of both China and Pakistan are mainly emphasized in the content analysis to answer the major queries of this study.

This proposed study is segregated into four parts. First part details about the CPEC energy units and seeks to explore why most of the new additional capacity from CPEC power plants is heavily skewed towards coal. It also analyses the variations in China's aspiration for greener BRI and CPEC coal-fired units. Section two deals with Pakistan's energy crisis and examines its energy security through 4As framework quantitatively. Part three explores the prospects, challenges, and remedies for environmental and debt sustainability. Last section sums up the study and provides policy recommendations as well.

2. Literature Review

Measurement or quantification of energy security is a key concept of this study. In an empirical energy-development scholarship, it still remains an unresolved agenda. In this context, the seminal contribution from Bordman (Boardman, 1991) who coined the concept of (fuel) energy security and attempted to quantify it for the economy of the United Kingdom (UK) after 1970s oil price shocks. However, two dimensions of energy security such as energy availability and affordability are taken into consideration. Subsequently, abundance of literature attempted to quantify energy security by employing several indicators and sample economies (Karekezi et al, 2012), (Pachauri et al, 2011), (Ketting, 1995), (Sovacool, 2012). These texts can primarily be segregated into three types. In the first type, energy security is quantified by household's share of income or expenditure reserved for consumption of energy. A household is deemed deficient in energy if it is incapable of spending a threshold level of its income on energy (Foster et al, 2000). This is called by Schuessler (Schuessler, 2014) as "The Ten Percent Rule." The second technique emphasizes on engineering (technology) oriented estimates to draw a threshold level of energy (González-Eguino, 2015). Because of its acute technical nature, it has been put into revisions multiple times. One key disadvantage of this approach is that it incorporates absolute energy security rather than relative energy security. The last method is in compliance with the construction of multipronged or extensive index for analyzing energy security (Wang et al, 2015), (IEA, 2012). It is deemed comprehensive as it involves various socio-economic and technological dimensions of energy security. So, it is preferred to analyze energy security in Pakistan.

2.1. Energy Services Availability

Talking about the energy security index, one of its crucial aspects is energy services availability. Ensuring uninterrupted supply of energy and its affordability is very tough especially for developing nations (Latief et al, 2020). They are not only required to meet the challenges of growing energy needs but also to maximize their production in renewable energy in order to meet the Sustainable Development Goals (SDGs 2015) of UNDP3. Regarding Pakistan's economy, Shahbaz (Shahbaz, 2015) argues that the annual GDP growth of Pakistan was held back to about two percent from 1991 to 2013 primarily because of the unavailability of energy. Acording to Okun's Law, unavailability of energy results into high rate of unemployment in the society (Knotek, 2007). A strong linkage between energy security and its services in

Pakistan has been endorsed by the existing scholarship (Mahmood et al, 2017), (Qurat-ul-Ann et al, 2021). Access to the services of energy is employed as a "proxy variable" to quantify Europe's energy poverty (Bollino et al, 2017). Energy poverty is described by the International Energy Agency (IEA) in the following words: "a lack of access to modern energy services….." This linkage is also supported by Wang et al (Wang et al, 2015). Keeping in view the recommendations by International Organization (IOs) and existing empirical literature, availability of energy services is employed as an important aspect of energy security index.

2.2. Clean Energy

It is an established fact worldwide in the scholarship of energy that the growth of economy is usually achieved at the cost of degradation of environment (Ullah et al, 2020). This trade-off between economic prosperity and environmental degradation is illustrated by the fact that high level of production requires high consumption of energy, hence, results into high concentration of emission of dangerous gasses into the environment. It implies that more and more environmental degradation may be caused by reduction in energy poverty. So, there is a dire need of mechanism in which energy poverty reduction does not degrade the environment. This can only be achieved if clean energy sources are preferred over dirty energy sources into the primary energy mixture for longer periods of time. It takes us to another important aspect of energy security index, namely clean energy. In this context, the existing scholarship demonstrates that there is a direct linkage between environmental sustainability and quality of energy services (Wang et al, 2015), (Yu et al, 2020). Regarding the index of clean energy, the research focuses on six key indicators. They contain data about a country's dependence on renewable and non-renewable energy sources. In the case of clean energy, a country's preference for clean energy is determined by the indicators including nuclear energy, preference and access to clean energy and technology for domestic needs, and proportion of renewables (Thiam, 2011). On the other side, a country's trend towards dirty energy is reflected through preference for non-renewable energy, biofuels, and hazardous gasses emissions into the environment (Papageorgiou et al, 2017). A particular focus on clean energy in energy security index is also motivated by COP21 in which international community placed huge emphasis on the quality of environment and to reduce dependency on energy acquired by fossil fuels. The establishment of coal energy units in Pakistan under the umbrella of CPEC is considered deviation from the commitments of COP21.

2.3. Energy Governance

Among various root causes of energy crisis in the developing world, poor or bad governance structure is a major one (Nussbaumer et al, 2012), (Zaman et al, 2018), (Bazilian et al, 2014). Talking about key governance issues in Pakistan, compromised pricing mechanism, high line and distribution losses, costly energy generation projects, and limited capacity addition are major aspects behind energy governance problems. The magnitude of energy crisis and insecurity is determined primarily by these factors (Zaman et al, 2018). The governance of energy is primarily

concerned with energy services' provision at optimal cost and time (Khalid et al, 2016). Energy governance has two dominant aspects: institutional management and combination of financial and institutional management. So, line and distribution losses are employed to capture the governance of energy. Going by the statistics of World Bank, total line and distribution losses in Japan are nearly 4.4% compared to 17.5% in Pakistan of total electricity generation. Almost 7.6% share of all the tax collection was utilized to provide subsidies on energy in the fiscal year 2007-2008, while it rose to nearly 18% in 2011-2012 (Amjad et al, 2015). A poor or bad governance structure of the country is reflected through growing share of subsidies of energy sector. Three indicators are used as proxies of energy related governance. Among these three indictors, the first two deal with domestic supply side mechanism of governance, while the third is linked with country's reliance on overseas imported energy. In the case of third indicator, country's reliance on overseas imported energy is directly proportional to the amount of shock in supply on country's domestic growth of GDP (Zaman et al, 2018).

2.4. Energy Affordability

The aspect of energy affordability in the energy security index is usually deemed a vague concept (Bradley, 2009). However, according to many scholars this concept carries immense significance and has sound theoretical justifications (Whitehead, 1991). While defining this concept, it implies a situation or scenario in which a household can afford or capable of affording energy within its budgetary limits. In this case, this is basically an issue for low-income households or nations (Pachauri et al, 2011). A reverse relationship is found between affordability and security of energy. So, energy crisis can be minimized with cost-effective energy efficiency (Department of Energy & Climate Change, 2011). Energy affordability is discussed as an aspect of energy security by Wang et al (Wang et al, 2015) and Bollino and Botti (Bollino et al, 2017). Basically two approaches are found in the existing scholarship to quantify energy affordability: expenditure and consensual-based approach (Bollino et al, 2017). The first one is "micro-based" where a proportion of household's income is utilized to acquire energy items. It is considered as a proxy of affordability. The second one is "macro-based" where energy affordability's assessment is measured with some accumulative level variables of proxy. Three proxy variables are adopted for this study to capture the energy affordability. Four-wheel and two-wheel registrations are the first two proxy variables. The rate of motorization is broadly employed as an indicator for comparing economic development levels across countries. The third proxy variable is the gas consumer registration. Being a developing country, our sample economy is consistently shifting to natural gas consumption from biofuels. Hence, this shift would demonstrate an increasing trend in energy affordability over time.

3. Discussion and Analysis

3.1. The Geography of CPEC

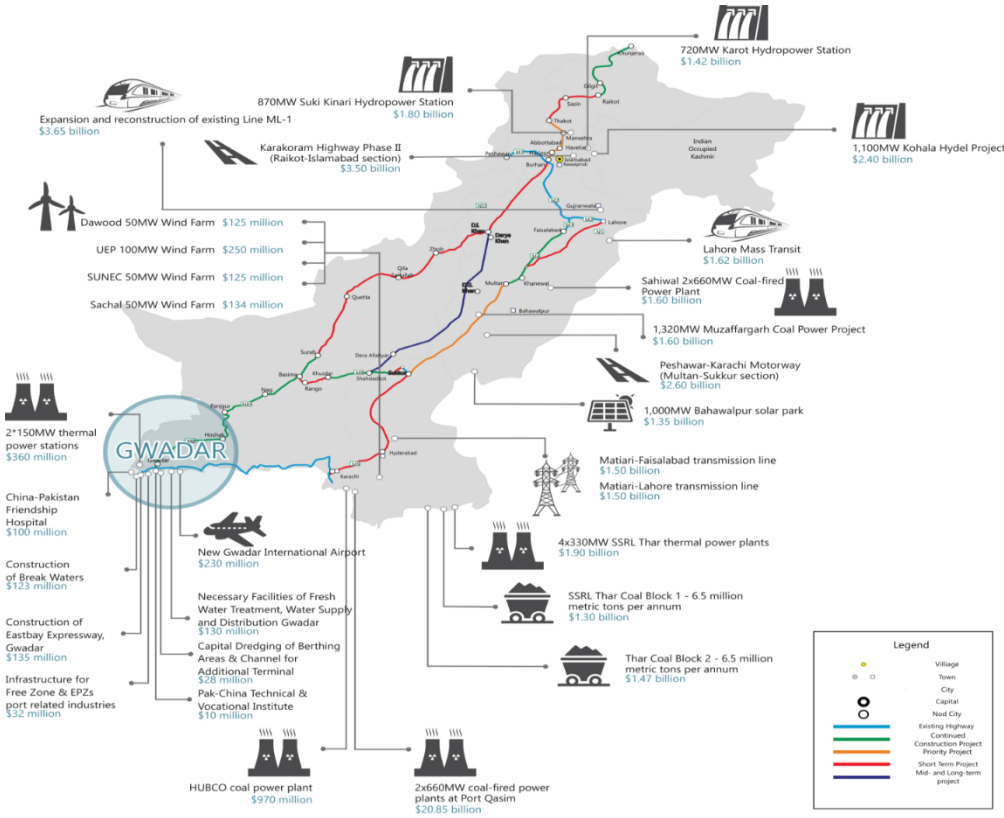
The CPEC is a mega investment project launched by China that includes: communication infrastructure; sea port; special economic zones; energy projects; and vocational training institutes etc. Hence, it tempts investors from almost all the sectors that can play a vital role in the overall development of the region (Khan et al, 2020). The communication infrastructure, one of the major aspects of CPEC, is meant not only to enhance connectivity but also to uplift the economic stature of less developed cities in the whole country (Khan et al, 2020).

CPEC is both a development scheme and strategic gambit (West, 2016). Although the close ties between China and Pakistan are traced back to decades, the CPEC is a demonstration of highly intensified and expanded strategic cooperation between them especially at a time of rising geopolitical ambitions of China and persistent concerns about the security and development of Pakistan. It is projected to enhance connectivity not only in Pakistan but also with other countries in the region through a mechanism of highways, railways, pipelines accompanied by energy, and various other infrastructural development projects to redress looming energy crisis required to trigger economic prosperity of Pakistan.

To achieve the objective of regional connectivity through communication infrastructure, four land routes have been proposed in Pakistan including: eastern; central; western and northern. The eastern alignment, though the longest in all three, is considered the most feasible to start with owing to the already existing infrastructure and comparatively better security setup. This eastern alignment spreads from Gilgit-Baltistan to Punjab and then to Balochistan ultimately connecting Gwadar deep-sea port which is deemed to be the window connecting China's Silk Road Economic Belt with the Chinese Maritime Silk Road. The second proposed alignment, the central route, is planned to connect central Punjab with Quetta and finally connecting Gwadar deep-sea port. This route is comparatively less developed and requires massive scale of investment and time to be completed. The third alignment, the western route, the shortest of all and originally planned under CPEC, connects Khyber Pakhtunkhwa with Quetta and then to Gwadar deep-sea port in Balochistan. The northern alignment is linked with all these three routes and traverses from Gilgit-Baltistan to China's borders.

CPEC reflects a global extension of the efforts of China to deliver security through economic development. Keeping in view Pakistan's energy crisis which is severely affecting almost every sector of economy, Chinese investments in energy infrastructure under the umbrella of CPEC are particularly welcomed by Pakistan. Realizing the renewable and non-renewable energy potential of Pakistan, energy projects in coal, solar, wind, hydro, nuclear have been planned throughout the country to mitigate the energy crisis in Pakistan (see the Map 1: Energy Projects in CPEC).

Map 1: Energy Projects in CPEC[2]



3.2. CPEC Power Projects

Talking about Pakistan's primary energy mix, most of its primary energy supplies come from non-renewables while hydropower remains a major renewable source of energy beside wind and solar whose proportions are increasing slowly. More than 50 million people in Pakistan do not have adequate access to electricity, hence, worsening already troubled economy (Unwin, 2019).

The looming energy crisis in Pakistan has only been worsened by acute shortfall in energy. Owing to capacity lacking in the electrical grid in Pakistan and inefficient use of available sources of energy, Pakistan, on an average, lost USD 9.38 million per year from 2012 to 2017 every year. Oil and natural gas are used as major sources of electricity generation in Pakistan, which has made Pakistan highly dependent on overseas imports of fossil fuels. In order to mitigate climate effects and reduce dependency on overseas energy imports, nuclear energy---along with

[2] CPEC: $62 Billion Worth of Chinese Investment, *Blue Ocean Residency*, https://www.blueocean.pk/gwadar-cpec, Accessed on: May 25, 2023.

hydropower and other renewables---provides the country with clean alternate source of energy. Though it contributes only 6.81 % of Pakistan's primary energy mix, Islamabad has sought help from China to maximize their collaboration in both civil nuclear energy and other renewables (Khalid, 2020). The following part details about the energy collaboration between China and Pakistan both in renewables and non-renewables under the umbrella of CPEC:

3.2.1. Coal Projects under CPEC

Realizing the urgency of the energy crisis in the country, Pakistan, in collaboration with China, launched several coal-fired power projects to mitigate the looming energy crisis in Pakistan. Though the focus is directed towards reduction of economic and energy poverties under the global energy agenda, countries both in the developing and developed world are trying to provide households with environment friendly and affordable energy by properly implementing "Sustainable Development Goals" (SDG) till 2030. Energy crisis has drained Pakistan's economy that affects the GDP by nearly 2 to 4% every year (Aftab, 2014). Table 1 below contains list of coal-fired projects under the umbrella of CPEC in Pakistan:

Table 1: Coal Power Projects in EPEC[3]

Serial No.	Name of the Project	Capacity MW	Status	Est. Cost (US$ Million)	Jobs Created
1	Sahiwal Coal-fired Power Plant	1320	Operational	1912.2	3770
2	Coal-fired Power Plant at Port Qasim Karachi	1320	Operational	1912.2	4000
3	China Hub Coal Power Project, Hub Balochistan	1320	Operational	1912.2	4200
4	Engro Thar Coal Power Project	660	Operational	995.4	3000
5	SSRL Thar Coal Block-I 7.8 mtpa & Power Plant	1320	Under-progress	1912.12	2000
6	HUBCO Thar Coal Power Project	330	Under-progress	497.70	805
7	HUBCO Thal Nova Coal Power Project	330	Under-progress	497.70	305

The coal-fired power plants in Sahiwal, Port Qasim, Hub Balochistan and Engro Thar are all operational and producing 4620 MW of electricity. All these projects except Engro Thar employ imported coal and super-critical technology is used in these coal-fired power plants. Nearly 15000 jobs have been created through these power projects. SSRL Thar Coal Block-I power plant is under-progress and almost 70% of the work is completed. Local coal will be utilized to produce electricity from this power plant. As far as the HUBCO Thar Coal power plant is concerned,

[3] Energy Projects Under CPEC, *CPEC Secretariat: Ministry of Planning, Development, and Special Initiatives*, https://cpec.gov.pk/energy, Accessed on: May 20, 2023.

almost 75% work on this project is already completed. Fifty percent work on HUBCO Thal Nova power plant is completed. Most of these power projects have been sponsored by Chinese companies. In the context of employment opportunities, more than 18000 jobs have been created through coal-fired power projects. Though this number is nominal but its impact on overall economy of the country is significant in terms of mitigating electricity crisis in Pakistan. The addition of 6600 MW electricity generated by these coal-fired power plants in the national grid is much needed to mitigate the energy poverty/crisis in the country that will eventually result into higher economic growth and poverty alleviation.

Considering the global agenda of providing clean and affordable energy to households enshrined in the SDGs and adverse climate effects on Pakistan, emphasizing coal-fired power plants is, in fact, a deviation from the SDGs but much needed to reduce the intensity of energy crisis by utilizing the huge domestic reservoir of coal deposits in the country as a short term solution. The government of China has facilitated Pakistan both with technology and much needed capital to successfully implement these projects which strengthens their bilateral ties further.

3.2.2. Hydropower Projects under CPEC

Regarding hydel potential of Pakistan, Aftab Ahmad Khan Sherpao, the then Federal Minister for Water and Power, once stated that the country has been blessed with a hydel potential of more than 40,000 MW of electricity (Sherpao, 2021). However, just 15% of it has been harnessed so far. In order to mitigate the looming energy crisis, it is imperative to exploit the untapped hydel potential in a cost-effective way.

In order to further harness the untapped hydel potential of Pakistan, huge investments are required which the capital scarce country like Pakistan cannot afford. Keeping these limitations and financial constraints in view, a policy in this regard was framed by Islamabad under the title “Policy for Power Generation Projects 2002” to attract foreign direct investments (FDIs). Under the umbrella of CPEC, an investment has been committed by China for exploiting hydel potential of the country. Table 2 given below provides the detail about hydropower projects launched with the collaboration of China:

Table 2: Hydropower Projects in CPEC

Serial No.	Name of the Project	Capacity MW	Status	Est. Cost (US $ Million)	Jobs Created
1	Karot Hydropower Project	720	Operational	1,720	4870
2	Suki Kinari Hydropower Project	870	Under-progress	2000	4250
3	Kohala Hydropower Project	1124	Under-progress	2,400	7500
4	Azad Pattan Hydropower Project	700.7	Under-progress	1,600	3000

Karot hydropower project is situated on Jehlum River with a capacity of 720 MW. This project was completed in June 2021 and since then it became operational. It was executed by Karot Power Company Ltd (KPCL), China Three Gorges (CTG), CSAIL, and CTGI. Considering the massive hydel potential of the country, this project produces just 720 MW of electricity but its in line with the SDGs agenda of clean and affordable energy. Almost 5000 jobs were created by this hydropower project. 70% of Sukhi Kinari hydropower project is completed and it is situated on River Kunhar, a tributary of River Jehlum. This project is also a joint venture between Pakistani and Chinese companies. Kohala and Azad Pattan hydropower projects are in their early phases of their construction. All these hydropower projects under CPEC would generate 3414 MW of electricity after their completion. Considering the inherent hydel potential, this hydropower generation is below par and needs to be enhanced over longer periods of time.

3.2.3. Wind Farm under CPEC

Pakistan being a coastal country is substantially enriched with wind power potential but unfortunately this potential is still under-utilized. To implement SDGs of providing clean and affordable energy, wind farms are considered of vital significance. Though the contribution of wind energy into the primary energy mix of Pakistan is insignificant, but it is on the rise gradually. Investments in renewable energy such as hydro and wind are necessary for mitigating both climate effects and energy poverty. Table 3 below provides detail about the wind power energy projects under CPEC umbrella:

Table 3: Wind Power Projects in CPEC

Serial No.	Name of the Project	Capacity MW	Status	Est. Cost (US $ Million)	Jobs Created
1	Hydro China Dawood Wind Farm, Gharo, Thatta	50	Operational	112.65	500
2	UEP Wind Farm, Jhimpir, Thatta	100	Operational	250	900
3	Sachal Wind Farm, Jhimpur, Thatta	50	Operational	134	450
4	Three Gorges Second and Third Wind Power Project	100	Operational	150	950
5	Western Energy (Pvt.) Ltd. Wind Power Project	50	LOI stage		150

Most of the wind farms presented in the Table 3 are operational except Western Energy wind power project. The amount of electricity generated by these wind farms is comparatively far less than other coal-fired and hydro power projects in terms of cost. Also the number of jobs created by wind farms is less than the jobs

created in coal and hydro power projects. Wind farms are usually considered costly enterprises than other forms of power generation. Keeping in view the environmental challenges caused by CO2 emissions, long-term investments in clean energy such as wind are mandatory for Pakistan.

3.2.4. Solar Projects under CPEC

Solar energy is another important form of clean and environment friendly source of energy. Pakistan, like other renewable sources of energy, is quite rich in solar potential. The weather in Pakistan remains sunny and hot for most of the year which is quite suitable for solar energy. Though, the contribution of solar energy is very insignificant into the primary energy mix of Pakistan but it is gradually rising. In order to deal with the acute electricity crisis in the country, solar panels are utilized as an alternate of costly and insufficient supply of electricity. Solar energy projects are also included into the energy projects launched under CPEC. Table 4 below contains information about solar power projects in Pakistan:

Table 4: Solar Power Projects in CPEC

Serial No.	Name of the Project	Capacity MW	Status	Est. Cost (US $ Million)	Jobs Created
1	Quaid-e-Azam Solar Park (Bahawalpur)	400/600	400 MW completed. 600 MW under implementation	520 / 781	1200

Quaid-e-Azam Solar Park is the only solar power project launched under CPEC. It is situated in Bahawalpur region of Punjab province. It is executed by Zonergy. A wind farm of 400 MW is completed and 600 MW is under construction. Solar energy projects, both at small and large scale, are encouraged beyond CPEC projects and proposals are being floated to install solar energy into public sector organizations in Pakistan to manage the electric shortfall.

3.2.5. Nuclear Energy Cooperation between China and Pakistan

At a time when the government of Pakistan is shifting its focus to nuclear energy along with other renewables, nuclear energy provides the country with clean source of energy. As far as primary energy mix of Pakistan is concerned, currently it only accounts for 6.81% of overall energy production. China has always been a major collaborating partner of Pakistan in civil nuclear technology and their collaboration in this regard in touching new heights.

Tracing the history of Sino-Pak civil nuclear collaboration, it started back in the late 1970s. Civil nuclear energy collaboration between China and Pakistan was largely driven by economic and geostrategic elements. While Pakistan sought Chinese assistance in building nuclear energy program to mitigate the electric shortfall in the country, China aspired to cultivate strategic partnership with Pakistan in South Asian region to strike power-parity with India. Table 5 given below contains list of civil nuclear energy project between China and Pakistan:

Table 5: Civil Nuclear Energy Projects between China and Pakistan

Sr.No.	Name of the Project	Capacity MWe	Status
1	Chashma Nuclear Power Plant-1 (CHASNUPP-1 or C-1)	300 MWe	Operational
2	Chashma Nuclear Power Plant-2 (CHASNUPP-1 or C-2)	300 MWe	Operational
3	C3 and C4	315 MWe	Operational
4	Karachi Nuclear Power Plant-2 (K-2)	1014 MWe	Operational
5	Karachi Nuclear Power Plant-3 (K-3)	1014 MWe	Operational

Note: Karachi Nuclear Power Plant-1 (KANUPP-1 or K-1) 137 MWe, General Electric Canada

Following the 1986 deal concluded between China and Pakistan, Beijing agreed to provide Pakistan with its indigenously developed Qinshan-1 nuclear power plant. Resultantly, the construction of Chashma-1 or C-1 started in 1993 and it became operational in 2000. The plan to construct Chashma-2 or C-2 was agreed in 2005. For bridging the gap between demand and supply of energy further, "China National Nuclear Corporation" (CNNC), in collaboration with PAEC agreed to construct C-3 and C-4 at Chashma site. Both C-3 and C-4 became functional in 2016 and 2017 respectively. It is argued by few analysts that C-3 and C-4 were actually the response of the US-India civil nuclear deal struck back in 2008.

The construction of K-2 and K-3 was announced by China and Pakistan back in 2013 at Karachi each with a capacity of 1014 MWe. Both of these projects are operational now adding substantial quantities to the already existing nuclear energy in Pakistan. The overall energy capacity of the first five nuclear power plants (K-1, C-1, C-2, C-3, and C-4) was 1318 MWe. With K-2 and K-3 being operational, it is expected to generate 3346 MWe by 2022.

3.3. Why Power Projects under CPEC are Dominantly Skewed towards Coal Power Plants

Coal fired projects have been emphasized under CPEC priority plants primarily because of the "pull" factor from Pakistan and "push" factor from China. In order to lower the price of electricity and preserve foreign currency, Pakistan has long attempted to harness the massive reserves of coal in the Desert of Thar for power production. Moreover, Pakistani policymakers believed that coal offered the best chance for the nation to quickly develop a significant amount of power capacity in the near future. There is a complementarity of interests between Pakistan and China to develop coal power plants as it provides China with additional overseas markets for Chinese enterprises and Pakistan with cheap source of energy. Both Beijing and Islamabad also offered generous financial incentives to Chinese power companies to encourage them to build coal-fired power plants.

3.3.1. The "Pull" Factor from Pakistan

Islamabad places a lot of weight on expanding the proportion of coal into primary energy mix as evidenced by the focus that is placed on coal power plants in CPEC. In 2015, which coincided with the start of CPEC, coal generated just 0.1 percent of the nation's electricity, compared to 38 percent worldwide in 2015 (SBP, 2015). Raising the proportion of coal in the energy mix, power generation has been the subject of a number of Pakistani power industry reforms. In order to develop domestic resources, especially coal, the policy which was adopted in 2002 seeks to attract investments both from domestic and overseas (NEPRA, 2002). This is reflected in the statement made by the Water and Power minister back in 2004 in the following words: "the objective of the Government is to facilitate investors in developing coal mines and coal power plants in Pakistan" (Abbasi, 2020). Similar intent is displayed in the "National Power Policy 2013" which states that "development of coastal energy corridors based upon imported coal (later mixed with local coal), rapid proliferation of coal mining all across the country—especially at Thar, and the conversion of fuel oil power plants to coal power plants" (PPIB, 2014). Thar is one of the greatest coal reserves in the world and the government believes that it will play pivotal role in transforming the primary energy mix of the country.

The coal reserves in Pakistan remained unexploited due to the lack of technical expertise, financing and infrastructure until the launch of CPEC. Thar coal's poor quality made it expensive to extract, thus lots of companies shied away from making investments in it.

Due to international concerns about carbon emissions, global monetary institutions (World Bank and IMF) prohibited financing for coal-fired power projects. For example, in 2009 the World Bank took its support away from providing Pakistan in the coal-powered projects due to its initiative for reducing carbon emission (Shah, 2012). China has consequently become Pakistan's only option to look to for its coal-fired power projects.

3.3.2. Generate Cheaper Electricity

The CPEC power projects' substantial increase in coal-fired production capacity demonstrates Islamabad's desire of reviving the proportions of oil and coal into its primary energy mix. The electricity which is generated through oil is far more expensive than the one which is produced by coal. For instance, in 2014, the oil products accounted for 40% of the nation's generation capacity, while coal accounted for just 0.1 percent (SBP, 2015). The price of energy produced from these imported oil products has been significantly greater than that of electricity produced through coal. The cost of producing power from oil products was on average four times greater than the cost of producing electricity from coal. This very decision of the government to switch from oil to coal in the production of electricity was motivated by this discrepancy between the generating prices of oil products and coal in the belief that it would lower the price of energy (Dawn, 2012).

3.3.3. Secure Foreign Exchange

There is a strong assumption in the government circles that increasing the power production through coal-fired plants will help reducing the import costs in the shape of fossil fuel to generate electricity. For instance, it was predicted by the Planning Commission back in 2011 that US$ 8 billion or 4% of GDP could be saved by switching a dozen oil-powerd plants to coal-fired power plants (Tribune, 2012).

3.3.4. Benefits for Overseas Investors

The Pakistani government provides monetary benefits to entice international businesses to establish coal mines and coal-fired power facilities. All foreign investors are eligible for some of these benefits. They are promised high return rates on equity and national guarantees. Other incentives are only available to Chinese companies, most notably Islamabad's unfulfilled promise to create revolving funds to guarantee continuous payments to electricity producers.

The assessments of the dangers of doing business in Pakistan by Chinese government agencies and electricity corporations show the need for these incentives. In its most recent advisory to Chinese businesses operating in Pakistan, for instance, "China's State Administration of Taxation" notes that Pakistan has a substantial external debt. This very low debt service capability of Pakistan may prove very risky for Chinese businesses in the country. It further states that Chinese businesses obtain very low returns on their investments. Investing in Pakistan carries a number of hazards, not the least of which is the potential of delayed electricity payments, which make it very difficult for businesses that operate power plants in the country to buy coal and pay lenders.

3.3.5. The "Push" Factor from China

The Chinese desire to relieve its surplus capacity in various sectors including coal-fired power plants by searching overseas business opportunities complements Pakistan's attempt to boost the proportion of coal-fired electricity into its primary energy mix. Beijing has urged its monetary institutions to aid in the construction of international power projects in order to promote the export of its machinery. Furthermore, the former Prime Minister Nawaz Sharif election campaign promise to address the power outage issue by bringing required electricity into the national grid is in line with Chinese businesses.

3.3.6. Find New Overseas Markets

In order to meet the limited chances for expansion domestically as it seeks to make its electricity mix green, Chinese companies are building coal-fired power stations in Pakistan and various other nations. This creates new business opportunities for Chinese energy enterprises. China has substantially reduced power generation capacity through coal from 76% in 2008 to 62 % in 2017 (Downs, 2019). Renewable energy sources now account for the majority of new capacity deployments. Consequently, Chinese producers of coal power equipment are searching for new

markets abroad, particularly in nations with abundant coal resources but limited generation capacity.

3.3.7. Financial Support

The financial backing offered by Chinese financial institutions is another factor driving the establishment of coal power project by Chinese banks and power firms. To help reduce local surplus capacity in this sector, the Chinese government has urged them to make it easier for exports of power generation machinery. Xi Jinping's remarks and official publications both contain Beijing's directives. In order to encourage the overseas expansion of overcapacity industries, the State Council's "Guiding Opinions on Overcapacity" propose for additional loan financing. It encourages “Chinese financial institutions, particularly policy banks like the China Development Bank and the Export-Import Bank of China (China Exim bank), to provide additional funding for international projects that will boost the export of Chinese goods, including machinery for power generation” (The Export-Import Bank of China, 2023).

3.4. CPEC, Environmental and Energy Sustainability

Analysts have expressed concern over the possibility that infrastructure being built as part of the BRI may have detrimental environmental impact. Most of the infrastructure, energy, and industrial projects under the BRI are likely to have a negative environmental impact. The coal-fired power plants stand in direct contradiction to the principle of environmental sustainability which is heavily incorporated in the BRI. In the worst-case scenario, BRI nations could, according to Ma Jun and Simon Zadek of Tsinghua University, be responsible for more than half of the world's carbon dioxide emissions by 2050 (Jun & Zadek, 2019).

As a significant portion of energy production in the BRI nations, coal power plants frequently take center stage in questions of its environmental sustainability. According to a World Resources Institute report, coal is the preferred fuel for China’s debt financing of power generation and transmission networks in BRI nations. Furthermore, according to Fitch Solutions, energy projects created under the BRI will continue to be primarily focused on coal power projects (Fitch Solutions, 2018). As a result, Beijing's promise to create a green BRI conflicts with the majority of CPEC power projects.

4. Conclusion

The study concludes that the preference which is given to coal-fired power projects under CPEC reflects both “pull” and “push” factor by Pakistan and China respectively. The former Prime Minister Nawaz Sharif’s bid for reelection by addressing the power outage issue coincides with Xi’s unveiling of the BRI. To prioritize coal over oil was meant to reduce electricity generation costs and secure foreign exchange and it was the major factor behind the “pull” from Pakistan. To search new overseas markets for surplus energy equipment and the capability of the

monetary institutions of China to finance energy projects were the key rationale behind its "push" factor.

The emphasis on coal-fired projects to generate electricity underscores the significance of host country priorities to determine the BRI's environmental sustainability. Good number of analyses of Chinese export of coal-fired plants to overseas countries seems to emphasize more on the elements driving Chinese to sell coal-power technology than on the elements that push host countries to purchase them.

Regarding the criticism of 'debt trap' which is leveled against China, It seems less likely that China is deliberately employing this strategy to trap Pakistan for establishing control of strategic assets of the country or to influence decision-makers in Pakistan. It is, indeed, true that Chinese economic and strategic interests are better served through these mega projects in Pakistan that also help strengthening the economy of Pakistan. But, it might add to the debt burden of Pakistan owing to the sovereign guarantees provided by Pakistan.

References

Abbasi, S. A. (2020). Is Coal Power Generation a Sustainable Solution for Energy Needs of Pakistan: A Delphi-SWOT Paradigm? *International Journal of Energy Economics, 11*(1), 308–317. https://doi.org/10.32479/ijeep.10598

Abdullah, F.B.; Iqbal, R. ., Ahmad, S.; El-Affendi, M. A. ., & Abdullah, M. (2022). An Empirical Analysis of Sustainable Energy Security for Energy Policy Recommendations. *Sustainability*, *14*, 6099.

Aftab Ahmad Khan Sherpao. (2021). *Hydel Potential In Pakistan*. https://nepra.org.pk/Policies/Hydel Potential in Pakistan.pdf

Aftab, S. (2014). *Pakistan's Energy Crisis: Causes, Consequences and Possible Remedies*. The Norwegian Peacebuilding Resource Centre. https://www.files.ethz.ch/isn/177484/ade59fba5daf67a11a1c217434abf440.pdf

Amjad, R.; Burki, S. J. (Eds. . (2015). *Pakistan: Moving the Economy Forward*. Cambridge University Press.

Asim, Muhammad, Adnan Qamar, Ammara Kanwal, Ghulam Moeen Uddin, Muhammad Mujtaba Abbas, Muhammad Farooq, M. A. Kalam, Mohamed Mousa, and K. S. (2022). Opportunities and Challenges for Renewable Energy Utilization in Pakistan. *Sustainability*, *14*(17), 10947. https://doi.org/10.3390/su141710947

Asma Khalid. (2020, February 12). China-Pakistan Nuclear Energy Cooperation: History and Key Debates. *South Asian Voices*.

Bazilian, M.; Nakhooda, S.; Van de Graaf, T. (2014). Energy governance and poverty. *Energy Res. Soc. Sci.*, *01*, 217–225.

Belt and Road: Coal Power Exports to Remain Key Focus. (2018, July 31). *Fitch Solutions*. https://www.fitchsolutions.com/power/belt-and-road-coal-power-exports-remain-key-focus-31-07-2018

Boardman, B. (1991). *Fuel Poverty: From Cold Homes to Affordable Warmth*. Belhaven Press.

Bollino, C.A.; Botti, F. (2017). Energy poverty in Europe: A multidimensional approach. *PSL Q. Rev.*, *70*, 473–507.

Bradley, R. (2009). Comment—Defining health insurance affordability: Unobserved heterogeneity matters. *J. Health Econ.*, *28*, 255–264.

Dawn. (2012, October 1). *Conversion to Coal-Fired Power Generation*. https://www.dawn.com/news/753267/conversion-to-coal-fired-power-generation

Day, R.; Walker, G.; Simcock, N. (n.d.). Conceptualising energy use and energy poverty using a capabilities framework. *Energy Policy*, *2016*(93), 255–264.

Department of Energy & Climate Change. In Annual Report on Fuel Poverty Statistics 2011. (2011). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/%0Afile/48138/2181-annual-report-fuel-poverty-stats-2011.pdf

Erica Downs. (2019). *THE CHINA-PAKISTAN ECONOMIC CORRIDOR POWER PROJECTS: INSIGHTS INTO ENVIRONMENTAL AND DEBT SUSTAINABILITY*.

Foster, V.; Tre, J.-P.; Wodon, Q. (2000). Energy prices, energy efficiency, and fuel poverty. In *Latin America and Caribbean Regional Studies Programme*. World Bank.

González-Eguino, M. (2015). Energy poverty: An overview. *Renew. Sustain. Energy Rev*, *47*, 377–385.

Jack Unwin. (2019, September 27). What does Pakistan's energy mix look like and what is its future? *Power Technology*. https://www.power-technology.com/analysis/pakistan-energy-mix/

Karekezi, S.; McDade, S.; Boardman, B.; Kimani, J.; Lustig, N. (2012). Energy, poverty, and development. In *Global Energy Assessment Writing Team, Global Energy Assessment: Towards a Sustainable Future* (pp. 151–190). Cambridge University Press.

Ketting, N. G. (1995). Towards a sustainable energy future. *Energy Policy*, *23*, 637–638.

Khalid, I.; Mukhtar, A. (2016). Energy crisis: An issue of good governance, a way forward. *J. Political Stud.*, *23*, 101–116. http://pu.edu.pk/images/journal/pols/pdf-files/7-IRAM-ASIA_v23_1_16.pdf

Khan, Z., Changgang, G., & Afzaal, M. (2020). China-Pakistan economic corridor at the cross intersection of China, Central Asia and South Asia: Opportunities for regional economic growth. *Chinese Economy*, *53*(2), 200–215. https://doi.org/10 .1080/10971475.2019.1688005

Knotek, E.S., I. (2007). How useful is Okun's law? *Econ. Rev.-Fed. Reserve Bank Kans. City*, *92*, 73–103.

Lagarde, C. (2019). *BRI 2.0: Stronger Frameworks in the New Phase of Belt and Road*. https://www.imf.org/en/News/Articles/2019/04/25/sp042619-stronger-frameworks-in-the-new-phase-of-belt-and-road

Latief, R.; Kong, Y.; Peng, Y.; Javeed, S. A. (2020). Conceptualizing pathways of sustainable development in the union for the mediterranean countries with

an empirical intersection of energy consumption and economic growth_. *Int. J. Environ. Res. Public Health*, *17*, 5614.

Ma Jun & Simon Zadek. (2019). Low-Carbon Belt and Road. *Project Syndicate*. https://www.project-syndicate.org/commentary/climate-change-belt-and-road-infrastructure-investment-by-ma-jun-and-simon-zadek-2019-03.

Mahmood, R.; Shah, A. (2017). Deprivation counts: An assessment of energy poverty in Pakistan. *Lahore J. Econ.*, *22*, 109–132.

Malik, S., M. Qasim, H. Saeed, Y. Chang, and F. T.-H. (2019). *Energy Security in Pakistan: A Quantitative Approach to a Sustainable Energy Policy* (No. 1024). https://www.adb.org/publications/energy-security-pakistan-sustainable-energy-policy

Narumon INTHARAK. (2007). *A QUEST FOR ENERGY SECURITY IN THE 21 S T CENTURY*.

NEPRA. (2002). *Policy For Power Generation Projects Year 2002*. https://nepra.org.pk/Policies/Power Policy 2002.pdf

NEPRA. (2017). *No Title*. https://www.nepra.org.pk/

Nussbaumer, P.; Bazilian, M.; Modi, V. (2012). Measuring energy poverty: Focusing on what matters. *Renew. Sustain. Energy Rev.*, *16*, 231–243.

Pachauri, S.; Spreng, D. (2011). Measuring and monitoring energy poverty. *Energy Policy*, *39*, 7497–7504.

Papageorgiou, C.; Saam, M.; Schulte, P. (2017). Substitution between clean and dirty energy inputs: A macroeconomic perspective. *Rev. Econ. Stat.*, *99*, 281–290.

Private Power & Infrastructure Board (PPIB). (2014). *National Power Policy 2013*. https://www.google.com/search?q=Government+of+Pakistan%2C+National+Power+Policy+2013%2C+13%2C&sca_esv=559959589&rlz=1C1CHBD_enPK946PK946&ei=cr7oZLnROtaDxc8PpbeB8Ac&ved=0ahUKEwi50paghviAAxXWQfEDHaVbAH4Q4dUDCBA&uact=5&oq=Government+of+Pakistan%2C+National+P

Qurat-ul-Ann, A.-R.; Mirza, F. M. (2021). Multidimensional energy poverty in Pakistan: Empirical evidence from household level micro data. *Soc. Indic. Res.*, *155*, 211–258.

Ramay, S.A. (2021). China's Debt Relief Diplomacy and the Western Conspiracy Theories. *China Today*. https://www.google.com/search?q=China's+Debt+Relief+Diplomacy+and+the+Western+Conspiracy+Theories&sca_esv=559959589&rlz=1C1CHBD_enPK946PK946&ei=i7XoZNvpPN7c4-EP5-S_-A8&ved=0ahUKEwib273h_feAAxVe7jgGHWfyD_8Q4dUDCBA&oq=Chi

na's+Debt+Relief+Diplomacy+and+the+W

Ramay, Shakeel Ahmad. (2021, August 9). China's Debt Relief Diplomacy and the Western Conspiracy Theories. *China Focus*.

Rehman, A.; Cismas, L. M. ., & Otil, M. . (2022). Electrical Energy Dilemma and CO2 Emission in Pakistan: Decomposing the Positive and Negative Shocks by Using an Asymmetric Technique. *Sustainability*, *14*, 8957. https://doi.org/%0A10.3390/su14148957

Rehman, A. (2019). The nexus of electricity access, population growth, economic growth in Pakistan and projection through 2040: An ARDL to co-integration approach. *International Journal of Energy Sector Management*, *13*, 747–763.

Schuessler, R. (2014). Energy poverty indicators: Conceptual issues—Part I: The ten-percent-rule and double median/mean indicators. *ZEW-Cent. Eur. Econ. Res. Discuss. Pap.*

Shahbaz, M. (2015). *Measuring Economic Cost of Electricity Shortage: Current Challenges and Future Prospects in Pakistan*.

Sovacool, B. K. (2012). The political economy of energy poverty: A review of key challenges. *Energy Sustainable Development*, *16*, 272–282.

State Bank of Pakistan (SBP). (2015). *Annual Performance Report 2014-15*. https://www.sbp.org.pk/reports/annual/arFY15/Vol1/APR-FY15(Complete).pdf

Syed Qaim Ali Shah. (2012, June 15). World Bank pulls out of Thar coal project. *The Express Tribune*. https://tribune.com.pk/story/393924/world-bank-pulls-out-of-thar-coal-project

Taghizadeh-Hesary, Farhad., N. Yoshino, Youngho. Chang, and A. R. (2019). Achieving Energy Security in Asia: Diversification, Integration and Policy Implications. In and A. R. Taghizadeh-Hesary, Farhad., N. Yoshino, Youngho. Chang (Ed.), *Introduction* (pp. 5–13). World Scientific.

The Export-Import Bank of China. (2023). *White Paper on Green Finance (2022)*. http://english.eximbank.gov.cn/News/WhitePOGF/202301/P020230106613030856905.pdf

The Express Tribune. (2012, October 20). *Govt All Set to Switch 3 Power Plants to Coal*. https://www.pakistantoday.com.pk/2013/10/20/govt-all-set-to-switch-3-power-plants-to-coal/.

Thiam, D. R. (2011). Renewable energy, poverty alleviation and developing nations: Evidence from Senegal. *J. Energy S. Afr.*, *22*, 23–34.

Ullah, S.; Mahmood, T. (2020). Energy consumption and four growth hypotheses:

An evidence from SAARC Nations. *Rev. Econ. Dev. Stud.*, *06*, 833–843.

Wang, K.; Wang, Y.X.; Li, K.; Wei, Y. M. (2015). Energy poverty in China: An index based comprehensive evaluation. *Renew. Sustain. Energy Rev.*, *47*, 308–323.

West, D. S. M. and J. (2016). Behind China's Gambit in Pakistan. *Council on Foreign Relations*.

Whitehead, C. M. E. (1991). From need to affordability: An analysis of UK housing objectives. *Urban Stud.*, *28*, 871–887.

Yao, Lixia., and Y. C. (2014). Energy Security in China: A Quantitative Analysis and Policy Implications. *Energy Policy*, *67*, 595–604.

Yu, S.; Sial, M.S.; Tran, D.K.; Badulescu, A.; Thu, P.A.; Sehleanu, M. (2020). Adoption and implementation of sustainable development goals (SDGs) in China-Agenda 2030. *Sustainability*, *12*, 6288.

Zaman, R.; Brudermann, T. (2018). Energy governance in the context of energy service security: A qualitative assessment of the electricity system in Bangladesh. *Appl. Energy*, *223*, 443–456.

Zhao, T. (2006). Rethinking empire from a Chinese concept "All-under-Heaven" (Tian-xia). *Social Identities*, *12*(1), 29–41. https://doi.org/10.1080/13504630600555559