

# Impact of Karot Hydro Power Project on Pakistan Economy

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## Abstract

*Pakistan has been facing the problem of energy crisis since 2007 and it has adversely affected the productivity and growth of the economy. To overcome this problem, under CPEC, 21 energy projects have been started in four provinces of Pakistan, Gilgit Baltistan (GB) and Azad Jammu & Kashmir (AJK). This study tries to access the impact of the CPEC energy project located in the Azad Jammu and Kashmir referred to as the 720MW Karot hydropower project on the economy of Pakistan using the Computable General Equilibrium (CGE) model. Based on Social Accounting Matrix (SAM) 2010-2011 and Global Trade Analysis Project (GTAP) database, this study simulates the impact of Karot hydropower project on some of the macroeconomic variables. The simulated results reveal that real GDP and total exports to other countries increase owing to the investment in hydropower projects as well as an increase in the supply of electricity. Moreover, investment in the Karot hydropower project also increases the growth of the interlinked sectors such as manufacturing sector, transport, and communication, agriculture and services sector respectively. This study also observes that the real prices of factor input also increase which would have a direct impact on wellbeing of the people.*

**Keywords:** CPEC, Karot Hydro Power Project, Real GDP, Real Wages, Pakistan Economy.

## Introduction

The share of Azad Jammu and Kashmir's economy in the GDP of Pakistan is only 2.3 per cent and the share of the population in the total population of

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Pakistan is 1.950 per cent.<sup>1</sup> The low performance of Azad Jammu and Kashmir's economy is not owing to a shortage of economic potential, natural and human resources but due to underutilisation of natural and human resources. There is inadequate physical infrastructure in terms of highways and roads, and particularly hydropower potential could not be exploited properly in this region due to financial constraints. Pakistan including Azad Jammu and Kashmir (AJK) has been facing a severe energy crisis since 2007 due to circular debt, fuel mix transformation and underutilisation of energy plants. Pakistan is still facing an average shortage of 5000 MW<sup>2</sup> due to substantial dichotomy between installed capacity and actual production.<sup>3</sup> With the increase in population, households and industries have rapidly increased the demand for energy in the form of electricity and gas respectively. Electricity is required in every sector of the economy including household, agriculture, manufacturing and transport. The development of the power sector has been ignored for a long and its production capacity has not been increased despite the rise in population and industrial expansion. Fortunately, AJK is having a hydropower potential of 9257.27MW which can cater 50 per cent of total national need.<sup>4</sup> It is indeed sufficient to redress the acute energy crisis facing Pakistan and contribute to its development. A few years ago, AJK were producing approximately 1500 MW of electricity through hydropower resources. For instance, Mangla Dam has an installed capacity of 1150MW and the rest of the amount was being produced by small and micro dams. It is worth accentuating that the total requirement of electricity for household, commercial and industrial sectors is 400 MW. Thus Azad Kashmir was contributing 1100MW to the national grid of Pakistan.<sup>5</sup> In 2017, the Patrind hydropower project was completed with an installed capacity of 147MW.<sup>6</sup> Since 2018, the Neelum and Jhelum hydropower projects have been supplying 969MW electricity to the national grid. On

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<sup>1</sup> Planning and Development Department, Government of Azad Jammu and Kashmir, 2017.

<sup>2</sup> "Power Cuts Return as Shortfall Touches 5,000 Megawatts," *Pakistan Today*, June 9, 2021, <https://www.pakistantoday.com.pk/2021/06/09/power-cuts-return-as-shortfall-touches-5000-megawatts/>

<sup>3</sup> Maha Rehman, "Pakistan's Electricity Generation has Increased Over Time. So Why Do We Still Not Have Uninterrupted Supply? The problem lies with distribution and transmission," *Dawn*, June 10, 2019, <https://www.dawn.com/news/1430728>

<sup>4</sup> AJK Statistical Yearbook (2019).

<sup>5</sup> *Kashmir Watch*, May 17, 2019, <https://kashmirwatch.com/39719-2/>

<sup>6</sup> Star Hydro Power Limited, <https://www.patrind.com/>

average, Azad Kashmir is producing 2616MW electricity altogether and contributing to the socio-economic development of the country.

China Pakistan Economic Corridor (CPEC) is the flagship project of Belt and Road Initiative (BRI) initiative and mutually beneficial for both China and Pakistan. It consists of four major components; roads, railroads, energy projects and special economic zones (SEZs). CPEC is important for Pakistan to overcome problems of economic development, energy crisis, and rural-urban connectivity hitches. For China, it is important to secure its energy and gas supply routes, to explore the South Asian and Central Asian markets to absorb its excess supply of goods and services and last but not the least to maintain its global dominance through exploration of markets.

China is investing US\$60 billion in roads and energy projects under the project of CPEC. It is expected that this investment would transform Pakistan into a hub of economic activities. CPEC has few projects that were of short duration and were completed at the end of 2018 and few will be completed by 2023. However medium-term projects will be materialised in 2025 and long-term projects will be completed in 2030 respectively. It is documented that CPEC project will directly increase the 700000 employment opportunities between 2015 and 2030 and increase economic growth from 2 to 2.5 per cent.<sup>7</sup> Therefore, this project is vital for Pakistan to bring people out of poverty through the creation of job opportunities, sectoral development, face to face connectivity and increase in the income that likely enhance living standard.

CPEC is evolving as a hot centre for all sorts of investments. It would unveil new vistas of progress, development and prosperity in the region. Azad Jammu and Kashmir state would also be a recipient of the massive project since five projects have been sanctioned under CPEC. CPEC projects in AJK would not only lead to infrastructure development in the form of energy and roads but it will be a catalyst for the fast development of tourism industry to earn revenues with likelihood impacts on economic growth.

The Karot hydroelectric project has been started in 2017 to produce 720MW electricity with an estimated cost of US\$1698.20 million and likely

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<sup>7</sup> Rashida Haq and Uzma Zia, "Multidimensional Wellbeing: An Index of Quality of Life in a Developing Economy," Social Indicator Research 114, No.3 (2013).

to be operational in December 2021.<sup>8</sup> Energy project located at Kohala Muzaffarabad has started to produce 1124MW of electricity and its estimated cost is US\$2364.05million.<sup>9</sup> Another project named Azad Pattan hydropower project has been started on River Jhelum with installed capacity of 700MW and it will be operational in 2026.<sup>10</sup> These hydropower projects have been started not only to overcome the acute energy crisis but also to raise the living standard of people by providing job opportunities to unemployed people that will have ripple effects on the alleviation of poverty. Moreover, these hydropower projects ensure durability and reliability of uninterrupted electricity supply over the long period of operation. Also this source of generation of electricity has environment friendly attributes and it is included in the category of renewable energy production. Cost of electricity production through hydel source is small, and its operation and maintenance cost is cheap relative to the other source of electricity generation. Hydropower dams have more benefits other than producing electricity. For instance, they regulate water flow, provide fresh water, diminish the impacts of floods and irrigate soil for crop production. Therefore, hydropower is considered as catalyst for socioeconomic development as long as it provides both electricity and water resource management and it can continue to do so in the future. Hence investment in hydroelectric projects will produce short and medium-term economic benefits during the construction and operational phase and long-term benefits due to the supply of electricity for productive purposes which will bring the economy on the trajectory of increasing growth. The main objective of this study is to examine the impact of the Karot hydropower projects under CPEC on real Gross Domestic Product (GDP) and total exports of Pakistan.

This study analyses the impact of the Karot hydroelectric project started in Azad Kashmir on the real GDP and total exports through the computational general equilibrium model (CGE). Second, this study also estimates its impact on the growth of output of different sectors of Pakistan such as agriculture sector, manufacturing sector, transport & communication and services sector. Using the CGE model, this study also simulates the impact of the Karot hydropower project on real wages

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<sup>8</sup> Website of China Pakistan Economic Corridor, <http://cpec.gov.pk/project-details/16>

<sup>9</sup> Azad Pattan Hydropower Project, NS Energy, <https://www.nsenergybusiness.com/projects/azad-pattan-hydropower-project/>

<sup>10</sup> Ibid.

of labour. This study uses two types of data sets to reach out our objectives: a) Social accounting Matrix (SAM) of 2010-2011 and b) Global Trade Analysis Project (GTAP) power database. This study could not estimate the impact of the Karot hydropower project on the local economy of Azad Jammu and Kashmir due to non-availability of statistical data.<sup>11</sup> Therefore, we have to rely on national statistical data to estimate its impact on the economy of Pakistan.

## Literature Review

Since long, infrastructure development has been considered very important for the development and growth of the countries. Infrastructure development enhances the domestic and interregional connectivity for the trade of goods and services. Moreover, it improves social and economic indicators of countries. For example, it has been claimed that quantity and quality of schooling in terms of enrolment, and the outcome has improved in Ghana over the time 1988 to 2003 due to improvement in infrastructure, better school quality and availability of schools.<sup>12</sup> Infrastructure development has reduced the distance and time and increase mobility that has a positive effect on school enrolment in Ghana and Guatemala.<sup>13</sup> Similarly, improvement in transportation and geography has positive impact on the health care utilisation services in urban and small urban areas of North Dakota, South Dakota, Montana and Wyoming. CPEC projects will increase private investment in Pakistan owing to the highways construction, establishment of SEZs and development of energy infrastructure. Therefore, CPEC projects would increase employment opportunities and thus increase GDP by 1.5 per cent.<sup>14</sup> Moreover, CPEC will decrease travel time and transportation cost and will enhance access to schools and health utilisation services in all districts along the western route. Reduction in travel time

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<sup>11</sup> Arif Kamal et al., "Rejuvenating the Economic Environment in Jammu and Kashmir: Mapping the Potential of Investments Across Various Regions," Conciliation Resources Burghley Yard, 106 Burghley Road London NW5 1AL United Kingdom (2013).

<sup>12</sup> Daniela Vuri, "The Effect of Availability and Distance to School on Children's Time Allocation in Ghana and Guatemala," *Understanding Children's Work Programme*, Working Paper (2008).

<sup>13</sup> Ibid.

<sup>14</sup> Syed Tahir Hijazi et al., "An Employment Impact of China Pakistan Economic Corridor CPEC Projects," *International Journal of Information Research and Review* (2017).

raises school enrolment and attendance of primary and middle school students and enhances the health care services across the western route. The industrial development in SEZs will boost deteriorated industrial sector that spurs economic growth.<sup>15</sup> Similarly, China's investment in the transport infrastructure projects under CPEC will reduce distance of 10000km for China to access the markets of the Middle East, Africa and Europe. Therefore, the exports of agriculture goods of Pakistan to China will increase through mutual trade and thus increase the GDP growth of Pakistan from 0.29 per cent to 0.42 per cent whereas exports of non-agricultures goods of China will flow to Pakistan respectively.<sup>16</sup> Energy project under CPEC will bolster economic activities due to increase in foreign direct investment (FDI), creation of job opportunities, increase in tourism and cultural exchange, infrastructure improvement and socioeconomic cooperation.<sup>17</sup>

The aforementioned literature indicates that CPEC project will impact the socioeconomic condition of Pakistan and therefore it is considered as a game-changer for Pakistan in terms of increase in infrastructure development, trade, employment creation and increase in private investment. The literature cited also clearly shows that no one has studied the socioeconomic impact of hydropower projects started under CPEC on real GDP, total exports to other countries, industrial output and factors real wages. Therefore, this is the pioneer study that simulates the effects of an investment in the Karot hydropower project on the economic development of Pakistan using the CGE model. Comprehensive data set of SAM 2010-2011 of Pakistan and the GTAP database are used for analysis of this study.

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<sup>15</sup> Muhammad Haris, "Identifying Investment Sectors along Pak China Economic Corridor," Memoir of International Academic Symposium on China Pakistan Economic Corridor, (2015).

<sup>16</sup> X. Wei, T. Ali & J. Huang, "A Quantitative Analysis of the Effects of China-Pakistan Economic Corridor on Pakistan and China," 30<sup>th</sup> conference of agriculture economists (2018).

<sup>17</sup> Muzammil Khurshid, Athar Rashid & R. M. Ammar Zahid, "Impact of CPEC Energy Projects on Socioeconomic Development of Pakistan," Proceedings of the International Conference on Renewable, Applied and New Energy Technologies (2018).

## Methodology and Data

The impact of the Karot hydropower project can be measured in a model that diffuses the effect on inputs, inputs prices and output of the economy. Therefore changes in the factor inputs and output would have spill over effects on employment and trade in an economy. The global static CGE model can be used to quantify the impact of investment in the Karot hydropower project on the input and output of different sectors of the economy.

The CGE model provides framework through which this study investigates the decisions of producers and households in response to change in factor demand due to change in investment. Lets assume that investment in hydropower has increased, it leads to an increase in the demand for factor inputs such as labour, capital and intermediate outputs of manufacturing industries and other sectors. Thus employment increases and income rises. The major benefit of using the CGE model is its ability to link different sectors within the economy. A change in any one sector of the economy impacts all interlinked sectors of the economy.

The CGE model is based on the framework of the neoclassical model which assumes that markets are perfectly competitive and constant returns to scale in production. Further, this study assumes that firms maximise the profit whereas household maximises the utility. Producers make their production decision either using a cost minimisation principle or profit maximisation approach. Similarly, households or consumers take their decision based on maximising their utility behaviour. Similarly, the general equilibrium model used in this project can delineate the sectoral interlink age within the economy and the behavioural equations explain the effect of incremental investment on the interlinked sectors and increase in electricity in the form of MW on the output and wages of the workers. The static CGE model can be applied with the help of the GTAP model and it is supported by the GTAP modelling framework.

The multi-sector CGE model has been employed using a newly developed My GTAP model.<sup>18</sup> This model captures the inter-relationship

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<sup>18</sup> Peter Minor and Terrie Walmsley, “*MyGTAP: A Program for Customising and Extending the GTAP Database for Multiple Households, Split Factors, Remittances, Foreign Aid and Transfers,*” GTAP Working Paper (2013). Also, Muhammad

between factor inputs, their prices, and markets. The database contains input-output tables and a global MyGTAP database of trade, the economy, and other variables. This MyGTAP model is a bit different from the standard GTAP model because the standard GTAP model considers just one private representative household while the MyGTAP model has various options to consider multiple household and factor inputs which explain easily the interlink age between various household, their income, and their expenditures within the economy as shown in the figure no. 1.

### Flow of the GTAP model



The differentiated household based on the level of income and factor inputs supplements the model capacity to capture the impact of a policy change on the welfare level of all the households. The expenditures are divided into three categories, a) the private expenditures, b) government expenditure and c) investment-savings. Moreover, households own the factor of productions and assets of the economy. Firms hire factor inputs such as labour and capital and use them to produce output. There exist

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Aamir Khan et al., "A Household Level Analysis of the Pakistan-Malaysia Free Trade Agreement," *Journal of Asian and African Studies*, 53, No. 7 (2018).



markets where firms sell goods to the household sector or other firms and industries and households also sell factor inputs to firms. Therefore, the quantity demanded and supplied determine the price of a factor of production and the prices of output.

This study uses two data sets, the latest available GTAP database 9a and Pakistan Social Accounting Matrix (SAM) constructed by the International Food Policy Research Institute (IFPRI) for the year 2010-2011.<sup>19</sup> The latest Pakistan's Social Accounting Matrix (SAM) 2010-2011 is merged into the GTAP model to augment the needed data. GTAP database consists of 57 sectors while SAM 2010-2011 includes 16 households that are taken from urban and rural areas.

## **Results and Discussion**

With the formation of a consolidated CGE model based on SAM 2010-2011 and the GTAP database, the impact of investment in the Karot Hydropower project and increase in its production in the form of 1MW on the economy are analysed which includes macroeconomics effects and sector effects. Therefore key variables here are an investment in the hydropower project and additional electricity produced through this project in MW. We assume that US\$1.7 billion are invested in the Karot hydropower project and this investment in this power project will produce 800MW of electricity. To examine the impact of investment in hydropower projects on the national economy, the Keynesian closure rules are used in the CGE model which assumes that the investment in hydropower projects is exogenous. We also consider the assumptions of standard MyGTAP, for example, all sectors are perfectly competitive, free mobility of factor input labour and capital among sectors while land and natural resource are immobile.

Here we assume that US\$1.7 billion are being invested Karot hydropower project and it will produce additional electricity of approximately 800 MW, then we simulate its impact on real gross domestic product and total exports using the CGE model. The results for the changes in real GDP and total exports are shown in Table no. 1.

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<sup>19</sup> IFPRI, "Pakistan Social Accounting Matrix, 2010-11," Islamabad, Pakistan: IFPRI's Pakistan Strategy Support Program, [pssp@idspak.com](mailto:pssp@idspak.com)

**Table No. 1**  
**Impact on Pakistan Real GDP and Exports**

<b>Variables</b>	<b>US million dollar</b>
Real GDP	141
Pakistan's total Exports	61.2

Source: Author's simulations

From Table no.1, it is found that with an increase of the Karot hydropower investment and output in the form of electricity in MW, the demand for investment in other sectors also increases, and two macroeconomic variables such as real GDP and total exports to other countries also increase gradually. The table No.1 indicates that investment in the Karot hydropower project increases real GDP to US\$141 million and total exports of worth US\$61.2 million would also increase. This simulation implies that increase in the investment in the hydropower project leads to an increase in the fixed assets investment and also enhance the stock investment. Therefore, it has a positive impact on the growth and development of the economy. Because due to an increase in exports, employment increases, more raw material is purchased and aggregate demand increases. More investment is made to cater increase in the aggregate demand. Therefore, an increase in exports increases aggregate demand which increases economic growth.

### **Sectoral Impacts**

An increase in the Karot hydropower investment in the state of Azad Jammu and Kashmir pulls the economic growth and sector's output growth. The simulated results are provided in the table no. 2.

**Table No. 2**  
**Percent Changes in Output**

<b>Variables</b>	<b>Sim-I</b>
Grains and Crops	-0.2393
Vegetables and Fruit	0.2810
Meat Live Stock	0.1856
Extraction	0.5362
Processed Food	0.2663
Leather	0.2471
WAP	0.2121
Textile	0.229
Light Manufacturing	0.4362
Heavy Manufacturing	0.8514
Transport Communication	0.1659
Financial Services	0.0012
Business Services	0.2596
Oth Services	0.3637

Source: Author's simulations

It is clear from Table no. 2 that investment in the Karot hydropower project leads to an increase in the production of each sector. For example investment in hydropower project and its expected output of 800 MW will remarkably increase 0.8514 per cent output of heavy manufacturing industry, 0.4362 per cent of light manufacturing, 0.5362 per cent of extraction, etc. This study can notice that investment in the Karot hydropower project has a positive but minor impact on the growth of financial services. However, all other sectors grow at a positive rate except for Grains and Crops. Table no. 2 also provides evidence that investment in hydropower projects has a positive impact on the leather industry, Wearing Apparel Products WAP and textile industry. These industries were badly affected by the acute energy crisis in Pakistan. These simulated results also show that electricity generation through hydropower will enhance the productivity and growth of the major sectors of Pakistan's economy such as agriculture, industries, and services.

### **Changes in Real wages**

As this study assumes that labour and capital are perfectly mobile among the different sectors of the economy. Therefore this study also analyses

the impact of investment in the Karot hydropower project on percentage changes in real factor wages and results are presented in the Table no. 3.

**Table No. 3**  
**Percent changes in Real Factor Wages in Pakistan**

<b>Factor codes</b>	<b>Factor description</b>	<b>Sim-I</b>
flab_s	Labor-Small Farmer	0.1980
flab_m	Labor-Medium Farmer	0.2023
flab_w	Labor-Farm Worker	0.2155
flab_l	Labor-Non-Farm Low Skilled	0.1895
flab_h	Labor-Non-Farm High Skilled	0.1955
flnd_s	Land-Small	0.1762
flnd_m	Land-Medium	0.1799
flnd_l	Land-Large	0.1840
fliv	Livestock	0.2619
fcap_a	Capital-Agriculture	0.1847
fcap_f	Capital-Formal	0.1457
fcap_i	Capital-Informal	0.1968

Source: Author's simulations

The simulated results indicate that investment in hydropower projects has a positive impact on the real wages of labour. Real wages of farm worker increased by 0.2155 per cent followed by medium farmers of 0.2023 per cent, labour small farmers, high skilled labour, and low skilled labour. Similarly, the real factor price of land also increase; for example price of large land increases to 0.1840 per cent followed by medium-size land and small size land. Moreover, the price of capital or return on capital also increases. This study can see that return on informal capital increases by 0.1968 per cent which is a bit higher than the price of formal capital and capital used in agriculture. This study infers from these simulated results that investment in the Karot hydropower project increases the real prices or returns of various factors used in the production of goods and services which will enhance the living standard of the workers.

## Conclusion

During the implementation of the China Pakistan Economic Corridor, special attention has been paid to the energy crisis that Pakistan has been facing since 2007. Moreover, three major rivers namely Neelum, Jhelum and Poonch are flowing down in Azad Kashmir. This region has the colossal potential to produce renewable energy in the form of hydropower projects. Therefore, two hydropower projects i.e. Mangla dam and Neelum-Jhelum hydropower projects are already operational in Azad Kashmir and supply electricity to the national grid. Moreover two other projects such as the Karot Hydropower Project and Kohala hydropower project have been started in Azad Kashmir to use untapped natural resources, for instance, water and human resources. Provisional economic data of major macroeconomic indicators of Azad Kashmir is not published and also not available. Therefore, this study has assessed the impact of investment in the Karot hydropower project on the macroeconomic variables such as real GDP and total exports of Pakistan then on the percentage change in the sector's output. This study has also examined the impact of investment in the Karot Hydropower project on real factor wages. This study has found that investment in the Karot hydropower project helps in improving the development of the country through an increase in real GDP and total exports to foreign countries. Indirectly we can say that increase in investment, increases employment, income increases, aggregate demand increases and therefore output increases. As for the impacts on the growth rate of each sector, besides the energy sector, heavy manufacturing, petroleum & extraction, and light manufacturing sectors would be the fast-growing sectors. The growth rate of the financial sector is relatively low compared to other sectors.

It is seen that an incremental investment of US\$1.7 million in hydropower project, it would increase the real GDP by US\$141 million and total exports boost up by US\$61.2 million. This simulation shows that investment in the Karot hydropower project will give a positive shock to the economic parameter which this study has explained. Moreover, this investment would also have a positive impact on the growth of various sectors of the economy. Particularly increase in energy production in the form of electricity will enhance the productivity of the manufacturing, textile, transport, communication and the agriculture sector. At the initial stage of development, the local resource is utilised and the infrastructure is

built. With the development of infrastructure, the industrial sector will progress gradually. Moreover, investment in hydropower in the state of AJK brings economic prosperity through an increase in the returns of factor inputs. From the results of the simulation, it is revealed that the real wage of skilled and unskilled workers will increase. The investment in hydropower projects will increase returns to the capital of the price of capital and also enhance the rental price of land. Overall this project will enhance the wellbeing of workers in all regions of Pakistan and Azad Kashmir due to an increase in their real wages.