ENERGY DYNAMICS OF CHINA-PAKISTAN ECONOMIC CORRIDOR (CPEC)

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Abstract

Energy security is essential for the economic development of a state. At present, Pakistan is facing an energy shortfall of 6,000 to 7,000MW. This chronic scarcity has severely affected social lives and economic activity in the country. Energy is the pivot of the Belt and Road Initiative (BRI), with an estimated total investment of $4 trillion. China-Pakistan Economic Corridor (CPEC), an integral part of the BRI, is an investment of $62 billion. CPEC apportions $34 billion for the energy sector. Institutional management of CPEC energy will help mitigate the causes of scarcity of energy in Pakistan. Energy portfolio of CPEC is based on coal, hydroelectric, solar, and wind power. Energy production under CPEC is focusing on renewable energy sources alongside non-renewable sources to ensure an affordable, sustainable, and reliable energy mix. This paper argues that cheap energy through CPEC will help address the issues of circular debt. Through CPEC energy projects, Pakistan's reliance on both expensive furnace oil and seasonal hydropower will be diversified towards renewable energy technologies. The paper further argues that CPEC energy projects will boost the energy sector of Pakistan by addressing energy scarcity and improving the socio-economic condition of the country.

Key Words: *BRI, CPEC Energy, Theory of Institutions, energy crisis, energy crisis management.*

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چین پاکستان اقتصادی راہداری میں توانائی کے محرکات

سید وقاص حیدر بخاری، مسرت جبین اور قائم رضا جعفری

خلاصہ

ریاست کی اقتصادی ترقی کے لیے توانائی لازم وملزوم ہے فی الوقت، پاکستان کو۶،۰۰۰ سے۷،۰۰۰ میگاواٹ توانائی کی کمی کا سامنا ہے یہ دائمی کمی ملک کی معاشی اور سماجی سرگرمیوں کو بُری طرح متاثر کر رہی ہے۔ توانائی، بیلٹ اور شاہراہ (BRI) کا محور ہے، جس پر سرمایہ کاری کا تخمینہ ۴۰ کھرب ڈالر ہے۔ چین پاکستان اقتصادی راہداری (CPEC)، BRI کا لازمی جُزو ہے، جو کہ ۶۲ ارب ڈالر کی سرمایہ کاری ہے۔

سی پیک میں ۳۴ ارب ڈالر توانائی کے شعبے کے لیے مختص کیے گئے ہیں۔ پاکستان میں توانائی کی کمی کی وجوہات دور کرنے کے لیے سی پیک توانائی کی ادارہ جاتی انتظامیہ کی مدد کرے گی۔ سی پیک کی توانائی کا دارومدار کوئلے، پن بجلی، شمسی توانائی اور ہوا سے توانائی پر ہے۔ سی پیک کے تحت توانائی کی پیداوار کے لیے توانائی کے ناقابل تجدید ذرائع کے ساتھ ساتھ قابل تجدید ذرائع کو عمل میں لا کر سستی، پائیدار اور یقینی توانائی کے حصول پر توجہ دی جارہی ہے۔ اس مقالے میں بتایا گیا ہے۔ کہ سی پیک کے ذریعے کم خرچ توانائی کا حصول گردشی قرضے کے معاملے میں معاون ثابت ہوگا۔ پاکستان میں توانائی کے ایسے منصوبے جو مہنگے تیل اور موسمی پن بجلی پر انحصار کرتے ہیں سی پیک کے ذریعے توانائی کی قابلِ تجدید تکنیک کی طرف منتقل ہو جائیں گے۔ مزید برآں اس مقالے میں یہ امر بھی زیرِ بحث لایا گیا کہ سی پیک کے توانائی کے منصوبے پاکستان میں توانائی کے شعبے کو فروغ دیں گے۔ اور توانائی کے شعبے میں کمی دور کرنے سے ملک کی سماجی اور اقتصادی صورتحال بہتر ہو جائے گی۔

Introduction

Energy is the soul of the modern machine age and has a profound impact on the lives of people and the development of the state. The secret of smooth economic development lies in reliable access to energy. Energy is the lifeline of the economy of a state. Thus, a state will suffer if its energy supply is disrupted. Smooth economic growth needs a sustainable energy supply. Energy shortfall or problems of energy distribution not only result in the loss of economic development but also negatively affect social cohesion in society and increase unemployment. For the economic development of any nation, energy, in all its forms, is essential. Energy is the basic need of every developed, developing, and underdeveloped state. Supply, conversion, and utilisation are its three components. Pakistan is up against the challenge of its demand and supply, especially when the gap is incessantly increasing. Currently, it lies somewhere between 6,000 to 7,000MW.[1] This gap hits every segment of society and poses a serious threat to economic development.

In this drastic situation, CPEC is crucial for Pakistan because it gives priority to energy projects. The proper function of these projects will enhance Pakistan's energy capability and could make Pakistan self-sufficient in the field. The revitalisation of Pakistan's energy sector will boost economic progress and industrial development. Adequate energy supply is necessary for industry, infrastructure, transport, agriculture, informational technology, and households. Besides, higher living standards are reliant on efficient and reliable energy supply.

Under CPEC, the diversification of existing energy reserves and exploration of fresh energy resources is an essential step towards sustainable development. Focus on sustainable energy through CPEC is likely to enhance the strategic reserves of Pakistan. Sustainability will attract foreign investors and open new horizons of foreign direct investment (FDI). It will add to revenue and increase the gross domestic product (GDP).[2] Efficient utilisation of energy reserves,

through an institutional mechanism in CPEC, will guarantee energy security of Pakistan.

Theoretical Framework

The sustainability and durability of energy components of CPEC can be enhanced while putting the analysis in the theoretical framework of the theory of institutions given by Douglas C. North. He states, "Institutions are the rules of the game in a society or more formally humanly devised constraints that shape human interaction."[3] He further states, "Institutions provide the basic structure by which human beings throughout history have created order and attempted to reduce uncertainty in exchange."[4] For North, institutions define constraints based on economic, political, and social dealings. In North's view, there are two kinds of constraints: formal (constitutions, law and rights of property etc.) and informal (sanctions, taboos, traditions and codes of conduct etc.). Institutions are established to overcome the obstacles defined as transaction costs. Institutions structure the transaction costs of exchange. In other words, North is arguing that institutions matter for economic incentives. Institutions influence the cost of the transaction, which includes the cost of designing, negotiating, and enforcing trade contracts. When there is no institution or when laws are poorly defined and enforced, the value of risk will be high during trade and prospects of economic growth will be reduced.

In a society, the major aim of the institutions is to reduce uncertainty by developing a stable and efficient structure for human interaction. Institutions evolve through different conventions, legal procedures, contracts between individuals, norms of the state and common laws.[5] Institutions, with a defined structure of the economy, increase feasibility and profitability during economic activity. Institutions are formed with formal and informal constraints along with their enforcement interaction. Relationship between an institution and technology define transaction costs that sum up to

production cost. Therefore, institutions change the choices available to human beings. Change in the institution is a difficult process because changes at the margin can be a cause of change in rules, informal constraints, and enforcement effectiveness.

In general, North made the following four basic contributions to social sciences viz neo-classical understanding of institutions, the neo-classical theory of state/government, the importance of economic theory, and qualitative analysis in history. Regarding the role of institutions, this neo-institutional approach has played a vital role in attracting different scholars. In society, institutions provide order and structure by aligning the expectations and actions of individuals. Institutions help in developing coordination between diverse actors of society. Institutions provide governance and are designed to reduce conflicts and set a basis for mutual benefits. Moreover, institutions help in reducing uncertainty within a society and, through structured rules and regulations, are helpful in increasing economic gains.

Institutions offer a reliable and structural way of human communication with an incremental change. Better knowledge, factual data, and variability of valuable attributes pave the way for maximum dependence on institutions for a structured and low-cost exchange. Therefore, by improving the policy structure of existing energy institutions for managing energy projects of CPEC is essential. This step can enhance the durability and sustainability of energy projects. By taking this step, the nation can effectively manage its ongoing energy scarcity.

Energy Portfolio of Pakistan

Pakistan is facing a severe and multifaceted energy crisis. In the energy system of Pakistan, the Ministry of Petroleum and Natural Resources and the Ministry of Water and Power are major actors. The formulation and implementation of policies for the generation of energy and its overall distribution is the responsibility of these institutions. The aftermath of inadequate energy policies with no

practical implementation has brought Pakistan to the verge of an energy shortfall. Governments have been formulating formal and informal policies for the generation of reliable, sustainable, and affordable energy. Due to these poor policy mechanisms, the nation is compelled to rely on expensive and non-renewable energy reserves.

Within the institutional frameworks, Water and Power Development Authority (WAPDA), National Electric Power Regulatory Authority (NEPRA), and other such institutions are working for the same purpose with no satisfactory results. Poor institutional structure and weak policies are prominent among the bunch of reasons that cause deep-rooted and deep-seated crises of energy. For long, energy crises have been creating serious hurdles in the way of the progress of Pakistan. The graph of energy-generation is very low while the demand for energy is being multiplied drastically. Additionally, the aftermath of inadequate policies brought Pakistan to the verge of an energy shortfall. Pakistan has vast reserves of cheap and renewable energy resources. Due to poor policy mechanisms, however, the nation is compelled to rely on expensive and non-renewable energy reserves. Since the establishment of WAPDA in 1958, successive governments have been formulating formal and informal policies for the generation of reliable, sustainable, and affordable energy. The policies never come to anything, however, if not implemented practically.

Pakistan has sufficient reserves of renewable energy resources (solar, wind, biomass, etc.) for power generation. Moreover, Pakistan also has abundant reserves of coal for power generation. Till now, the share of coal was negligible in the energy mix. In 2014, the total share of coal was 0.07 per cent in the energy mix, furnace oil had a share of 36.58 per cent, high-speed diesel had 2.79 per cent, wind 0.37 per cent, natural gas 22.45 per cent, and nuclear 1.78 per cent. However, in March 2018, after four years, there was no share of high speed diesel, coal share had increased to 14.46 per cent, contribution of furnace oil

had decreased to 16.14 per cent, share of LNG came to 24.32 per cent, share of local natural gas generation was 21.28 per cent, share of nuclear was 8.99 per cent, solar 0.81 per cent, wind 1.71 per cent, baggase 1.04 per cent and power import from Iran had a share of 0.48 per cent in the total energy mix.[6]

Over the last few years, this poor energy mix has become the major cause of energy scarcity. Mismanagement is a big cause of energy shortfall. On the political front, lack of political will and differences between provincial and federal governments are serious hurdles in the way of the implementation of suitable energy policies.

Despite various energy policies, the nation has been facing energy scarcity for a few decades. This huge shortfall has hit the areas which were previously exempted from power outages. With every passing day, this gap is widening. Reports say that it is causing an economic loss of more than $100 billion per annum.[7] It also disturbs the social coherence and industrial development. Due to structural problems and power deficit, the cost of energy is rising. Key issues of energy shortfall are power losses, power theft, power mismanagement, and technological failure.[8]

Energy as Part of the Belt and Road Initiative (BRI)

Energy cooperation is an important aspect of the BRI. For energy cooperation, there is a need for massive infrastructural investments. However, under the BRI, energy cooperation does not merely mean infrastructural investments. According to *Visions and Actions on Energy Cooperation* document, the energy goals of the BRI are as follows:

1. To enhance open and inclusive cooperation in energy for the benefit of the community. This cooperation is based on shared interests with responsibility and destiny;
2. To enhance the security of regional energy resources and to improve their distribution;

3. To enhance the integration of regional markets of energy; and
4. To thrust ahead low-carbon and green development.

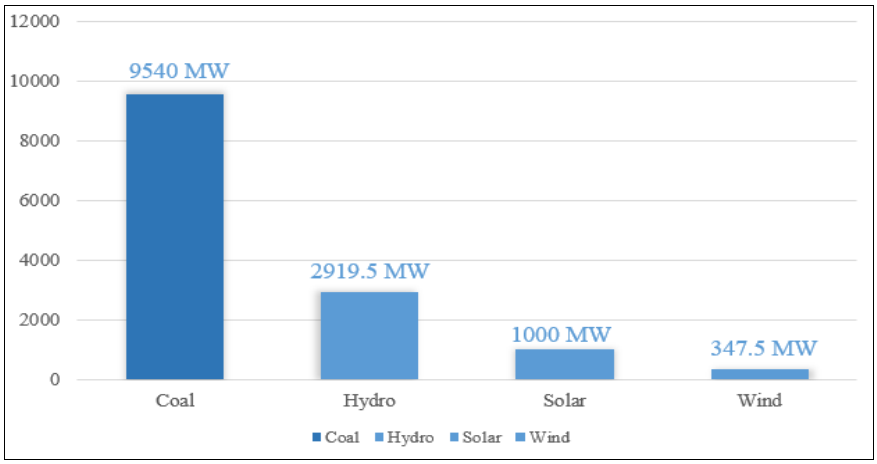
Energy cooperation under the BRI is cooperation and collaboration among individuals, companies, and governments. In the BRI, CPEC is connecting the western part of China with Pakistan through Gwadar Port. CPEC is an energy corridor for both China and Pakistan.

Energy Dynamics of CPEC

CPEC is a $62 billion investment, which is divided into two domains: energy and transportation.[9] For energy, $34.746 billion have been reserved, which amount to 55 per cent of the total investment.[10] The magnitude of CPEC energy investment is extraordinary. The current price tag of CPEC is six times the total developmental assistance ($7.5 billion) of the United States to Pakistan from 2009 to 2014.[11] Energy domain of CPEC is further divided into two parts: generation of energy and its transmission. CPEC is meant to boost the energy-generation capacity of Pakistan. This investment will boost the exploration of energy through indigenous resources.

In CPEC power projects, the four key sources comprise of coal, hydropower, wind, and solar are being used. Pakistan is also focusing on enhancing the share of renewable energy in the energy mix. For long, Pakistan has been focusing on renewable energy resources. CPEC renewable energy projects are solely focusing on this dimension.

Division of CPEC Energy Generation Portfolio in Megawatts



Source: Official Website of China-Pakistan Economic Corridor.

Energy Generation Projects of CPEC and their Present Status

The fundamental purpose of CPEC energy projects is to generate sufficient energy to fulfil the energy requirements of Pakistan. Minding future energy demands of Pakistan, twenty-one projects are part of CPEC. These projects are divided into three categories: The first category comprises of fifteen projects called the Energy Priority Projects. The second category is of four projects called the Energy Actively Promoted Projects. And the third category consists of two projects called Potential Energy Projects.

In 2014, twenty-four projects were proposed in the preliminary draft of CPEC. In that draft, seven projects were in the actively promoted category and seventeen were priority projects. Later on, due to diverse reasons, a few projects were dropped and the figures came down to nineteen.[12] The key reason behind pulling out of these projects was technical non-compatibility. Incompatible projects were Salt Range Mine-Mouth Power Project (300 MW), Sunnec Wind Farm (50 MW), Gadani Power Park (1320 MW), Chicho Ki Mallian Power Park (1,320 MW), and Muzaffargarh Coal Power Project (1320 MW).[13] China

is fully supporting these projects both technically and economically. In these projects, private Independent Power Producers (IPPs) are playing a vital role and governments of Pakistan and China are taking no direct part. These Chinese-financed energy projects are the centrepiece of CPEC. The top priority of CPEC is to equip Pakistan with modern technology to let it manage its drastic energy scarcity. Chinese companies are executing several of the CPEC projects as IPPs. For Pakistan, the Ministry of Water and Power is playing its role as the coordinating body. When these projects will start functioning, they will help by adding sufficient energy to the national grid.[14] It will bring down the reliance of Pakistan on expensive furnace oil. These projects carry immense importance, for they pave the way for a prosperous Pakistan. Following are some details regarding the projects:

CPEC Coal-Fired Power Projects

In CPEC, a major source of energy generation is coal. Ten coal-based power plants are envisaged under CPEC with an almost 880 MW capacity. More than 70 per cent of energy under CPEC will be generated by coal.[15] Pakistan has vast reserves, about 186 billion tonnes, of untapped coal. To decrease its dependence on imported fossil fuel, Pakistan's government plans to increase the annual use of local coal from 4.5 million tonnes to 60 million tonnes.[16] Government is trying to explore and use domestic resources of coal. Karachi-based Port Qasim Coal Power Plant is running on imported coal. The estimated cost of the project was $1,912.2 million. Currently, two independent units of this plant are generating 1,320 MW energy. Ministry of Water and Power is coordinating this project through the Private Power and Infrastructure Board. Similarly, in Sindh, at Thar Block II, there are three projects: The 2,330 MW coal-fired power plant, Engro Thar Block II, the 1,330 MW mine mouth lignite-fired power project, TEL, and the 1,330 MW mine mouth lignite-fired power project, Thal Nova. These three projects, with an estimated cost of $2 billion, will generate 1,320 MW energy. At present, the sites are not

functioning. They are estimated to start functioning by June 2019. Engro Power Gen Thar Ltd and China Machinery Engineering Corporation (CMEC) are financing the projects as Independent Power Producers. The Ministry of Water and Power is coordinating the process through its supervisory agency called the Private Power Infrastructure Board (PPIB). Surface Mine project, located in Sindh at Thar block II with an estimated cost of $1,470 million is a coal-based project, which has not started functioning till now. This project is sponsored by the China Machinery Engineering Corporation (CMEC) and Sindh Engro Coal Mining Company (SECMC). The Ministry of Petroleum and Natural Resources and the Ministry of Water and Power are the coordinating ministries and Thar Coal Energy Board (TCEB) is its supervising agency. At Thar block I, there are two projects named as SSRL Thar Coal Block-I and SEC Mine Mouth Power Plant. The installed capacity of these projects is 1,320 MW. The estimated cost of these projects is $2 billion and $1.3 billion. The executing and sponsoring companies of this project are CCTEG and SSRL and Shanghai Electric Power Company Limited. This project is financed by IPPs. Hence, the Ministry of Water and Power is the coordinating ministry and the PPIB is the supervisory agency. The project Thar Mine Mouth Oracle Power Plant and Surface Mine is located in Sindh province at Thar block VI. The primary input of this project is Thar coal and it will generate 1,320 MW energy. Yanzhou Coal and M/S Oracle Coalfields SEPCO are executing and sponsoring companies of this project.

In Punjab, the Sahiwal coal-fired power plant has started functioning with an installed capacity of 1,320 MW. This project is functioning with two units of 660 MW with an estimated cost of $1,912.2 million. The primary source of this project is imported coal and it uses supercritical technology. Huaneng Shandong Rui Group of China, an IPP, is its sponsoring and executing company. The Ministry of Water and Power is coordinating this project through the Punjab Power Development Board (PPDB) as the supervising agency.

In Balochistan, an imported coal-based power project at Gwadar will produce 300 MW energy. The primary input of this project is imported coal. China Communications Construction Company (CCCC) is executing and sponsoring this project. In this project, the Ministry of Water and Power is the coordinating ministry while the Gwadar Development Authority (GDA) and Gwadar Port Authority (GPA) are supervising agencies. In Balochistan, a China Power Hub Generation Company (CPHGC)-run coal-fired power plant with a capacity of 1,320 MW is functioning. The primary input of this project is imported coal and it is located at Hub. China Power Hub Generation Company (Private) Limited is executing and sponsoring this project. This project is financed by IPPs. In this project, the Ministry of Water and Power is the coordinating ministry while the PPIB is supervising agency.[17]

In Punjab, the mushroom growth of coal-based power generation plants under CPEC is raising environmental concerns. These projects aim to use indigenous coal for power generation. The cost of coal-based power plants is less than hydro, wind, and solar plants. In the long run, it is sure to give direct benefit to consumers in terms of tariffs. By 2021, the expected percentage of coal-based power generation in the energy mix of the country will reach 18 per cent. This fundamental change will happen due to the increased number of coal-based power generation plants.[18] These plants are a remedy for the shortfall of energy and would serve to reduce public frustration with excessive power outages. This coal-driven energy resource would reduce excessive use of furnace oil. The CPEC coal-based power projects are providing the quickest and cheapest source of energy generation, utilising both imported and domestic coal. This way, Pakistan would get low-cost energy. At present, the share of coal in the energy mix is low. Thus, Pakistan has the most expensive energy in Asia at the cost of $0.13 per unit, whereas the same is $0.09 for Bangladesh, $0.11 for China, and $0.12 for India.[19]

CPEC Hydroelectric Power Projects

Hydropower is an environmentally friendly and renewable source of energy generation. Under CPEC energy projects, the second main component is the production of energy by the use of hydropower. The Ministry of Water and Power is also focusing on the construction of hydropower projects. Here, the PPIB through PPP (Public Private Partnership) is in support.

In district Mansehra of Khyber Pakhtunkhwa, located on Kunhar River (a tributary of Jhelum River), the Suki Kinari hydropower station is being installed. The estimated cost of this project is $1,956 million and it will start generating 870 MW of energy by the end of 2022. The sponsoring and executing companies of this project are China Gezhouba Group Company Ltd and Suki Kinari Hydro (Pvt) Ltd. The project is financed through IPP. The Ministry of Water and Power is the coordinating ministry and the PPIB is supervising it.

Karot hydropower station is located on the Jhelum River. The installed capacity of this project is 720 MW and its estimated cost is $1,698 million. This project will start functioning by the end of 2021. The sponsoring and executing companies are CSAIL/CTGI/CTG (China Three Gorges) and Karot Power Company Ltd. (KPCL). This project is financed by IPPs. The Ministry of Water and Power is its coordinating body while the PPIB is its supervisory agency.

In CPEC, Kohala hydropower project is categorised as energy actively promoted project. It is located in Azad Jammu Kashmir near its capital of Muzaffarabad on the Jhelum River. Its estimated cost is $2,355 million and its installed capacity is 1,100 MW. By 2025, it will start to function. The executing and sponsoring companies of this project are CTG/CWEI (China Three Gorges) and (CWE Investment Corp). This project is financed by IPPs. The Ministry of Water and Power is the coordinating body and Alternative Energy Development Board (AEDB) is its supervisory agency.

In CPEC energy projects, Phandar hydropower station and Gilgit KIU Hydropower are potential energy projects. Phandar hydropower station is located in Gilgit-Baltistan with an installed capacity of 80 MW. The feasibility of this project is under the review of experts of both sides. Gilgit KIU Hydropower is also located in Gilgit-Baltistan with an installed capacity of 100 MW. The feasibility of this project is also under the review of experts of both sides.[20]

By 2023, Kohala, Karot, Neelum Jhelum, and Suki Kinari hydropower projects will add 3.7 GW of energy to the system. These projects are not part of CPEC, for they were initiated in 2008 yet China is constructing and financing them.[21]

Pakistan established its first hydropower plant in 1960. Therefore, Pakistan is quite experienced in hydropower technology. Nevertheless, under CPEC, hydropower projects are shaping the energy system anew, providing a sufficient share through renewable energy technology. Economic assistance of China for CPEC hydropower projects will boost the confidence of the government in energy generation.

CPEC Wind Energy Power Projects

Alternative Energy Development Board (AEDB) has initiated many wind power projects in Sindh. UEP Wind Farm is located in Jhimpir, Thatta. Its primary source is wind and it operates on wind turbine technology. It is functioning with an installed capacity of 99 MW. The estimated cost of the project was $250 million. UEP Wind Power Private. Limited (UEPL) is the executing company which is also sponsoring this project. The Ministry of Water and Power is the coordinating body, while the Alternative Energy Development Board (AEDB) is supervising it.

In the same district, another project named Sachal Wind Farm is also operating on wind turbine technology with the wind as its primary energy source. It is functioning with an installed capacity of 49.5 MW. The estimated cost of the project was $134 million. Its

executing and sponsoring body is Sachal Energy Development Pvt. Ltd. (SEDPL). It was also financed by IPPs. The Ministry of Water and Power is the coordinating body, while the Alternative Energy Development Board (AEDB) is supervising it.

Three Gorges Second Wind Power Project and Three Gorges Third Wind Power Project are also located in Sindh. They both use wind turbine technology. The capacity of the projects is 49.5 MW each and its estimated cost was $150 million. This project is operational and Three Gorges Third Wind Farm Pakistan Pvt. Ltd. (TGTWF) and Three Gorges Second Wind Farm Pakistan Ltd. (TGSWF) are their executing and sponsoring bodies. This project is also financed by IPPs with same coordinating and supervising bodies.

In CPEC, there are two wind power projects under energy actively promoted projects. First is Cacho Wind Power Project, which is also located in Sindh. The executing and sponsoring body of this project is Cacho Wind Energy Pvt. Ltd. and its installed capacity is 50 MW. This project is also financed by IPP with the same coordinating and supervising bodies. Second is the Western Energy (Pvt.) Ltd. Wind Power Project as an IPP. Western Energy (Pvt.) Ltd. is its executing and sponsoring body. It is also located in Sindh. The installed capacity of this project is 50 MW. Like previous projects, it is also coordinated by the Ministry of Water and Power and Alternative Energy Development Board (AEDB) is its supervising agency.[22]

In Pakistan, the generation of energy through wind is novel. In comparison with hydro and solar initiatives, the scale of energy generation through wind power is smaller. However, these projects will encourage future investments. Pakistan needs to learn from Chines experiences to make use of this technology and utilise it for energy generation more efficiently because it is an environment-friendly and renewable energy source.

CPEC Solar System Power Projects

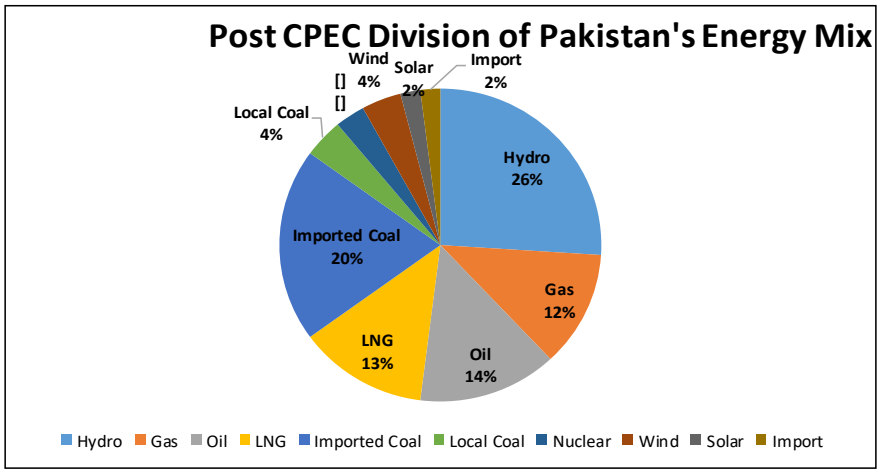
The newly introduced solar technology is a component of

energy generation through CPEC. Among solar projects, the 1,000 MW Quaid-e-Azam Solar Park is located in Bahawalpur. Its primary input source is solar and it uses PV solar technology. The estimated cost of this project $1,302 million. Zonergy is its executing and sponsoring body. It is coordinated by the Ministry of Water and Power and both Alternative Energy Development Board (AEDB) and Punjab Power Development Board (PPDB) are its supervising agencies.[23]

The use of solar technology is increasing day-by-day. In many cities, WAPDA is utilising solar technology to illumine street lights. People are promoting the use of this technology for their domestic use as well because it is a renewable and cheaper source of energy.

CPEC Energy and Management of Pakistan's Energy Scarcity

Energy projects of CPEC will play a key role in reducing is energy shortages. These projects, being beneficial for people, will contribute to load management. They are essentially the backbone of CPEC.



Source: Yasir Arafat, "Challenges and Solutions in Building CPEC-A flagship of BRI," *Centre of Excellence, China-Pakistan Economic Corridor*, Working Paper No. 17, (2017), p.5.

According to Ahsan Iqbal, former Minister for Planning, Development, and Reforms, the total energy generation capacity of CPEC projects is 17,045 MW.[24] This massive energy portfolio is sufficient to fill the demand and supply gap of 6,000 to 7,000 MW. It shows that CPEC energy projects will not only address energy scarcity but will also make Pakistan an energy self-sufficient state. Therefore, it is essential that these projects are well-managed by improving the structure of the existing energy institutions. Institutional management will enhance the durability and sustainability of these projects. Institutional reforms may provide a foundation for the achievement of self-sufficiency in the energy sector of Pakistan. Effective energy reforms ensure effective management of energy resources and judicious integration of renewable energy technologies. An effective institutional framework brings all policymakers together for the development of viable policies for promoting national interest. Simultaneously, they join hands when they are playing their role in developing national consensus beyond their parties or self-interest. Efficient energy institutions enable long-term energy efficiency and, thus, help a state respond effectively and efficiently to energy crises. Academic research and experiences confirm that countries with strong and efficient institutional frameworks have strong and efficient energy traditions. A long-term and efficient energy strategy helps plan and then put into practice an effective and efficient response to an energy crisis.

In Pakistan, the problem is not on the side of policy, rather on the side of implementation. Governments have been formulating useful energy policies with no practical outcomes because the implementation mechanism remained too weak to produce adequate results. Through effective institutions, this problem may be controlled because institutions employ their own enforcement mechanisms and implement the policies in their own trustworthy ways.

Analysing the post-CPEC energy portfolio of Pakistan, it is notable that a negligible share of renewable energy in the energy mix of Pakistan is making gradual progress. The share of wind and solar (4 + 2) is a big step in the progress towards renewable energy. Another key accomplishment is the reduction in reliance on imported furnace oil. It is a very big burden on the economy. So its import must decline and it is declining.[25]

Energy projects of CPEC, adding the bulk of energy, are sure to address energy scarcity of Pakistan. Through CPEC energy projects, Pakistan will be able to overcome economic crises. In 2014, before the inauguration of CPEC energy projects, the per unit cost of power was PKR 9.69. At present, it is PKR 15.53 but in 2020 it is expected that the per unit cost of power will be reduced to PKR 9.10. There is a link between energy and development. Both are fundamental to the economic development of a state. A strong combination of these factors leads a state towards sustainable progress and energy security. According to NEPRA, through CPEC energy generation there will a shift of energy mix from expensive oil-based generation (Tariff: PKR 10.4506/KWH) to coal-based generation (Tariff: PKR. 8.117/KWH).[26]

Owing to different energy projects of CPEC, an improvement in energy generation is seen. In 2012-13, energy capacity was 22,812 MW which reached 29,573 MW in February 2018. There was a record growth of 30 per cent in the same period, which is a positive sign.

Generation of energy may vary due to certain constraints and fluctuations in its usage. In 2012-13, the generation capacity of energy was 96,496 GW/h which in 2016-17 reached 117,326 GW/h with an admirable growth of 22 per cent. Simultaneously, from July-February 2017 in FY 2018, generation of energy remained 69,956GW/h.[27] Funding for CPEC, in the form of Foreign Investment, is categorised under FDI which ensures 17 per cent return on equity. Mainly, China Development Bank and China Exim Bank are providing loans against their own balance sheet.

By the completion of the long-term CPEC energy projects, the energy mix of Pakistan will acquire more sustainable balance by 2029-30. Diverse power generation sources of CPEC will enhance the energy security of Pakistan. Through CPEC energy, current reliance of Pakistan on both expensive furnace oil and seasonal hydropower will be reduced and energy mix will remain inclined towards renewable energy technologies like hydro, solar, and wind. CPEC energy will enable Pakistan to generate cheaper energy by 2030. CPEC energy will provide a better chance to reduce the cost-tariff deficit. The issue of circular debt in the energy system of Pakistan will be resolved through a reduction of the cost-tariff deficit. The utilisation of cheaper renewable energy will also reduce generation cost, which will give direct benefit to the end user.

CPEC Transmission and Distribution Lines

In 2015, Pakistan was confronting 20-25 per cent transmission and distribution losses, which were becoming a cause of a rise in tariffs. In comparison with transmission losses, distribution losses are higher, amounting to 70 per cent. These losses are a major cause of increasing circular debt and distribution companies are unable to control them. Pakistan's power sector is using overhead lines for transmission and distribution of energy. Poor management system, old transmission lines, and outdated infrastructure of grid stations are the reasons of T&D losses. Equipment of energy distribution is too old and not working properly, which provides opportunities for theft of energy.[28]

On the transmission side, there are two transmission line projects in CPEC. One is Matiari to Lahore ±660kV HVDC Transmission Line Project. This line will carry 2,000 MW with 10 per cent overload capability for two hours. The expected cost of the project is $1658.34M and it will start functioning by March 2021. The second line is from Matiari to Faisalabad. This line will also carry 2,000 MW with 10 per cent overload capability for two hours. The estimated cost of the

project is $1,500 million and it will start it functioning by 2018/19. Both these transmission lines are executed or sponsored by China Electric Power Equipment and Technology Co. Ltd. (CET)/State Grid Corporation of China (SGCC). These two projects are coordinated by the Ministry of Water and Power. Moreover, the National Transmission and Despatch Company (NTDC) is the supervising agency.

During 2017-18, the transmission system of NTDC has been strengthened. In the national grid, for the evacuation of additional power of 4,340 MVA, 2700 MVA on 220 KV and 500 KV systems respectively. The system of current transmission lines is extended by adding 372 km and 1,157 km on 220 KV, and 500 KV, respectively.[29]

Addition in Transmission Capacity

Items	**Units**	**Targets 2017-18**		**Achievements up to June 2018**	
Transmission	MVA	500 KV	220 KV	500 KV	220 KV
	MVA	4800	6360	2700	4340
Transmission	KM	1853	809	1157	372

Source: Pakistan 2025, Annual Plan 2018-19, Government of Pakistan, Planning Commission. Ministry of Planning, Development and Reform, (2018), p. 131

Improving the structure of transmission lines will definitely reduce line losses. This will help transmit energy from the generation site to the national grid and onward to the end-user. Sustainable energy generation, with reliable transmission system, will boost industrial capacity and finally, the issue of circular debt will be resolved.

Conclusion

CPEC is a win-win synergy not only for Pakistan and China but also for the whole region. Energy-related projects of CPEC are the backbone of the energy policy of the government. A major portion of the FDI ($34 billion) has been allocated for energy generation and transmission to meet the energy demand of Pakistan. Funds through CPEC is the largest FDI in Pakistan, which will overcome its energy crisis. Energy projects of CPEC have immense importance because the source of energy generation projects will be the renewable and alternative energy potential of Pakistan. Pakistan, through CPEC, will be able to get sustainable and reliable energy to support its industry and unhindered supply of energy for local consumption. Sustainable energy through CPEC will lead to sustainable development in Pakistan. These projects are not only the lifeline of the economic sector but the overall development of Pakistan is also linked with its different projects. Infrastructure projects of CPEC will improve roads and access towards markets will become easy. CPEC will enhance the social, economic, political, and strategic significance of Pakistan. This project is important for Pakistan because it will help reduce public and fiscal debt. These things would provide ways for sustainable economic development.

CPEC energy projects are environment-friendly and Pakistan has substantial renewable energy potential. This positive dimension of renewable energy technologies has increased the overall desire of China to invest. By 2020, China plans to invest $400 billion on renewable energy. By 2030, it desires it to constitute 20 per cent of its total energy mix. That is why China is promoting renewable energy through CPEC and these technologies have a central place in the energy projects of the corridor. These projects will provide Pakistan with an opportunity to address its energy insecurity. They have the potential to reduce the level of energy insecurity to zero and provide cheaper and diverse energy mix. Based on various types of

technologies, CPEC energy projects have a great potential for the energy sector of Pakistan and this sector is struggling hard to cope with energy crisis for such crisis have a great impact on the GDP of the country.

China and Pakistan are in need of energy and this corridor will help them in their energy shortage. The growing industry of China needs energy in the shape of raw material. At present, the industrial sector of Pakistan is operating at half its capacity due to the unavailability of smooth supply of energy. If this sector would get energy as per its needs, it would be able to utilise its full capacity. By doing so, the energy sector would provide opportunities for jobs and would help to reduce the unemployment ratio. It is evident that the continuous supply of energy would affect not only the life of the people but would also improve the performance of the industrial sector. A sustainable supply of energy would help in improving the image of the country before the international community.

Notes and References

1 Fawad Yousafzai, "7,000MW Shortfall Trigger Extra Unscheduled Load Shedding," *The Nation*, (02 May 2018).

2 Asia Maqsood, "CPEC: Pakistan's Quest for Energy Security," *Pakistan Observer*, (3 January 2018).

3 Douglass C. North, "Institutions, Institutional Change and Economic Performances," (New York: Cambridge University Press, 1990), 3.

4 Ibid., 118.

5 Ibid., 7.

6 Energy Dependence: "CPEC and Pakistan's Energy Portfolio," *Institute of Policy Studies,* Brief No. PB-2018-VI-JN, (28 June 2018), 5.

7 Muhammad Asif, "Energy Crisis in Pakistan: Origins, Challenges and Sustainable Solutions" (Karachi: Oxford University Press, 2012), 25.

8 "Pakistan Vision 2025," *Ministry of Planning Development and Reform*, (Islamabad, Government of Pakistan, 2015).

9 Salman Siddiqui, "CPEC Investment Pushed from $55b to $62b," *The Express Tribune*, 12 April 2017.

10 Muhammad Ishaq, RuanJian Ping and Bilal Ahmed, "Pakistan-China Economic Corridor (CPEC): Opportunities, Threats and Challenges," *International Affairs and Global Strategy,* Vol. 52, (2017), 9.

11 Michael Kugelman, "The China-Pakistan Economic Corridor: What It Is, How It Is Perceived and Implications for Energy Geopolitics," in "Asia's Energy Security and China's Belt and Road Initiative", *The National Bureau of Asian Research*, Report No. 68, (November 2017), 18.

12 Shebonti Ray Dadwal and Chithra Purushothaman, "CPEC in Pakistan's Quest for Energy Security," *Strategic Analysis, Vol. 41, No. 5*, (2017), 1.

13 Fawad Yousafzai, "Pakistan, China Drop 5 CPEC Energy Projects," *The Nation*, 19 May 2017.

14 China-Pakistan Economic Corridor: Opportunities and Risks, *International Crises Group*, (29 June 2018), 11.

[15] Arif Rafiq, "The China-Pakistan Economic Corridor: Three Years Latter," Center for Strategic and International Studies, (12 February 2018), available at https://reconnectingasia.csis.org/analysis/entries/cpec-at-three/

[16] Government of Pakistan, "Pakistan 2025: One Nation One Vision," Ministry of Planning Development and Reform, (2014), 61.

[17] http://cpec.gov.pk/energy

[18] Harris Azhar and Amina Syed, "Impact of China-Pakistan Economic Corridor (CPEC) on the Energy Sector of Pakistan," *Corridor Culture And Connectivity*, Pak-China Institute, Vol. 3, (October 2017), 15.

[19] Harris Azhar and Amna Syed, "Impact of China-Pakistan Economic Corridor (CPEC) on the Energy Sector of Pakistan," *Pakistan-China Institute*, (2017), 17.

[20] http://cpec.gov.pk/energy.

[21] Harris Azhar and Amna Syed, "Impact of China-Pakistan Economic Corridor (CPEC) on the Energy Sector of Pakistan," 22.

[22] http://cpec.gov.pk/energy.

[23] http://cpec.gov.pk/energy.

[24] Muhammad Irfan, "17,000MW to Be Generated Under CPEC Energy Projects, Senate Told," *Daily Pakistan*, 21 February 2018.

[25] Energy Dependence: "CPEC and Pakistan's Energy Portfolio," *Institute of Policy Studies,* Brief No. PB-2018-VI JN, (28 June 2018), 5.

[26] Yasir Arrafat, "Challenges and Solutions in Building CPEC-A Flagship of BRI," *Centre of Excellence, China-Pakistan Economic Corridor*, Working Paper No. 17, (2017), p.6.

[27] Pakistan Economic Survey 2017-18, *Finance Division, Government of Pakistan*, 210.

[28] Shakeel Khan and Farhan Ashraf, "Analysis of Pakistan's Electric Power Sector," *Blekinge Institute of Technology* (March 2015), 37-38.

[29] "Pakistan 2025," Annual Plan 2018-19, Government of Pakistan, Planning Commission, *Ministry of Planning, Development and Reform*, (2018), 131.