ENVIRONMENTAL AND ECONOMIC IMPACTS OF THE CHINA-PAKISTAN ECONOMIC CORRIDOR ON PAKISTAN ENERGY SECTOR: A PANORAMIC VIEW

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ABSTRACT: *China-Pakistan Economic Corridor (CPEC) has launched China and Pakistan as a mega-project for economic growth, with a strong emphasis on energy infrastructure production. This research study attempts to consider the expense and viability of utilizing alternative energies and a different energy balance relative to CPEC energy-intensive ventures. For current CPEC schemes, leveled energy, CO_2emissions, and SO_2 emissions were measured using information obtained from Pakistan generation licenses and tariff records because coal-fired plants currently comprise half of announced CPEC electricity generation projects and 69% of power, casting doubt on the environmentally friendly language around the Belt and Road Initiative(BRI) initiative. Generalized plants were then used to construct an optimization model around Leveled Cost of Energy (LCOE) and pollution under various constraints. Moreover, model findings demonstrate more cost-effective and less polluting solutions utilizing massive re-gasified natural gas plants and hydro projects. A literature review indicates that Chinese-born political and economic conditions, as well as Pakistani political influences, lead to coal usage over other technologies.*

Key words: Environment, pollution, LCOE, environmental cost, economic goals, energy generation, CPEC, China and Pakistan.

1. INTRODUCTION

Relations between Pakistan and China date back to the Silk Road, but in 1950 formal links started. Pakistan becomes the first Muslim country to acknowledge China as the People's Republic and the first airline in the world to fly a flight to and from China is Pakistan International Airlines. China has become the main trade partner in Pakistan on an ongoing basis [1]. Since the 1960s, the ties between Pakistan and China have developed steadily and the two countries have become deep friends now. This connection was further reinforced by the building of the Karakorum Highway (KKH) in 1972. The CPEC is part of the One Belt, One Road (OBOR) project in China-Pakistan. This is a multifaceted transport, electricity, and other growth project platform intended to support regional connectivity between Pakistan, China, and Eurasia. CPEC was launched in April 2015 as an expenditure of 46 billion dollars [2] but its value grew by 62 billion dollars in 2017[3]. As a result of CPEC, China will find relaxed links to the Middle East, Africa, and Europe while the infrastructure and economy as a whole in Pakistan will be upgraded [3].

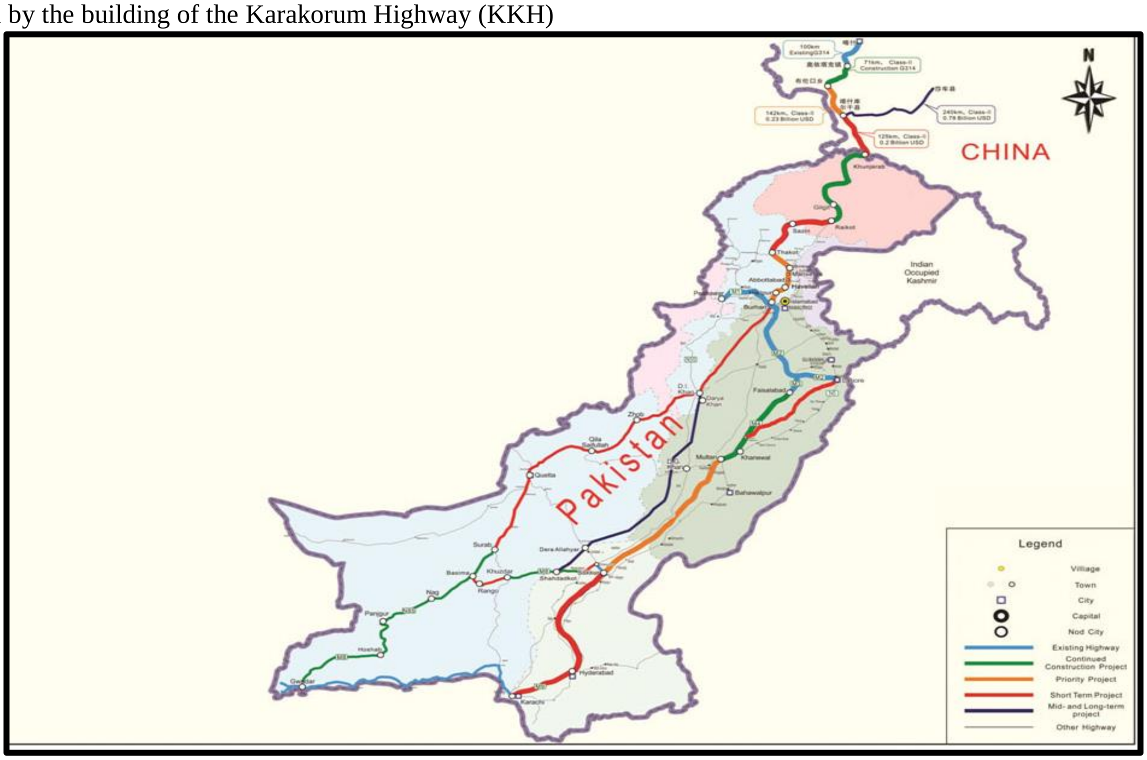


Figure 1.1: Districts in KPK along northern CPEC road route.

Many CPEC projects have started, including the construction of railways, the installation of power stations and development of Gwadar Port, economic areas, and social sector projects, but most important are road construction projects in the country which can be broken down into the northern part of roadways and 3 other alignments such as the western one (Figure-1.1) CPEC road networks in Pakistan have many advantages. The most advantages are social and fiscal, but all potential environmental losses must be avoided. These advantages would include meeting energy needs throughout the region, meeting world-quality roads and rail networks, building capacity, and increasing the rate of jobs. EIAs are the requirements of both Pakistan and China national environmental laws as well as of the Environment and Development Statement adopted by both countries [4]. EIAs are needed by both states.

A study found that Chinese Foreign Direct Investment (FDI), which contributed to current environmental problems in Pakistan, faces two major challenges, in particular air quality and water consumption [5]. Another research using a rigorous Multi-Fuzzy environmental and social risk assessment model cautions that investment project building would have the most immediate, visible and risky effects on water, air, biodiversity and soil [6].

The CPEC is a mega project between the two adjacent nuclear power plants, China and Pakistan, whose citizens enjoy a proven brotherly friendship. The Economic Corridor is a megaproject known for the city, known as a regional game-changer. The geographic position of Pakistan positions it right at the center of this global initiative, as it will become a hub linking the Middle East, Europe and Africa with the Republic of Germany. Pakistan is highly expected from this initiative, but only a small number of players concern the disastrous environmental effects of the project in Pakistan. The side effects of building the modern road, the railways and the elevated road traffic are of special concern. Additional environmental impacts would occur in the modern energy power stations, grids, fossil fuel, additional roads and the large manufacturing areas along those paths. All these advances can be believed to have a significant effect in Pakistan on ecology, biology, air quality, water quality, wildlife and agriculture. The precise degree and thoroughness of this effect are not understood.

Countries need to change their energy markets considerably to achieve this goal, accounting for 72 percent of world GHG emissions [7]. However, several developed countries are still struggling to deliver sustainable, stable electricity. The population is growing and electricity demand is also increased with further urbanization. In this case, developed countries want environmental remedies that do not jeopardize their economic growth. The Paris Agreement of several developed countries, where mitigation of climate change also depends on foreign assistance, reflects this desire.

Investments are one aspect that policymakers accelerate reforms in the energy market. In 2016, 42% of the 1.7 trillion USD of global oil investments is publicly funded according to the International Energy Agency (IEA) [8]. Many environmental organizations contend that policymakers should reallocate these public funds to low carbon fossil energy to fulfill their Paris Accords [9-10].

Not just domestic also abroad are public funds included, usually, these funds drain from emerging nations into developing countries and can therefore play an important role in forming the energy sectors in medium- and low-income countries. G20 countries and multilateral organizations funded US$38bn in coal projects abroad from 2013 through to 2016 and US$25bn in solar, wind, and geothermal projects [11]. International fossil-fuel investments are still more important than renewable energy investments, but the pattern is changing [12].

China has been a leading participant in the foreign financing of electricity throughout the years. Chinese spent more on coal in foreign countries ($15 billion) than any other nation from 2013 to 2016. At the same time, it was fifth for foreign investment in renewable energies ($0.6 billion) [6]. However, renewable energy expenditure in China is rising fast. China spent more than any other nation on green energy abroad in 2016 with a growth of 60 percent year-on-year in sustainable energy investments abroad [13].

The Belt and Road Initiative is central to China's foreign investment policy (BRI). In 2013, BRI has been announced the proposal for China to fund development projects throughout Asia, Africa and sections of Europe in more than 65 nations. China-Pakistan Economic Corridor is the flagship program (CPEC). Under the CPEC, China will support Pakistan in the financing of projects relating to infrastructure, primarily for electricity, transport and industry.

Currently, 216 schemes are announced, including gas, solar, wind and water projects, and transmission and distribution facilities. Special energy projects have been reported for the CPEC. Of these, 20 are "priority projects," ranging from active to still in the authorized phase. The other six initiatives are either "Active Promoted" or "Potential" [14].

These investments have criticized their environmental effects. The bulk of the new capacity is gas, but there is a mix of energy sources. To date, the CPEC coal expenditure is a mix of subcritical and supercritical facilities without supercritical facilities. Furthermore, several coal schemes are mine-to-mouth, which means that the supplies of domestic coal can be used. The sulfur and ash content of this coal is high [14].

This research analysis attempts to address this question: are Chinese energy generation investments under CPEC the right solution, or are low-carbon alternatives economically possible, for meeting Pakistan's energy requirements and yet ecologically sound as claimed? In this context, for all CPEC energy projects mentioned above as well as for emissions of greenhouse gases and other contaminants, the first half estimates the leveled costs of electricity (LCOE). This LCOE is a typical way of comparing the cost of generating one (usually $fMWh or $/KWh) unit of electricity for various forms of power stations. The optimization model was then used to measure LCOE, the overall expense funded, and the pollution under various conditions, reflecting multiple investment scenarios utilizing existing CPEC projects and alternative projects. During the project and the literary analysis, other plants were focused. Overall, the outcomes of this paper are aimed at shaping BRI policy on investment and supporting Pakistan.

2. **Background**

2.1 Belt and Road Initiative

The Silk Road Economic Girdle (SAG), and the 21st-Century Maritime Silk Road, jointly recognized as the Belt and Road Initiative was declared in September 2013 by China (BRI). [16]. BRI might possibly be one country's biggest ever initiative for foreign infrastructure growth. In investments already planned or ongoing, Fitch Ratings Agency forecasts about $900 billion, which will reach a value of 4 trillion dollars over its lifespan. China is projected to spend more than $150 billion annually in more than 65 countries over the next decade [17].

The BRI projects cover electricity to move to industrial parks. However, it is not known precisely what makes a project officially BRI. BRI is more a "philosophy" than realistic investment guidance as an initiative than a business plan [18]. Nevertheless, for President Xi, BRI has become a top priority and also a constitution of China [18]. Consequently, considering its vague existence, Chinese firms, banks, and others are heading towards BRI [19].

The Chinese political banks and trade banks are projected to have most of the EUR 900 billion in funding. The Silk Road Fund is one of BRI's financial tools. The foundation of the Fund was committed by President Xi in 2014 for $40 billion. The bulk of this money (65%) comes from Chinese deposits of foreign currencies and the CIC (China Investment Corporation), the remaining 45% [20]. It is also announced that "major four" Chinese state-owned commercial banks are rising BRI funds [21].

BRI has been extensively debated as to environmental integrity and sustainability. On the one side, China announced plans to hold BRI 'green,' with its May 2017 Guideline to Promote the Green Belt and Road [22] published. Apart from the BRI, after their International Green Finance Seminar in Beijing, the Chinese government also released a paper. The paper, titled "Chinese Overseas Investment Environmental Risk Management Initiative," requires consideration of the environmental, social, and governance considerations and greater divulgation for investment details. However, the importance of these records was disputed, since they do not include legal rules [23]. Moreover, in BRI nations, China has strongly financed gas. Overall, Chinese coal expenditure in these countries has risen between 2001 and 2016, including year-to-day fluctuations [24].

In comparison, the Asian Infrastructure Investment Bank (AIIB), primarily driven by China, has described its activities as "Lean, Clean and Green," pretending to work in the context of high environmental standards. The same year the BRI was declared and activity began in 2016, this multilateral development bank was proposed by China. Whilst China proposes, AIIB has over $100 billion in capital from 84 Member States. Following their 2017 Annual Meeting, their Energy Sector Strategy was announced, which enables coal and oil ventures to replace less productive production or to integrate the energy grid into reliability. While the AIIB has been honored for renewable investments, some groups have been frustrated that future coal investments have been made [25].

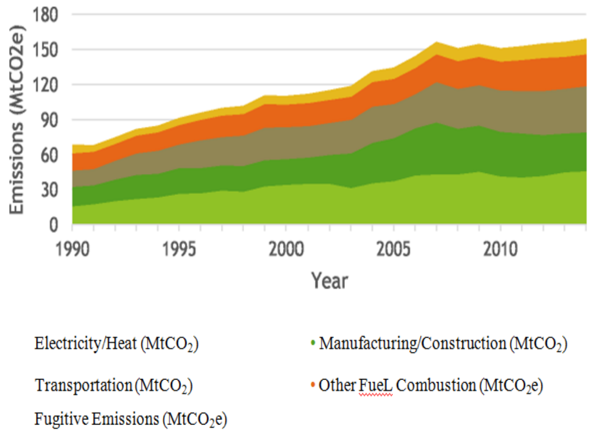
2.2 Pakistan-Energy and Climate

Pakistan faced a substantial disparity in electricity demand and availability starting at the turn of the 21st century. By 2006, the difference was half the generation power of the country. A limited portion of solar, nuclear and wind (9 percent). Just 150 MW were deployed (<1%) with coal capacity. The production would not utilize any of our renewable capacity. Renewable hydropower in 2015 accounted for just around 1% of production [27]. Pakistan is reportedly targeting 5% non-hydro-renewable electricity production by 2030, although it is estimated that this goal would rise to 15%.

The energy crisis in Pakistan has been influenced by many causes. Pakistan spent extensively in thermal generation fuelled by petroleum in the 1 980s at a low oil rate. Pakistan depended mostly on imported oil without domestic oil supplies. As rates re-broke, Pakistan's energy costs rose, causing a huge economic strain and hindering thermal energy plants' capacity to satisfy the increasing energy demand. The government made natural gas accessible to the transport industry in 2005 to limit oil use. Unfortunately, natural gas has played a major role in the production of energy, which already strains to decrease gas supplies. The government also struggled to improve hydraulic capacity, which was once a major part of its generation [26].

The power supply of Pakistan has also been hit by financial problems. T&D infrastructure is heavily funded to maintain low energy costs and reduce the expense to customers in comparison to expensive oil imports. However, these subsidies have been questioned that they do not help the people in need. In 2012, the lowest consumers received just 0.3% of the aids [28]. Another challenge was the growth in the private sector's output from 1994 onwards. The administration refused to compensate the independent power producers (IPPs) back and the IPPs could not function with optimal capability without that revenue [26].

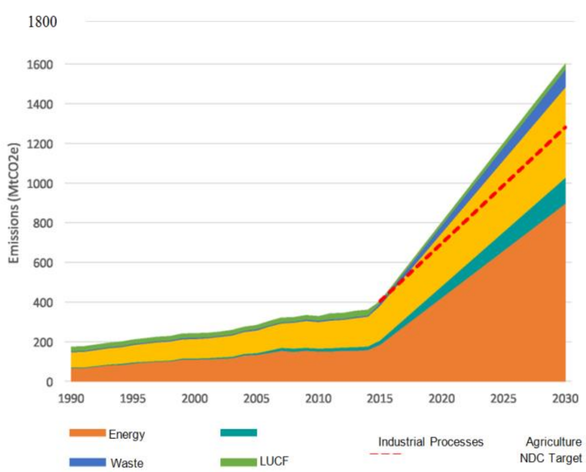
Under the Paris Agreement, Pakistan's nationally determined contribution (NDC) closely represents the problems facing the energy market. In 2015, their oil sector accounted for 45 percent higher than any other sector of gross pollution. The biggest share of Pakistan's energy pollution and about 12.8 percent of its overall emissions in 2014 is electricity and heat (Figures 2.1&2.2). Their NDC ventures would virtually quadruple their baseline cumulative pollution between 2015 and 2030. They expect the energy sector share to grow to 56% during that time, as seen in Figure 2.2, over the same period. The NDC states that coal and nuclear power would necessarily be needed to close down their electricity gaps, but that natural gas, wind and hydropower would also play a growing part. Figure 2.2 indicates a pledge by Pakistan to reduce its emissions by 20% of its estimated baseline emissions by 2030[29].



Data Source: Climate Watch

Figure 2.1. Emissions of Energy (Pakistan)

Figure 2.2. Pakistan's Historic and Projected Emissions



Data Sources: Climate Watch, Pakistan's NDC

Figure: 2.2: Pakistan's Historic and Projected Emission.

2.3 Economic Corridor (Pak-China)

One of the main land-based strategies under BRI was announced by the China Pakistan Economic Corridor (CPEC) in 2015. The relationship would connect the deep-water Gwadar Port of south-western Pakistan with the autonomous Xinjiang Uygur Region of north-western China. CPEC was defined as "the regional linkage mechanism" which "will have positive impacts on Iran, Afghanistan, India, the Central Asian Republic, and the area, not only for China and Pakistan"[30]. Like BRI, CPEC has no input from the media on how it is being implemented.

Though projects involving CPEC span many fields, the CPEC portion includes power generation and T&D infrastructure. Cooperation with China could ease the energy crisis in Pakistan. The twenty priority projects alone will raise capability by over 11 GW and add over 14 GW to all 21 projects. Coal will represent 69% of the additional power, 21% for hydro, 3% for wind, and 7% for solar. The actual price tag is $26 billion [12], based on the two- and twenty-two "estimated costs" projects mentioned on the CPEC Web site (20 priority projects and two active projects). Generally defined in Figure 2.3 is the CEPEC map.

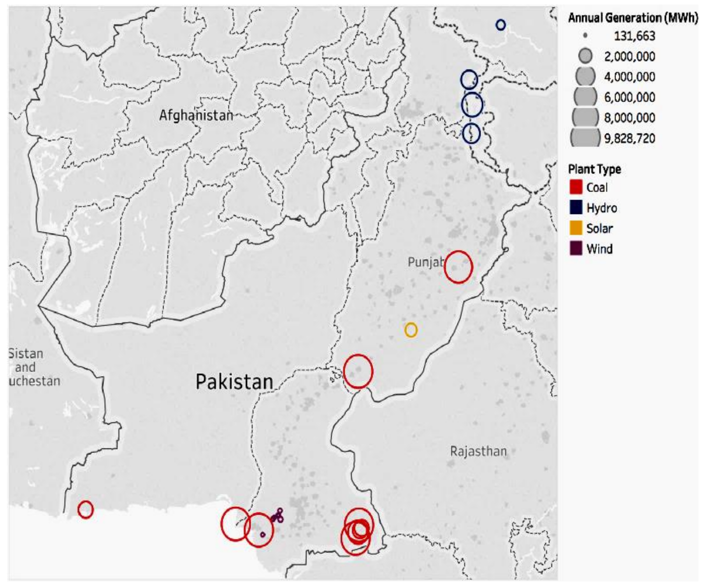


Figure-2.3: CPEC generation and types of projects.

The word 'Central Republics' in this quotation is, however, archaic, as it was used in the context of constituent countries under the former Soviet Socialist Union Republics, can referring to the countries of Uzbekistan, Turkmenistan, Tajikistan, Kyrgyzstan, and Kazakhstan.

While an authoritative list of energy ventures is available on the CPEC website, there is a certain doubt over just what the CPEC is? In particular, Chinese government media have named many Chinese funded nuclear reactors CPEC ventures on the website of the State Council of China and on the websites of the construction corporation [31-33]. . For this report, a comprehensive list of CPEC energy ventures has been used on the official CPEC website.

2.4 Project Financing

The projected net expense of these programs is over USD 22.4 billion. The huge size of the loans places special importance on low-cost funding options for Pakistan's long-term growth. For the next 10 to 20 years, there are enormous discussions about the CPEC's funding responsibility for Pakistan. This portion would also discuss CPEC electricity infrastructure funding schemes. All details were obtained from the Pakistan National Electricity Regulatory Authority tariff documentation (NEPRA).

The Belt and Road Initiative is announcing that it would provide BRI member countries with inexpensive financial help with concessional loans at reduced or even nil interest rates [34]. The CMEC ventures however do not profit from these low-cost funding alternatives, but faceless attractive floating interest rates of 4.5% to 5% above and above the London Interbank Rate (LIBOR). Further, in addition to interest, Chinese banks are now demanding loan-proportional upfront export insurance and financial payments. For these electricity development ventures, the debt-to-equity levels are still strong. Thus, these schemes are subject to a reasonably large interest rate and other related costs.

The equivalent interest rate on CPEC energy ventures is between 6.5% and 7.5% based on the USD LIBOR (Quarterly and Semi-annual USD LIBOR over 2%).

By contrast, it has funded Pakistani development programs at rates between 5% and 8, 5% [35], and Pakistan's real bank interest rates are about 11% [36]. There is a reason behind higher interest rates for energy development programs, although not as low as the BRI has first announced.

Different from other infrastructure ventures, instead of the Pakistani government, CPEC would be established and run by private power producers. In addition, private power suppliers can pay back debts and interest. In general, the return on equity of CPEC energy ventures ranges from 18% to 35%, enabling private producers to pay more. Interest rates are affordable since these energy projects produce fair benefits, but the interest rate is not low enough to uncompetitive reduce other financing alternatives, especially after the Sino Sure and other funding fees are taken into consideration.

2.5 Health Impacts of Coal

China is to shut down and cancel coal plants domestically to tackle air emissions while funding coal projects in Pakistan. More than one hundred coal plants proposed or under development were scrapped by the Chinese National Energy Administration in 2017, cutting at least 120 gigawatts of the country's potential coal-fired capacity [37]. In 28 counties, including highly polluted regions, such as Beijing and Tianjin, the Ministry of Environmental Protection prohibited the usage of gas. The government's Work Report this year states that during the past five years China has cut coal output by at least 800 million tons. More than 200,000 boilers that were used for coal burning, heating, or industrial uses for inhabitants were shut down during the same period [38]. Interaction to the air pollution problem plans to limit coal use were launched first in 2013[39]. The main towns of northern China recorded 2.5 particulate matters (PM) in the air between 300 and 1.000 meters per cubic meter. China has been badly hit by air pollution. Such elevated particulate matter is dangerous to human health and can lead to respiratory failure, emphysema, lung cancer, or premature death. Coal is China's only major contributor to PM2.5 and studies show that 366,000 premature deaths have been triggered by burning charcoal in China in 2013[40]. Coal's effects on human health can be seen in both phases of its use for energy production from extraction to after-combustion. Pakistan's development of large coal could contribute to a severe health crisis. The sulfur content for Pakistan's gas, mostly known as the Thar coal, is higher than that of Australia and Indonesia (1, 38%) (0.4-0.85 percent) 2. Even though power stations are using smoke-cleaning sulfur desulfurization devices, emissions are possible. Acid rain and respiratory disease were contributed by the release of sulfur dioxide. Furthermore, the power stations installed for processing Thar coal are all sub-critical, which indicates low performance. As a result, more coal inputs are needed to produce the same energy production as supercritical power plants. Further inputs to coal are showing increased emissions, waste, and health effects. In addition to the nature and volume of technology, the health effects of coal are often dependent on other aspects, including topography and distance from inhabited areas. Unlike the global impacts of Greenhouse gas pollution, the local, regional and national impacts of smog type emissions are [41]. Rising health impacts are the shortest distance from plants to inhabited regions.

Table 3.1. CPEC Energy Projects*

	Project Name	**Characterization**
1	Coal-fired Power Plants at Port Qasim Karachi	Priority
2	Suki Kinari Hydropower Station	Priority
3	Sahiwal Coal-fired Power Plant	Priority
4	Engro Thar Block II Coal fired Power Plant	Priority
5	TEL Mine Mouth Lignite Fired Power Project	Priority
6	ThalNova Mine Mouth Lignite Fired Power Project	Priority
7	Surface mine in block II of Thar Coalfield	Priority
8	Hydro China Dawood Wind Farm	Priority
9	Imported Coal Based Power Project at Gwadar	Priority
10	Quaid-e-Azam Solar Park	Priority
11	UEP Wind Farm	Priority
12	Sachal Wind Farm	Priority
13	SSRL Thar Coal Block-I &SEC Mine Mouth Power Plant	Priority
14	Karot Hydropower Station	Priority
15	Three Gorges Second Wind Power Project	Priority
16	Three Gorges Third Wind Power Project	Priority
17	CPHGC Coal-fired Power Plant	Priority
18	Matiari to Lahore ±66OkVHVDC Transmission Line	Priority
19	Matiari (Port Qasim)-Faisalabad Transmission Line	Priority
20	Thar Mine Mouth Oracle Power Plant & surface mine	Priority
21	Kohala Hydel Project	Actively Promoted
22	Rahimyar khan imported fuel coal Power Plant	Actively Promoted
23	Cacho Wind Power Project	Actively Promoted
24	Western Energy (Pvt.) Ltd. Wind Power Project	Actively Promoted
25	Phandar Hydropower Station	Potential
26	Gilgit KIU Hydropower	Potential

*As reported in the tariff documents.

**Italicized projects are not generation projects and therefore were not included in analysis.*

3. METHODS

3.*1 Data*

Information was obtained from the CPEC official websites, cpec.gov.pk, on the promoted energy ventures under the CPEC as part of the BRI. Of the 26 projects on this website, 23 are generation projects, 2 are transmission projects and 1 is mining. In conjunction with surface mining, two coal-fired plants are being built. Because of the goals of this study, only the 23 generation projects are included and the expense of surface or transmission lines are not used (Table 3.1). In these 23 programs, 17 are "Priority Projects," 4 are "Priority Projects" and two are "Potential Projects." Priority projects are the most extensive and therefore have the most accessible details, whereas potential and active promoted projects have been under construction at earlier levels.

The Quaid-e-Azam Solar Park (Bahawalpur) for 1000MW was not all installed at once. The remaining 900 MW was added as a separate initiative and only the first 100 MW is already set up. As there is just a generator permit and tariff document for the original 100 MW there is a scaled up variant of the 100 MW plant. Project details are dependent. The models must differentiate these ventures because LCOE estimates are highly responsive to the annual generation CPEC energy project data have been compiled mainly from three main sources: the CPEC official web site, licenses generation applications and tariff documentation. NEPRA publishes both the application for the production of licenses and the tariff determination papers. The data gathered from these records is outlined in Table 3.2. For each project, not every variable was expected. For instance, only charges for coal projects were required for power and fuel and only for hydro projects were need for water charges.

Table 3.2. CPEC Energy Project Data Collected

Variable	**Units**
Nameplate Capacity	Megawatts (MW)
Project Life	Years
Upfront Costs	Million USD
Capacity Factor	--
Annual Generation	Megawatt hours/year (MWhlyear)
Fixed O&M Costs	USD/kWh or Million USD/year
Variable O&M Costs	USD/kWh or Million USD/year
Insurance Costs	Million USD/year
Water Charge	USD/kWh
Fuel Consumption	g/kWh
Fuel Price	USD/Metric ton
Desulfurization Technology	--
Coal Type	--
Coal Carbon and Sulfur content	%

Any ventures have no tariff paper or generation authorization at the time of this article. These project numbers have been calculated by using the other project numbers or by scaling them to the next generation from a related CPEC project. For e.g., for the Imported Coal Based Project in Gwadar, neither a generation license nor a tariff document could be found. However, it is known that the project summary on the official CPEC website provides a 300MW generation. It may be calculated the numbers from the 1320 MW Imported Coal Project in Port Qasim by assuming identical technologies. This assertion probably underestimates the LCOE, given that certain prices, such as property, do not rely on the scale of MW. In reality, the cost of capital was higher than would be suggested by the scaled calculation. In this situation, it is better to underestimate the fairest representation for coal ventures.

Moreover, in the documentation shown to NEPRA several of the ventures, in particular gas, had rather close numbers. The comparisons are probable because of the expectations of the contractor that it will be with another if those numbers passed through the regulator on one project. As Port Qasim was the first CPEC coal project imported, a precedent appears to be developed for future CPEC coal projects.

This also applies to ventures through Thar Block that includes local coal mining projects. This may potentially suggest that programs around Pakistan would be carried out similarly. Local factors may, however, influence plant production. Such similar figures may therefore be a simplification which would mean that real plant generation and productivity are different from what was initially provided to NEPRA.

The authors' main statement is that NEPRA documents would be used by non-CPEC natural gas and nuclear power stations. The nuclear plant used was constructed with the help of Chinese companies and Chinese reactors, which should represent a CPEC project accurately [42]. However, a French firm ENGIE [43] designed the Uch natural gas station. It could also be a positive indication of external assistance to an energy initiative, but it is not Chinese. The re-gasified liquid gas (RLNG) plant is also owned by Quaid-e-Azam Thermal Power (Private) Limited, the Pakistani government firm. The main results of these assumptions are the financial figures, and the developers consider the constraints on the model's use of those plants. But the expense of resources and power, which make up a major part of LCOE, are unlikely to be impacted. Furthermore, for these two plants, the LCOE calculations are quite concurring with other CPEC technologies, meaning that these are rational conclusions.

The latest CCEC material on the official website was used for this report. However, if more projects are added, the website will probably be updated. Some pages often contain some CPEC programs which are not part of the government's website. The findings of this study will shift with the addition of further projects to represent different energy blends and pollution. The model will also have a current-generation basis, another average LCOE and a higher total expense. However, if the same kind of knowledge is required for new programs, these modifications are clear.

Pollution Data*:* In all coal schemes, tariff records containing sulfur, mercury, nitrogen and related methods used by plants to manage pollutants collect pollution-relevant data. Detailed chemical contents of their construction and coal appear in some project tariff records, although some projects show only the roots of coal supplies. Calculations presume that coal from a certain area has the same chemical content to derive emissions from all coal ventures.

3.2 LCOE Calculations

The leveraged cost of electricity (LCOE) and pollution for each project is estimated based on the data obtained for CPEC energy generation projects. LCOE calculates the total expense over the lifespan of producing one energy device for a generating system. The amount of both fixed and variable cost of annual fuel and capital expenditure (CAPEX) was estimated for LCOE, then divided by yearly generation (Equation 1). The recorded nameplate power and capacity factor were used to measure annual generation and this represents how long a plant is switched on during one year (Equation 2).

Equation 1.

$$LCOE\left(\frac{\$}{MWh}\right) = \frac{\text{Fixed Q \& M Costs+Variable O \&M Costs+Fuel Costs + CAPEX with financing}}{\text{Annual Generation (MWh)}}$$

Equation 2.

$$\text{Annual Generation}\left(\frac{MWh}{year}\right) = \text{Nameplate Capacity(MW)}\times\text{Capacity Factor(\%)}\times 365\ \text{days}\times 24\ \text{hours}$$

Financing expense estimates are often used to determine complete LCOE capital expenditures. But most of the proposals have both the upfront and the net expenses after funding in the tariff estimates released by NEPRA. NEPRA records in the LCOE estimation were granted complete funded amounts.

3.3 Emissions Calculations

This article focuses mostly on CO_2 emissions but for coal-fired power plants, SO2 emissions are also expected. The CO2 emissions and SO2 emissions have been measured based on the characteristics of the coal (heat, carbon, and sulfur) used and the charcoal used in the factory. Tariff records and generation permits collected information regarding heating material and coal composition. Either the net efficiency or the heat quality of the coal have been determined or measured using the power plants (g/kWh). This means that the quantity of energy that can be derived from the carbon depends on the characteristics of the coal and the extent of energy used by the combustion process.

Often measured based on fuel properties (i.e. heat content and carbon level) and fuel usage for alternative natural gas plants were emissions. Fuel usage was measured according to heat and power plant performance, as was the case with the measurement of the coal emissions. Interestingly enough, in kg/kJ of the tariff documents, the heat content of natural gas was given. Natural gas is mostly measured by volume; but, because the processing of the natural gas into CO2is not unique to the unit, these figures were also important in calculating estimates of pollution.

Carbon and sulfur content have been used for estimating pollution since the calculation of fuel intake. The ratio of carbon dioxide to carbon (CO2:C) for both coal and natural gas was measured using stoichiometric ratios. Table 3.3 will describe the combustion mechanism with both.

Table 3.3. Combustion reactions and stoichiometric ratios used for emission calculations.

Fuel	Reaction	Mole Ratio	CO_2 / C ratio
Coal	$C[s] + 0_2[g] \to C0_2[g]$	1:1	44/12
Natural Gas	$CH_4[g] + 2\ 0_2[g] \to C0_2[g] + 2\ H_20[g]$	1:1	44/12

This means that full burning is appropriate for a new, well-functioning power plant with sufficient oxygen in the boiler. Along with the carbon content (percent) inside the fuel itself and fuel intake, these ratios provide an estimation of CO2 emissions for each plant.

Emissions of the building of the facilities, fuel delivery and other emissions into the building and operating power stations are not included in such emissions calculations. Burning oils are the only carbon measured. Future plants will be similar to current plants without having these other pollution values. Since knowledge about the sites of potential plants is not specified, these additional emissions cannot be measured.

4. RESULTS

4.1. Generation Technology Analysis

This part of our findings offers additional context and Pakistan's unique factors for the various technological generations used to improve our concept. The viability of coal, gas, biomass, renewable energy, hydroelectricity, wind and solar are taken into account. The study was used to decide which alternate plants for our model and any additional limitations will be available.

COAL: Carbon is commonly considered an inexpensive energy source. Technological feasibility and financial sustainability are deemed secure assets as a generating source that is commonly utilized for long periods.

Pakistan's domestic carbon reserves have been estimated in the range of 185 billion tones in Tharparker in Sindh province. In 2004, if used correctly, the Pakistan government evaluated that half of these reserves would provide energy for 100,000 MW for 30 years[44]. However, these stocks could be heavy in terms of sulfur and ash [13].

Half of the 10 CPEC coal ventures would use Thar coal domestically and half will use imported coal. Thar coal plants use subcritical technology while importing coal-fired plants use supercritical technology more efficiently. Higher capital costs are needed in supercritical coal plants and the amount of carbon used per unit of power produced is also reduced.

Coal heat-fired plants currently constitute less than 1% of the installed production capacity in Pakistan; however, they are projected to play an ever more significant role[29]. 69% of proposed CPEC output is constituted by coal plants. Since our model requires alternate coal plants due to Pakistan's strong energy policy priority and substantial participation in the CPEC's current portfolio. It may be encouraged the model to conclude that more plants can be installed in Thar, due to the large scale of Pakistan's Thar Block. The concept also enables additional coal plants imported.

NATURAL GAS: Currently the main source of energy in Pakistan, natural gas accounts for 45% of installed power capacity and approximately half of the country's overall source of total primary energy supply (TPES). However, domestic supplies of Pakistan's natural gas have decreased. Pakistan switched to imported gas in response

Pakistan's imports of natural gas rose more than triple in 2016. Petroleum in Pakistan in 2017 [45]. The minister said that by 2022 imports might rise from 4.5 million to more than 30 million tons.

Pakistan has established a natural gas transport system to meet the expected rise in imports of natural gas. In 2015, in Port Qasim, Pakistan built its first liquefied natural gas LNG terminal. At the end of 2017 a second LNG terminal was installed and a third is scheduled to be installed in 2019 [45-47]. Moreover, the Iran–Pakish pipeline (also known as the Peace Pipeline) is under development and the Turkmenistan–Africa–Pakistan–India Pipeline is under construction (TAPI). Though the Iran-Pakistan pipeline is making huge strides in Iran, Pakistan is very much lagging in building on its borders.

In Turkmenistan and Afghanistan [48], the construction of the TAPI pipeline has started. Taking into account the rise in LNG terminals and gas pipes, we included in our model both imported natural gas and domestic natural gas choices.

Energy Resources:

The economy of Pakistan depends heavily on the 2015 oil, though petroleum accounts for 13 percent and around one third of its TPES built electricity generating power. In the 1 970's, when prices were down it was decided to invest in major oil despite limited financial resources. As rates escalated in the international market, almost two thirds of the energy supply was based on costly imports of oil [49]. In addition, national petroleum reserves were projected to expire by 2025[50]. No CPEC proposals for thermal oil power plants currently envisaged.

Ministry of Energy reported, in 2015, the three major challenges for Pakistan's energy market – demand/offer difference, scarcity, and inefficiency. In terms of affordability, the advisors referred to the formidable strain of oil-based energy on our economy [51]. The thermal oil plants from our model were thus dropped in the wake of the high price of imported petroleum and Pakistan's declining domestic reserves. This decision is backed by Pakistan's specified energy mix objectives**.**

HYDROPOWER (HYDEL):

Today, Hydel will be the largest component of Pakistan's green energy supply, accounting for 32 percent of its power generation. It is anticipated that this technology will continue to play an important role in meeting energy demand. But major hydroelectric dams require longer than thermal systems to execute. On average, one analysis showed that Hydel ventures in Pakistan were 200 per cent higher than originally expected over a projected completion period and 2,5 times higher [52]. Due to these long-term horizons, hide is considered part of a long-term plan, which does not react to the immediate demand for oil.

In the 1960s, Pakistan hydro power production was more than half, but the government struggled to maintain its growth in hydropower, as demand increased. The three biggest hydroelectric projects in Pakistan have been operating since 1967, 1974 and 2002, Mangla Dam (1000 Mw), Tarbela Dam (3478 MW) and Ghazi-Barotha Dam (1450 Mw) [52].

There is some major hydro dam work under way. Stage I of Dasu Dam (2160 MW) is scheduled to be available in 2023; a hydroelectrical project of Neelum-Jhelum (969 MW) is due for installation by the end of March 2018. The existing portfolio of the CPEC includes five hydropower projects including thesauri-Kinari-hydroelectric power plant (870 MW), Karot (720 MW), and the Kohala-Hydel-project (1100 MW) [12].

An approximate 60,000 mw of hydroelectrical capacity was recorded by the Pakistan Private Power and Infrastructure Board, of which only around 12% have been developed[12]. The Pakistani NDC has additionally identified the capacity of hydropower at 3,000 MW in both micro and small scales [29].

Hypdel for its strong potential in Pakistan, the low LCOE level and a considerable position in the energy portfolio in CPEC are included in our model.

NUCLEAR ASSETS:

While the installed capacity of nuclear power was 5% only in 2016 (1280MW), it is projected to increase by 9% by 2030. Nuclear has the advantages of non-intermittent generation of zero emissions. The NDC of Pakistan predicted that by 2030 these additions would prevent an annual CO_2 equivalent of 21,7 to 56,8 million tons [29].

Today, Pakistan has five Karachi 1 and Chashma 1-4 reactors. Moreover, there are two reactors under development, Karachi 2 and 3 and another Chashma 5, expected. The power generation from these projects is expected to rise in the range of 3483 MW [53].

In the production of nuclear energy in Pakistan, China has played a pivotal role, that includes financing, reactor design, construction contracts, and the supply of reactor fuel. In particular, China provided Chashma 3 and 4 reactors and Karachi 2 and 3 with 82 percent funding[53]. Sea projects were not included, as stated in the Methodology section, as they were omitted from the official website of the CPEC as official energy ventures.

It is speculated that the exclusion of these Chinese nuclear proposals from the CPEC a website has been motivated by political considerations. Because of its nuclear arms program and its largely exempt trade in nuclear power stations or resources, Pakistan is not party to the Treaty of Non-Proliferation[53]. While international attempts are being made to prevent proliferation, China and Pakistan have a long history of collaboration on nuclear power which many people speculate goes beyond civil development [54].

Resultantly, the China and Pakistan's long-standing nuclear partnership ventures, have meticulously contributed to the future needs of power generation for civil and defence purpose.

SOLAR AND WIND:

Solar and wind power accounted for 7% and 2% of the installed energy in Pakistan in 2016. However, only 1% of the generation was produced by the wind and only a small part was solar. Pakistan is reportedly targeting 5% non-hydro-renewable electricity production by 2030, although it is estimated that this goal would rise to 15%. The CPEC currently comprises wind power of 399 MW and solar power of 1000 MW.

Pakistan has a strong geographical potential for wind and solar production. The promise of these opportunities in Pakistan has been mapped by many organizations [55-57]. Pakistan has long, bright days of around 8-10 hours of solar radiation and isolation per day. One evaluation placed the solar capacity of Pakistan at 1600 GW per year[26]. The technological ability of Pakistan for wind power ranges from 346 to 360 GW and its overall generation capability is approximately 14 times in 2016[58]. To support green energy growth, Pakistan's energy policies are also developing. Pakistan adopted a program of net metering in 2015 to promote the use of distributed solar and wind energy. In addition, early feed-in rates used to guarantee project developers a long-term return on generated production have decreased annually. In 2006 Pakistan enacted finalizing tax concessions on clean energies for non-Muslims and non-residents, which include income tax exemptions, customs duties and tax exemptions and the Zakat payment exemption [59].

Because of the sun and wind, we incorporate those energy sources into our model, in line with Pakistan's energy targets and policies and their strong technological capacity.

4.2 LCOE Results: The LCOE estimates obtained by Pakistan CPEC measurements range from $23.50/MWh to 83.99/MWh (Figure- 4.1). This worth is comparable between about US $40/MWh and US $350/MWh[60].

The authors expect that, for three factors, the LCOEs measured would underestimate the real expense. First, NEPRA-approved tariff documents specify what is allowed to charge the power producer. Therefore, NEPRA negotiates the direct costs of these figures to a minimum with electricity suppliers. NEPRA understands that energy producers also continue to benefit from the reliability of long-term plants, so power generators also renegotiate the rate more often as they operate. However, the first predictions may be poor, in particular when they provide a basis for similar potential plants.

Secondly, during the construction of a power plant several issues may occur. This major issues are not covered by the tariff forecasts. As mentioned in the case of hydro-electric projects, sometimes bad management and other political considerations may affect power plants' construction times and drastically increase costs.

Thirdly, the computed LCOEs depend largely on the ability factor. The operating operating period of a power plant can vary greatly depending on several factors but is mostly based on the electricity demand. Plants often decrease due to maintenance requirements, power failures and grid instability. Renewable services often depend on the existing resources. For eg, water must be enough to run hydropower plants, a challenge in the summer, and solar plants must be unable to work during the night. Due to Pakistan's current grid volatility, the capability of these plants could be overestimated, the measured output could increase and the total LCOE could be lowered.

Calculations from LCOE indicate that hydropower is very economical and has the lowest LCOE in Pakistan (See Figure 4.1). This is the result of reasonably large capacity hydropower plants, however minimal to no fuel costs. For coal-fired, then thermal, ultimately, wind is the second lowest LCOE.

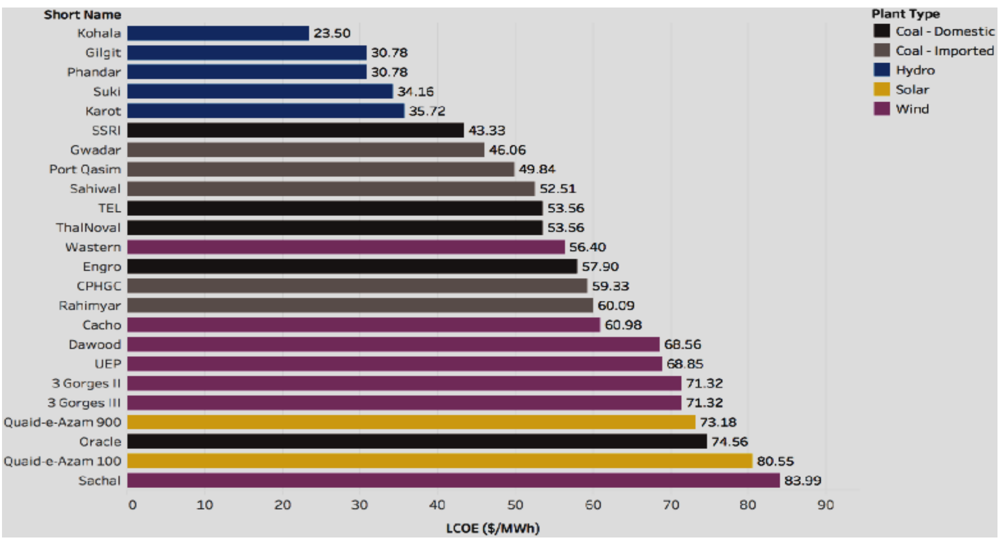


Figure 4.1.Calculated project's L.C.O.E. for C.P.E.C.

LCOE for widespread model plants were also determined (See Figure 4.2). The model plants are identical in terms of hydroelectric trousers, led by gas, wind and nuclear, having the lowest LCOE. Furthermore, model plants and gas form both a domestic sector and re-licensed gas imported, as well as nuclear decreases in various coal-fired plants

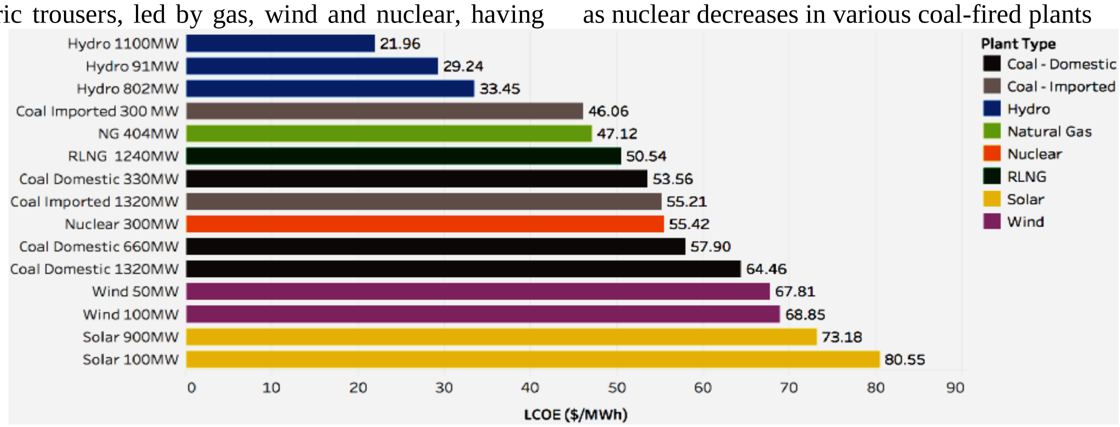


Figure 4.2. Model generalized plant's (L.C.O.E calculations').

4.3 Emissions Results

Total CPEC emissions of 51 million tonnes of CO_2 is estimated per annum in comparison to the gross emissions of energy and heating from Pakistan was by 10.3 percent higher for 2014[61]. For CPEC carbon ventures, the calculated CO_2 emissions estimate is from about one million to ten million tonnes each year. The plants can hardly be compared specifically because of the various plant sizes. Therefore, emissions were separated by annual generation so that plants with various capacities could be compared (Figure 4.3). In this metric, domestic coal is regularly twice as high as the emission of imported coal

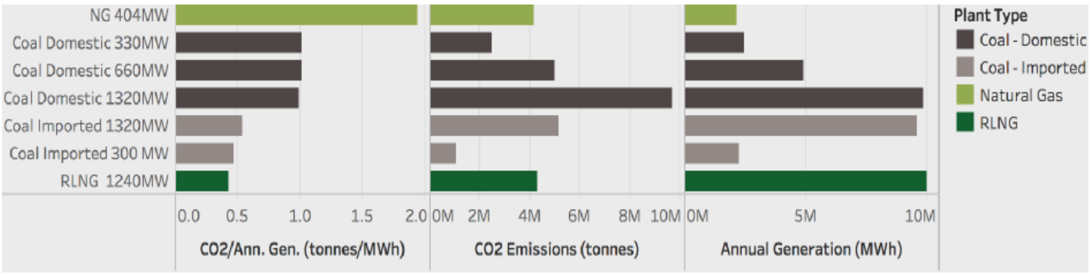


Figure 4.3 Comparison of CO_2 Emissions across CPEC coal Project.

It is necessary to remember that these pollution values do not represent pollutants other than fossil fuel combustion. The construction of the plants and the transport of fuels produce carbon. For consistency and lack of evidence to support these calculations, these values were omitted. Furthermore, there is concern about CO_2 and hydroelectricity reservoirs releases of methane [62]. Accurate hydroelectric reservoir emissions depend on the geology, temperature, bacteria, depth of the water and several other variables locally specified. The investigators felt that they did not have adequate knowledge to include an appropriate estimation of the emissions of such plants and proposed additional studies.

In the model generalized plants, the same procedure was adopted (see Figure 4.4). Again, in domestic coal the emission is about twice as high as imported coal emissions. There was an unprecedented increase in pollution in the natural gas plants. The Uch sector, which was used for the natural gas paradigm, contains low-energy gas, which means much more gas has to be consumed. The plant is not too large, too. Its emissions are also even higher at the annual generation level. In contrast, the regasified liquefied natural gas RLNG gas imported is far higher than the Uch gas or coal in heat quality, rendering its emissions ratio the lower as Figure 4.4 shows.

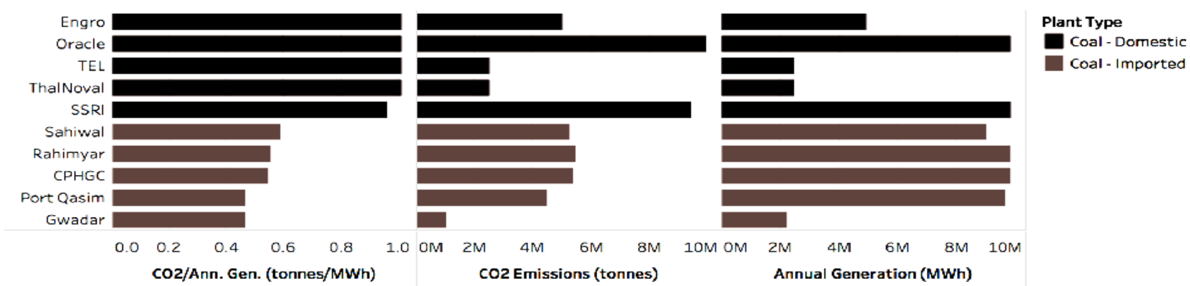


Figure 4.4: Comparison of CO_2 emissions across generalized coal and natural gas plants.

4.4 Result's (Optimization Model)

The optimizer model measures overall costs, average LCOE emissions, and CO_2 emissions depending on the selection of plants and minimizes one. The 15 optimizations are divided into four groups, resulting in overall costs of capital, average LCEO and CO_2 emissions. The findings are divided into each of these three groups, which they compare to their measured CPEC worth, offering us an insight into CPEC's overall emphasis and policy.

The basic line (minimization 1-3), below CPEC (4-7), thermal and sustainable constraints (8-11) and no nuclear or natural gas are the four categories under each segment (12-15). The baseline segment simplifies the three minimization targets when there are no additional restrictions. An additional limit pollution, expense or average LCOE are forced under CPEC, lower than CPEC. The natural Gas vehicles NGV clause excludes the option for nuclear or natural gas plants and at the time of this writing they weren't included in CPEC programs.

There is also minimization of thermal and green energy levels (8-11). A large part of the electricity system remains thermal with new technologies (usually coal, natural gas, and nuclear). This is because only the volume of electricity currently used is generated in electrical networks through large scale energy storage techniques. Renewable energy is not always accessible, particularly from variable sources (usually solar and wind). Hydropower is not necessarily a variable source since the water is released by the turbines at all times. For example, while the river levels are down, water cannot be utilized in the dry season, which makes it impossible to generate electricity. Countries require sources of energy that can be utilized at any time of day or year to achieve equilibrium by thermal production. These minimizations examine various thermal and sustainable generation mixtures to educate on how the three steps will impact these needs.

It is necessary to recall that these mechanisms of minimization do not necessarily reduce each component, which allows several strategies to be achieved. For example, pollution reductions may be achieved by preferring more solar and hydro, or vice versa and all restrictions can be fulfilled, without regard for all other considerations (such as the baseline minimization #2). This versatility should be taken into account in the analysis of such model effects. Nevertheless several general patterns towards the CPEC numbers are seen in the overall effects of combining the 15 sample scenarios.

CAPITAL COST TOTAL:

The total expenditure for the programs funded by the CPEC was \$23 billion at the time of this writing. Model findings reveal, in that the Model continues to achieve high total cost, sometimes double or more than the actual CPEC costs, whether the Model directly aim to reduce capital costs (see green bar of Figure 4.5) or if capital cost is used as a restriction. What this evidence reveals is that China and Pakistan opted for the lowest possible sum of total funding for electricity production. This could happen when further funds or donors are not present. Or that could be that more loans are impossible to get.

The only exception to this model pattern is the minimisation of emissions below the CPEC level, which required the model to pursue a solution at or under the CPEC cost for capital costs. The outcome created a CPEC cost situation, but less than half the emissions (Figure 4.5). It did so by the construction of major hydroelectricity and RLNG. Although the energy mix is unreal on this example, it points to building several big, powerful plants to produce electricity and maintain low pollution and costs. In addition, no coal was chosen by the model and RLNG plants were used

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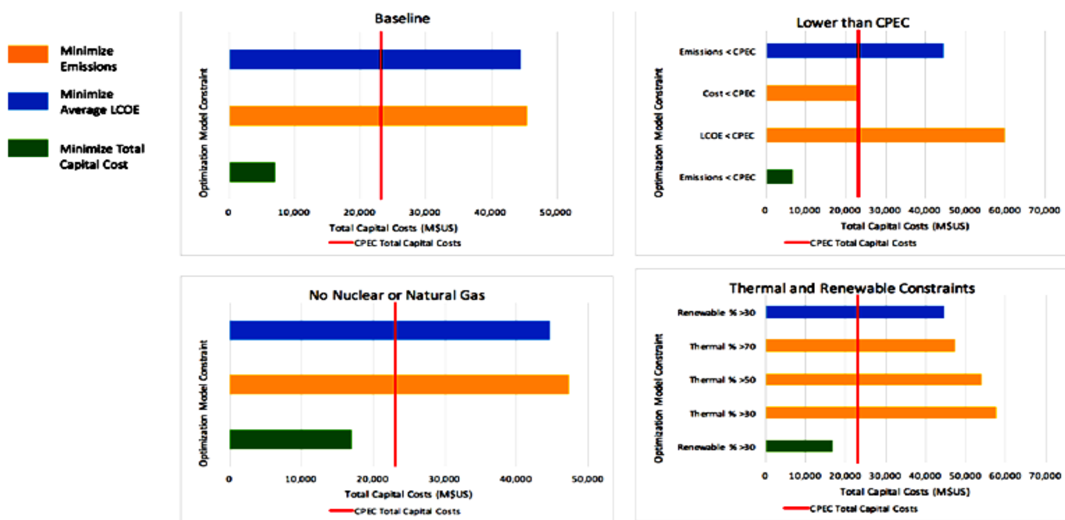
Figure 4.5. Total capital costs for each minimization optimization as compared to CPEC's total capital cost (red line).

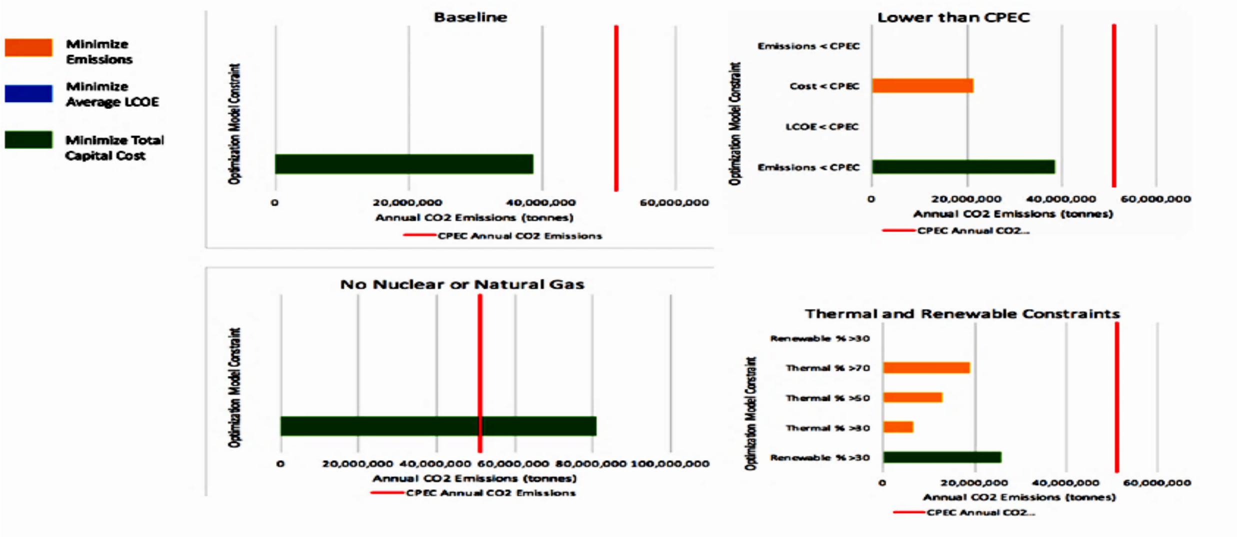


EMISSIONS:

CPEC emissions of 51 million tons of CO_2 a year were estimated. This amount is quite large compared with all but one of the models (See Figure 4.6). The only optimization leading to somewhat higher pollution was to actually reduce costs but to select natural gas or nuclear power stations. It has constructed ten major coal-fired facilities, which have generated over 80 million tons of CO_2.

Many findings of the model generated no pollution. This is impractical, since the majority of the pollution findings do not mean the total power produced will be green. The only exception was to reduce pollution because LCOE was smaller than CPEC, which constructed nuclear power stations to meet production requirements. This pattern is seen well in the case of thermal restriction where emissions increase due to the need for thermal power in the model (from 30% to 70%). However, the use of nuclear and natural gas facilities will also reduce these gases. Coal plants generally emit very high pollution and many alternatives produce considerably less emissions and the same reliability of electricity. However, no political considerations are taken into account in this outcome. Overall CO_2 emissions in comparison with overall CO_2 emissions (red line) seen in the Figure 4.6 for each minimization optimization.

Figure 4.6.Total CO_2 emissions for each minimization optimization as compared toCPEC's total CO_2 emissions (red line).



LCOE: The LCOE average was \$55.87/MWh for all CPEC programs. Surprisingly, the model presented strategies that are usually cheaper in LCOE, despite the average total costs of CPEC being less than most of the model output. The model was anticipated when the LCOE minimization was needed (see blue bars in Figure 4.7). However, the fact that green energy seemed to provide more LCOE than heat technology was not anticipated while emissions were kept to a minimum. However, given that there was no pollution attributing the LCOE to hydro-electric ventures and that the average LCOE was also reasonably poor in pollution minimization, which linked LCOEs to emission reductions.

More remarkable though, the model still generated average LCOEs that are below the CPEC while it focused on minimizing overall costs. These scenarios utilized many massive RLNG plants to produce energy while maintaining total prices, and because the LCOE of the RLNG plant was below the average of the coal-fired power plant, they also found that these scenarios were below CPEC. One scenario that indicated a higherLCOE was that nuclear or natural gas projects were not permitted and that the model constructed ten big coal-fired plants to reduce costs. The average LCOE in these coal plants was significantly higher than the average CPEC LCOE. For the purpose of analytical studies, the average LCOE in comparison to the average CPEC LCOE (red line), as shown above in Figure 4.6

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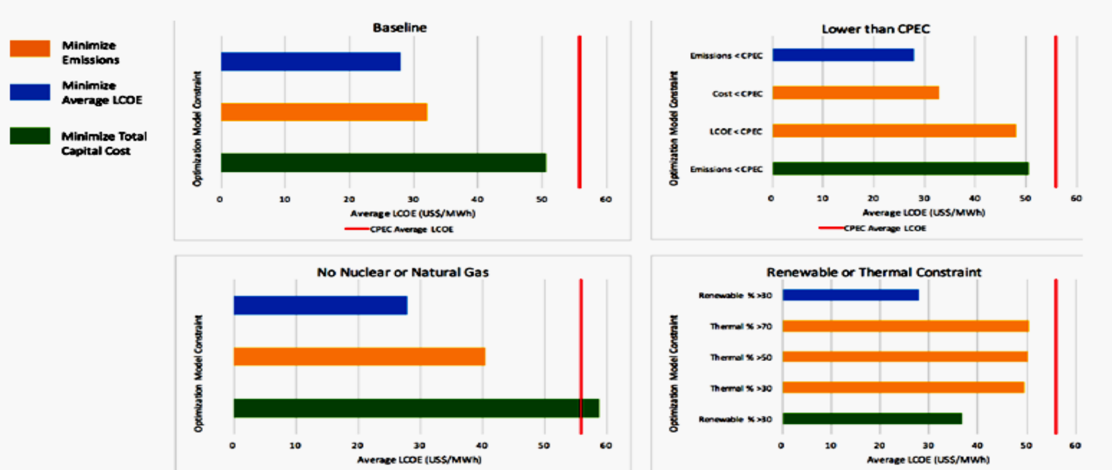
Figure 4.7. Average LCOE for each minimization optimization as compared to CPEC's average LCOE (red line).



The key point taken from these minimizations is that CPEC purchases the highest generation of China's least upstream funding costs. Capital costs would probably escalate to reduce pollution due to the need to create smaller solar plants to produce the same quantity of energy. Moreover, the cost of energy (LCOE), even though it is held down, does not equal cheap. In general, the lowest LCOE in coal ventures has little scope for improving both the hydroelectric and RLNG facilities. CPEC will reduce total energy and carbon costs by the use of hydropower capacity.

Electricity suppliers generally distribute their energy mix and invest in several plant varieties. In the case of technology, for example, if one kind of fuel becomes more costly, this will hedge from danger. In addition, it is beneficial to provide plants with various ages and lives such that not everything must be replaced at once, and political considerations will allow support to be distributed through multiple industries. Therefore, one technology should not be expected to be the target of CPEC investments. However, so much attention may be given to charcoal, which is not a "green" option in the manner in which BRI is attempting to represent itself. Moreover, this option does not have to be improved for Pakistani people as the idea discussed further in the next section will raise their electricity costs.

5. DISCUSSION

This document aims to reply to the question: Is the Chinese energy production investment under CPEC the most appropriate alternative to fulfill Pakistan's energy needs and is also environmentally sustainable as claimed? In this situation, it is important to carefully identify what makes economic sense. When it comes to the actual expense of the scheme, which accounts for the debt strain for borrowers and Pakistan, the existing CPEC system makes economic sense but is not "green."

If total capital costs continue to be the main problem, exploration of more productive imported RLNG natural gas plants could be an alternative. If LCOE is regarded as economically more valuable to retain, which is a key consideration in the next segment, then there are certainly cheaper and greener alternatives to pursue. This is achieved in the model with a stronger emphasis on hydropower performance.

5.1 The effect of LCOE on Pakistani price and subsidies for electricity

The data gathered for CPEC ventures and LCOE estimates was aimed to generate as much early funding as possible. While the total financial liability to buyers may be reduced, it may not take account of Pakistani citizens' costs of energy or of the debt strain that Pakistan's government will have to pay for increased rates of electricity.

Electricity rates in Pakistan are dependent on consumption, and electricity prices rise with fewer energy incentives. The Government of Pakistan offers incentives to cover the difference between payment and production costs to render energy available. In 2013, the Pakistani government raised heavy-duty duties and eliminated trade and agricultural subsidies to cut the subsidy costs [63]. In Pakistan, in 2014-2015 the energy grants remained 0.8% of GDP and were roughly the same as they were spending on medical care in that year[59]. The government already has a budgetary responsibility with the cost of balancing high energy rates.

The average CPEC ($55.74 fMWh) LCOE is compared by the performance of the models of our LCOE. This debt is approximately computed. With the help of LCOE, we will predict energy savings on these scenarios using an LCOE minimizing model ($28.01 FMWh) and the LCOE pollution minimizing system ($32.05 fMWh). The gaps in overall average energy costs of 85 million MWh will be $2.3 billion and $2 billion, respectively, for annual CPEC generation. Still more modest 5 dollars in the typical LCOE would minimize the total expense by more than 400 million dollars a year.

It is emphasized the fact that these are rough, averaged forecasts. Although, the energy mix selected will have a substantial impact on the LCOE and, if limited, considerable savings may be made for both the Pakistani government and customers. For instance, National Budget 2017-2018 plans for $596 million in power and debt subsidies[64]. The five dollars per MWh decrease in just the CPEC ventures will cover the LCOE average of about 67%.

5.2 In Pakistan, Coal's environmental and health effects

Major coal development may result in an acute health crisis in Pakistan. The largest coal supply to be produced in Pakistan, Thar coal, has higher levels of sulfur (1.38%) than that from Australia and Indonesia (0.4-0.85%)[13]. While gas desulphurization equipment is employed in the power plants to clean flue gas sulfur, there are unavoidable pollutants. These emissions of sulfur dioxide lead to environmental and health problems, such as acid rain and respiratory diseases.

More specifically, Thar coal-fired power plants are all subcritical, meaning poor production which badly affects the health of humans. The costs of constructing super-critical plants to burn poor-quality coal are not financially useful. Sub-critical plants are used. Consequently, more coal inputs are needed in the electricity plants to provide the same energy production as supercritical plants. More coal is used and more waste and wellbeing and the environmental consequences are increased. The more coal is burnt.

In addition to the form of technology and the amount of coal employed, other considerations, for example, topography and distance to inhabited areas, are often responsible for the health effects of coal. With the lack of reliable facilities for electricity transmission in Pakistan, power plants are likely to have been constructed near inhabited energy consumption areas. In contrast to global greenhouse gas pollution, smog-producing emissions, like SO_2, PM2.5, and PM 10, have more local impacts. The shortest path to urban places, the greater the effect on health and the atmosphere. Local contamination can be a national political issue if it is serious.

Economic opportunities: Other Fund incentives Coal in Pakistan:

The findings suggest that CPEC energy ventures are dominated by coal projects partially because the cost of capital is smaller. While low capital cost is preferable, other considerations such as incentive, benefit and interest rates are taken into consideration by investors. This segment explores the benefits of CPEC coal ventures from these three alternative viewpoints for several Chinese stakeholders. Please note that all CPEC coal ventures are operated by

Chinese or Chinese firms. Furthermore, several engineering, design, and building contracts for these ventures have been awarded to Chinese firms. This is especially relevant because China has restricted its charcoal industry to address issues of air quality and over-capacity.

In Pakistan, China has shut down coal plants with its borders while financing coal projects [37]. The air emission problem has launched massive plans to reduce carbon emissions for the first time in 2013 [39]. Air contamination has had huge health consequences for China. A handful of urban centers, in particular, because coal is the most important contributor to PM 2.5 in China[61], have recorded PM 2.5 over 1.000micrograms/quadrant. There have been studies showing that burning coal in China resulted in 366,000 early deaths in 2013 [40].

Apart from the effects of air emissions, China's coal industry has a huge overcapacity as power consumption reaches the needs of a population. China suffered from a large electricity shortage some six to ten years ago which resulted in a boom in coal production. Nevertheless, China's economy slowed as the latest ventures became active, thus overcome a slower rise in capacity because of decreased demand for oil. Consequently, coal-fired power stations and many of the coal mines that supported them have been shut down.

The Ministry of Environmental Protection prohibited the usage of coal in 28 towns, including highly polluting regions such as Pekin and Tianjin, to reduce health effects and overcapacity. The Government Work Report this year states China's coal output has fallen by over 800 million tons and over 200,000 coal-fired boilers have closed[38]. Both these measures resulted in China's failing coal sector and massive unemployment. Therefore, it is deemed highly necessary for the well-being of the China economy to pursue new markets abroad for Chinese coal enterprises.

FINANCIAL Rewards: There are also financial incentives behind these investor ventures, in addition to China's economic prospects. The CPEC energy ventures have comparatively high-interest rates and high investment returns, which means that the characteristics of these projects are more comparable than those of construction projects to commercial ones. BRI is advertising itself as providing reduced or even zero interest rate concessional loans to BRI members for inexpensive financial assistance [34]. CPEC energy programs are not being funded by development agencies and do not profit from these low-cost funding opportunities. The interest rates are less attractive, varying from 4.5% to 5%, in comparison to the London Interbank Average (LIBOR). Today's USD LIBOR is over 2%, the three and a half years' worth of USD LIBOR, so the interest rates for electricity ventures from CPEC ranges from 6.5% to 7.5%. In addition to the interest rate, China also charges an initial export insurance premium and financial charges.

The projected net expense of these programs is over USD 22.4 billion. The huge size of the loans places special importance on low-cost funding options for Pakistan's long-term growth. For the next 10 to 20 years, there are enormous discussions about the CPEC's funding responsibility for Pakistan. These ventures and the country, in general, will be subject to considerable financial pressures by combining comparatively high-interest rates and other charges. Though interest rates are not as low as BRI originally announced, higher energy investment investments are still rational behind higher interest rates. CPEC energy plants are built and run by private electricity companies rather than Pakistan's government, unlike other public infrastructure projects. The independent power producers still incur the repayment of loans and interest. CPEC energy ventures typically have a profit of about 18 and 35%, which enables higher debt paid by private suppliers.

SOURCES FUNDING: Another important item is that the CPEC energy projects obtain funding from the Chinese banks only, whilst the Asian Infrastructure Development Bank, Silk Road Fund, New Development Banks and the Chinese Banks collect funds from several other BRI projects. Production banks are not included in these energy ventures under the CPEC. While coal has very well-known environmental and health effects worldwide, CPEC energy ventures are not controlled to deter China from migrating its coal industry to Pakistan. One explanation may be that CPEC projects may be seen as high-return business ventures financed by non-development banks. This means that, while classified as a part of the BRI, the projects are not regulated by the environmental or social policy of development banks.

5.4 Nuclear hydroelectricity and disputes

In the model, hydroelectricity was an alternative to constructing coal-fired power plants in Pakistan at inexpensive and low emissions. It also identified nuclear power as an alternative to low-emission thermal plants to meet thermal requirements. But in Pakistan, both developments are controversial

Larger hydroelectric schemes in Pakistan are also regional since their main river systems come from both India and China and run over contested territory. Historic decisions for the distribution of water were taken with India under the 1960 Indus Waters Treaty and although, certainly, the upstream barrages and their impact on downstream water supplies are now being contested[65]. The goddamn building of Pakistan is seen to contribute to providing agriculture with energy and water safety [65]. However, differences between dominant agents and larger governing structures have caused tension about the municipal distribution of water [66] against smaller ethnic communities.

The Kalabagh dam, a 3 600 MW plant that was still not built even though the initial investigations of the site began in 1953 and viability were decided in 1972, is a prime illustration of hydropower controversy[66]. The province of Punjab is the largest sponsor of the dam scheme, while the province of Khyber Pakhtunkhwa is the biggest adversary. Punjab's help is generally due to the need for power, farm water and large flood controls that led to much debate after the 2010 flood[66]. Backflowing from a dam may affect local lands and possibly displace 34,500 residents in the province of Khyber Pakhtunkhwa [67]. This example shows how diverse political landscapes render investor-friendly or unsustainable ventures, in particular hydropower.

Pakistan constructed the first nuclear reactor for the production of electricity in the early 1 970s, with the support of the International Atomic Energy Agency (IAEA) [67]. Uranium deposits exploration started as early as the 1 960s for both nuclear and exportable applications [64]. However, the Indo-Pakistan War of 1971 meant that by 1972 resources were secretly divided from control into weaponry[68]. Pakistan did not sign the Nuclear Proliferation Treaty (NPT) of 1970[65] because of its desire to preserve strong nuclear security, especially against India. Pakistan is not able to acquire components for building and supplying nuclear reactors to produce electricity because they do not have enough local resources[69].

Current nuclear power stations are mostly feasible due to funding from China and imports, but Pakistan is controversial over Pakistan's decision not to sign the NPT. This applies especially to countries that have failed to accept foreign safety protections like Pakistan since China entered the Nuclear Suppliers Group (NSG) in 2004, which normally forbids exports of nuclear technology[68]. Notwithstanding the membership of NSG, China is still providing machinery[70]. However, recent US sanctions against seven Pakistani firms suspected to be a part of the illegal trade threw some uncertainty on their future membership[69]. Pakistan has submitted itself to join the NSG. The recent development may make it harder for countries other than China to cope with potential foreign nuclear power.

These disputes may affect potential hydro or nuclear growth. The economic and environmental paradigm is not easily implemented but should be taken into account when looking at potential energy developments in Pakistan.

Pakistani towns have a harmful air emissions from gasoline, gas, furnace oil and steel, which we use as a non-industrial economy, as a reference to environmental pollution. Air quality crises in Pakistan would be exacerbated by coal-fired power plants comprising a significant part of the first step of the CPEC. In reality, unless the government has a hard time tackling the low-quality diesel and oil products in the region, older trucks would continue to contribute significantly to this public health problem on the proposed Khunjerab–Gwadar road.

Climate change is already in Pakistan. Will climate and citizens remain secure as Pakistan plans to invest in imported coal-fired power plants employing various CPEC projects?

The amount of the CPEC is $54 billion, including electricity, fiber optics, infrastructure, railway and road infrastructure and industrial projects in Pakistan. Chinese President Xi Jinping has announced CPEC would link the Western Xinjiang Province of China and the port town of Gwadar during his visit to Pakistan in 2015. More than half of the CPEC's 33 billion dollars will go to 19 electricity projects; "about three-quarters of new power will come from coal power plants," said Reuters.

With its energy deficit of currently about 4000 MW, Pakistan has long required more electricity than it can generate. Pakistan has an annual demand for electricity of around 19,000 MW, according to the International Energy Agency (IEA) and just 15,000 MW.

And in the summer months from May to July, air conditioning systems add strain to the national power grid and sometimes trigger load shedding over many hours, this requirement extends over 20,000 Megawatts. By 2025, the IEA expects a combined demand for power to climb to over 49,000 MW as people in the world go up. The World Bank says that energy is still available to around 67 percent of Pakistanis.

5.5. Coal Control Plants Impacts

"The effect on the climate and wellbeing of coal plants is very negative. The most disturbing feature of the CPEC coal projects is that the economic cost value analysis and environmental impact analysis (EIA) of the said coal-based projects in Pakistan were lacking or similarly lacking" said Malik Amin Aslam, an ex-state minister for the environment who serves as global vice-president of the IUC, to The Diplomat.

Around 46 percent of the total emissions of Pakistan came from the energy sector in 2012, particularly coal-fired power stations. However, when Pakistan doubles in electricity, coal use drops by nearly 2 percent worldwide in 2016. China has cut coal demand by more than 1,5% and accounts for half of global coal consumption. The market for coal in the United Kingdom fell by 52.5%.

A study released by the Asian Development Bank in Feb 2018 found a significant rise in greenhouse gas pollution weakening attempts to mitigate the effects of climate change, as the ten gigawatts of generation power under the China-Pakistan Economic Corridor are planned for the Internet.

The effect on the climate would require the addition of water problems in Pakistan. Environmentalists believe that if action is not taken to tackle Pakistan's water shortages, it will run out of the sea in 2025. Some renowned environmentalists and water specialists foresee that: "Coal power plants are going to victimize animals and humans for [Water in] Thar and Gwadar. Sindh's Thar and the Gwadar district of Balochistan are well known for their water shortages. As coal-fired power plants need a lot of water, Saeed believes that the demand will increase in both districts, where coal-fired power plants are opened.

"Carbon pollution from coal-based plants will, of course, be damaging to the atmosphere and to human health, but plants would exacerbate in Pakistan where the water is already scarce due to the intense need for coal plants for water," said Saeed.

"Coal power stations are not economic either," Murad said. In addition to all those environmental issues. "The expense begins to decrease after 10 years of usage of hydropower, and it can quickly be renewed even after 80 years. However, a coal-fired power plant has an upper age period of 30 years; in certain cases, it will even last 10 years. Since the time is over and technology expires, it is no longer useful. Another plant must be built."

In the Pakistan-China friendship past, CPEC is an unparalleled effort, but what matters in business interests. Pakistan is at the receiving end of this project flagship and can therefore review, study and assess every project successfully until it is authorized. Pakistan is in desperate need but does not opt for coal-based power stations until scientific testing is conducted into their impacts.

A naturalist, who is also a close mate, often notes that creation also involves the high costs of natural and environmental destruction. With Gwadar's natural beauty in mind and its pristine beaches, the catastrophic impacts of construction can be minimized by choosing environmentally and nature-friendly ventures in emerging or undeveloped countries like Pakistan.

The CPEC will lead to very severe environmental issues, with China and Pakistan closely involved. There are no proposals to address environmental issues that are certainly going to hurt Pakistani citizens, in particular, Gilgit Baltistan and Balochistan.

Spatial and temporal aspects of the road sector and biotic and abiotic components linked to a vast road network could involve environmental impacts from the CPEC network. Furthermore, the footprint of certain linking roads has other indirect effects on landscapes and communities. Khan [70], examines that road changes the light on motorways and under major restoration or development would disrupt soil conditions. According to the habitat demand and ecosystem properties of organisms, spatial results may differ throughout this project. The negative externalities associated with temporary roads can arise because of road building, road usage and road maintenance. An important analysis by Gucinski *et al*.[71], indicates that roads can impact wildlife, ecosystems, and landscape levels adversely. Rehman [72] has also outlined the road results of the Pindi Bhattian Motorway and this effect is normal throughout the development of CPEC and the road and for long-term purposes.

For both China and Pakistan, CPEC holds the possibility of mammoth economic development. With reduced prices for the supply of oil and raw materials by China and the fall in shipping costs of finished products to the rest of the world, these economic gains can also be felt in the world. CEPEC is being highlighted by Pakistan as a game-changer which not only improves people's economic conditions but serves as a trigger for critical infrastructural developments that place Pakistan on the right track for real economic growth. for Pakistan, which could use this long-term economic uplifting.

Any of the main advantages for Pakistan from 2015 to 2030 would involve the development of "700,000 workers, which is forecast at approximately 2% annually." (Professors, 2016) The need for a "estimated 800,000 cars in the next 15 years" would result in an increasing number of roads and traffic flows[72]. The travel sectors would be guided by this. The projected loan development is estimated to be 2-3 percent per year in the local banks with an "existing deposit base of $90 billion and outstanding loans of $46 billion," [72] with about "US$30 billion in projects insured domestically and locally, with Rupees rising 2 billion per year in local premiums." As new railway and road developments improve mobility, tourism is projected to expand dramatically, and the hospitality sector will also be booming. Trade & trade would also improve, especially if free trade deals with our neighboring countries are better negotiated. The oil, gas & power delivery, cement, steel, construction, and allied industries will be boosted by several industries in particular" (Pakistan-China Institute, n.d.).

For all the advantages of CPEC, it is difficult to imagine a situation that would not negatively impact the climate by the large scale of developments and by the vast and complex road and rail networks. It can be said with assurance that they can and the main possible pitfalls must be highlighted, especially about the atmosphere. The roads and railway lines cross the valleys of the northern areas and have an enormous effect on the ecological and natural habitats of a large number of animals and fauna. Because of the proximity, along with the high altitude climate, to these emissions and residential sources in the Northern Areas, the adverse effects on the human environment would be strengthened. The natural by-product of the rise of transport density, which will cause many human and biodiversity issues and the overall environment, will be air quality and noise emissions. Air pollution Before the programs are initiated, careful preparation and prevention at this point are crucial. The adverse environmental consequences in hilly areas are more common than those in aircraft, mostly because of their effect on the tourism industry. The natural wealth and peace of mind of Gilgit-Baltistan (GB) are heavily dependent on tourism. There is tremendous potential to draw visitors in the future through improving Pakistan's tourism sector, but this is only feasible if we are working together to ensure the beauty of the region is maintained, preserved and even improved. The enormous infrastructure construction programs and anthropogenic CPEC activities would contaminate rivers, wetlands, mountains, game reserves and sanctuaries without considerable consideration and commitment to save these natural resources.

In addition to the atmosphere and energy, airborne illnesses and respiratory difficulties for the citizens of Pakistan would be the consequence of round-the-clock traffic, pollution of toxic emissions from other schemes, dust particles and suspended solids. Greenhouse gas accumulation would lead to deforestation through the transport schemes in the region and large-scale development.

Pakistan's climate change and global warmer problems have already been influenced by the melting glaciers of around 5,000 of them and the world is faced with seasonal changes and erratic weather conditions, which greatly influence the country's agri-economy. Uncontrolled emissions will aggravate the problem and affect both the quality and quantity of water, which could have devasting effects on Pakistan's future and quality of life.

The CPEC construction project will impact on water life and also on marine ecology as there's no proper disposal scheme in Pakistan, according to a study undertaken by Zhang et al.[6]. Incinerators are installed to compost and waste is dumped into water sources from a wide crowd. There is no method or solution for waste dumping in the CPEC building sector such that after the hazardous waste from the CPEC schemes has been discharged into water systems, the condition of the soil and water sources is inevitably polluted and, as a consequence, adverse effects on the environment of the local community. These citizens would suffer from various water-borne illnesses and water shortages since there will be a lot more demand on water supplies since the method of road building is going to use a lot of water." This is a recommendation not to be overlooked.

5.6 EIA - A legal requirement. Environmental impact assessment.

'Environmental Impact Assessment (EIA) is needed by both Pakistan and China's national environmental legislation as well as by the Environment and Development Declaration ratified by both countries"[4]. The likely effects of any infrastructure scheme to preserve the environment should be addressed and reduced. EIA advises and suggests a potential control action to safeguard the environmental sectors listed under the CPEC that the study covers.

EIA was introduced in Pakistan under Pakistan Environmental Protection Ordinance 1983, and the Ordinance demanded that each promoter present at the planning of a scheme, which may have negative consequences on the atmosphere, a comprehensive environmental impact statement under section 12 of the Pakistan Environmental protection Act (PEPA). However, as an order, it was subsequently removed and the Pepa Act (PEPA) of Pakistan was issued in 1997 (Environmental Protection Department, Government of Punjab, n.d.).

The Environmental Protection Agency (EPA) involved must be sent to the EIA before the building is commenced. Yet SEA's laws, strategies and services have so far not been subject to a legislative mandate. It also includes provisions to impose a fine if section 12 and other provisions of the Act are not complied with and any laws and regulations that could be applied afterward. The fine will reach 1 million rupees, including an extra-fine which can reach up to 100 000 rupees daily under which the violation continues. These penalties are much greater than fines for breaches of other legislation in the region.

CONCLUSIONS

If designed to satisfy environmental requirements, CPEC would provide Pakistan and China with several valuable social and economic resources, however, the comprehensive information centered on the guidelines of this study would be useful to decisions on environmental management. Indeed, extensive input from the study is required for the decision on the climate. There are certainly several ways to minimize the road consequences of research on this mega project. A simple planning mechanism is proposed by the use of current knowledge and research methods to implement a systemic societal, economic and climate evaluation to create improved road networks and resources in Pakistan.

A project as big as the Belt and Road Initiative offers many ways for China, including how it manages its environmental obligations abroad, to influence its foreign policy. A single nation, Pakistan and one initiative, CPEC, were examined in this study within a particular field, the energy industry. Though limited, it still represents trillions of dollars in energy infrastructure for a nation relative to the BRI in its entirety. The ultimate consequences are large and cannot be overestimated of China's expenditures in the environment.

Chinese commercial banks also exclusively managed CPEC energy ventures. Directing BRI construction funds for CPEC energy ventures will include further concessional funds for wind and solar generation technologies.

Models prove that hydropower has great promise, both reducing Pakistan's energy costs and reducing emissions of greenhouse gases. Improving hydropower projects management, reducing the likelihood of prolonged building times and potential raising in capital costs may lead to additional investment in that resource.

In cooperation with China, Pakistan is embarking on its mega CPEC project, part of the One Belt One Road scheme, with great promise for China as well as for Pakistan. The risk of disruption to the atmosphere is equally immense due to huge expected construction and energy production operations, mostly by coal. As China moves away from coal-based electricity and enforces tighter emissions control regulations, Pakistan has now initiated those programs, pending foreign agreements, without stringent environmental reviews being undertaken or without a very clear history of enforcing its environmental protection legislation. Unless Pakistan takes timely measures to avoid deterioration of the environment, its citizens will suffer significantly from the subsequent harmful effects on the atmosphere; this impact might affect the rest of the world as well.

The CPEC is willing to occupy Gilgit Baltistan from China, as it is Pakistan's only land connection with China. It is not noteworthy that the CPEC enters into the region of Gilgit (Gilgit Baltistan) that is inhabited by large numbers of local citizens in other areas of Balochistan. Resentment from occupied Gilgit Baltistan, it focuses today on the impact of the CPEC on the citizens of Balochistan, with its secret colonial policy.

Balochistan's riches are worth billions of dollars, such as gold, coppers, gas, and charcoal. For example, it is reported that the 500 trillion Reko Diq mine in the Chaghi District of Balochistan has made it the fifth-largest mine worldwide in gold and copper. Likewise, the mine has 412 million tonnes, 'averages of 0.5 grams of gold per tonne and 1.5 grams of silver per tonne,' in the ore reserves that include silver and gold.

In Balochistan, there are a lot of opportunities. Alone Sui Gas has changed Pakistan's economic environment, but it did not help the local citizens in Balochistan. Out of the 32 Balochistan district headquarters, only 1 has Sui gas installation. It says that Sui gas even does not favor the main part of the district headquarters, regardless of the small towns and villages. Gas is only available to 59% of Balochistan's urban population.

RECOMMENDATIONS:

China should do more to foster environmental and social protection for its projects on the investor side. Because of the CPEC energy programs, the implementation of tighter environmental policies for these banks would have a huge effect if only Chinese banks were to have finance and no development banks' financing. ' While it is too early to assess the effect of China's recent Guidelines, the 'Guidance on the Promotion of Green Belt and Road' and the Chinese Overseas Investment' Environmental Risk Management Initiative, may not entail compulsory action. In addition, a clearer definition of what comes under BRI will enhance the application of these requirements and their supervision.

Increased engagement with CPEC energy projects by Chinese development banks, multilateral development banks and other regulated sources of funding such as the Silk Road fund may also reduce the effect of CPEC on the climate. These sources could provide more concessional finance for non-commercial bank ventures in the field of renewable energy. This will help Pakistan fulfill its need for electricity, diversify its energy mix and help Pakistan meet NDC obligations.

Our models for Pakistan show that, in addition to the cost of capital in the first place in deciding which energy sources are better suited to their needs, they should recognize the LCOE for ventures. LCOE is a stronger measure of the cost of energy transferred to customers and its dependence on electricity and circulating debt subsidies would contribute to reducing electricity costs. To minimize building delays that raise the capital expense, Pakistan may also increase its hydropower projects management. This decrease could draw further investment in these low-emission schemes.

In future research, health costs and additional environmental costs can be incorporated into the model based on this study. Another way to make beneficiary countries realize the long-term impact of these programs is to increase BRI financial evaluations to other countries and industries. Improving BRI investment accountability and project specifics will encourage these analyses.

The foodstuffs or the goods manufactured in this area should be checked and balanced. Reusable and recyclable are both goods supplied to the consumer. This act will contribute to reducing contamination in the environment. There must be good waste storage sites and state-of-the-art infrastructure for disposal of hazardous waste from clinics, instead of being dumped in bodies of water and land, which will potentially have a catastrophic effect on the health of Pakistani citizens and the marine and terrestrial existence of plants and animals. In addition, careful deliberations should take the following factors into account.

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