International Journal of Engineering Works
https://www.ijew.io/
ISSN-p: 2521-2419
ISSN-e: 2409-2770
Vol. 9, Issue 03, PP. 51-56, March 2022
https://doi.org/10.34259/ijew.22.9035156

Socio-Economic Assessment of Mega Hydro Project and Wind Energy Project

Junaid ur Rehman[1], Haseen Ullah[2], Asfandyar Khalid[3], Zeeshan Ahmad[4]
[1,2,3,4] Department of Energy Management and Sustainability, USPCAS-E, UET Peshawar
Junaidurrehman058@gmail.com[1], haseen@myself.com[2], asfandyarkhalid@ymail.com[3], zesho1212@gmail.com[4]
Received: 28 January, Revised: 09 February, Accepted: 28 February

***Abstract*—** Pakistan depends too much on fossil fuels. Current energy shortage started a debate over mega dams' erection as Pakistan cannot afford its dependence on fossil fuel for energy generation for too long. Besides hydro, Pakistan has potential for other renewable sources of energy, Wind energy is one of them. In this study socio-economic assessment of wind energy project and mega hydro energy project is done. Socio-economic assessment includes land acquisition, resettlement issues, capital cost, tariff and operation and maintenance cost, taking Tarbella dam and FFCEL as case studies. After comparison of every aspect in details it is assessed that relocation of displaced people proves to be disastrous in mega hydro energy projects along with disadvantages such as waterlogging and salination around reservoir. Other than that, mega hydro projects generate clean and cheap electricity and provides reservoir for water storage to avoid floods, water scarcity and for irrigation purposes. Wind energy is not so damaging socially, despite, few small social hindrances such as noise pollution and infrastructure. Wind energy capital cost is very high and requires high expertise, above all, the biggest problem lies in intermittent supply of power and smaller life span of the project as compared to mega hydro power projects. If relocation process of displaced people is handled properly in mega hydro energy projects the overall socio-economic benefits of mega hydro projects are more than wind energy projects in current scenario. Pakistan should build mega hydro energy projects currently, but to cope with the global community she should also focus on wind energy as well for future.

***Keywords*—** Fauji Fertilizer Company Energy Limited (FFCEL), Renewable energy (RE), Mega hydro project.

I. INTRODUCTION

Population blast and rapid urbanization increased the demand for electricity since past few decades. Consequently, resulting in a shortfall and energy crises. The crises led to severity due to insufficient generation capacity, outdated grid system, failure of forecast, future planning and mismanagement[1]. Energy is required in every field I.e. Medical, education, trade and transportation, consequently becoming the essential commodity in modern era; Pakistan aims to decrease its dependency on fossil fuels. [2]. Fulfilment of the economic and other needs of the globe requires energy, however, the rise in global warming due to fossil fuels has shifted the emphasis from fossil fuel to renewable energy. It was not competitive initially, but it is getting into that zone of competition with other sources of energy as the cost is decreasing with the innovation in technologies [3]. Pakistan can grab this opportunity and can decrease its reliance on fossil fuels. It is a high time for investing in renewable energies [4].

Pakistan is unable to provide ample electricity to domestic use as well as to industrial use[1]. The heated debate over mega dams is going on in Pakistan so it's better to look out for renewable resources of energy such as wind energy [5]. Renewable energy sources could be the possible solutions for Pakistan's energy crises; Mega hydro energy and wind energy tops the list for Pakistan [2]. The coastal line in Baluchistan and Sindh is blessed with economically viable 20,000 MW potential. This amount of wind energy is easily extractable in Pakistan, though potential for wind energy is much more than this [6]. While the potential for hydro energy in Pakistan is about 60,000 MW. A very small amount in it is utilized while major chunk of it is untapped [7]. In Pakistan mega hydro projects such as Tarbela dam had been surrounded by the controversies since its announcement due to land acquisition initially and then relocation and compensation of affected people [3]. While the Wind energy requires high expertise and highest level of technology which Pakistan lacked before, but with the passage of time Pakistan has been acquiring that, depicted by Fauji Fertilizer Company Energy Limited (FFCEL) wind energy project [4]. A country potential for generating energy other than from fossil fuels needs research on the topic that which one between mega hydro projects and wind energy is suitable for the country in terms of socio-economic analysis. The Social assessment will include Land acquisition, noise pollution issue of wind energy projects, Pros of storage capacities of large dams and the job creation opportunities in the market. Economic assessment will include the capital cost, Operation and maintenance cost and the life cycle of both the energy projects, NPV based on payback period and normalization point of both the energy projects as well.

II. LITERATURE REVIEW

Energy is a strategic tool and often plays the part of a spur for sustainable progress. The consumption of energy per capita is commonly used as a tool for the sustainable economic growth of any country[9]. Any country needs energy as a key tool for its economic growth and social development [10]. Enormous insufficiency of power due to extensive reliance on imported fuels has spun into a striking hindrance to the sustainable economic and social development of any emerging country generally and Pakistan particularly. This situation marks an increase in immediate fuel costs and cut-off points possibilities in setting up new industries. The ongoing fissure amongst the demand and supply of power in Pakistan is about $2000 - 2500$ MW with a steady increase of $6 - 8\%$ per annum due to increase in demand [11]. Therefore, to end the energy crises, Pakistan needs renewable and sustainable sources of energy. Pakistan has tremendous resources of renewable energy for instance, solar energy, Wind energy, Hydro energy, and biomass energy. These energy resources will be the part of the future energy framework due to its sustainable nature [5].

Renewable energy is the best alternate source of energy for the electrification of the world due to few certain reasons. Fossil fuels are depleting and whole of the economies are running energy and the depletion of the fossil fuels can create economic chaos in the world. Fossil fuels causes serious environmental concerns such as Acid rain, climate change, greenhouse gases and Ozone layer depletion. Since oil crises in 1970's the world is shifting slowly and gradually towards the renewable as it's clean and sustainable source of energy. Pakistan possesses almost every type of renewable energy comprising hydro power and wind energy power [6]. A lot of potential sites for the hydel energy has been identified through out Pakistan the identified prospective of mega hydro power plants is 59 GW [12]. So, Wind energy projects and mega hydro projects are the two best available options for Pakistan to go for, as Pakistan is rich in both of these resources [1].

III. METHODOLOGY

This section includes that how the socio-economic assessment of mega hydro energy project and wind energy project will take place. A discrete investigation is being considered to think about the social and economic highlights of the mega hydro energy projects and wind energy projects. Tarbela dam will be taken as a case study for the socio-economic assessment of mega hydro project in Pakistan while FFCEL wind farm will be taken as a case study for socio-economic assessment of wind energy projects. The following parameters are considered for of socio-economic assessments Resettlement laws, Resettlement, Area and Population Affected, Cost of Resettlement, Outcomes of Migration, Real Capital and Functioning Costs, Fluctuation in Cost with time, Impact of Advancement in technology and effects on cost. Comparison of both socio-economic analyses will be taken into consideration and by comparison the results will be concluded. This research is descriptive investigation in which the socio-economic assessments of mega hydro and wind power project will be considered. FFCEL wind energy project and Tarbella dam has been taken as the case studies. The projects, which least effect on the society socially and economy wise and benefits the society socio-economic wise more will be preferred as best between the wind energy projects and mega hydro projects.

IV. RESULTS AND DISCUSSION

This section presents and analyse data. It will be then compared, and graphs will be generated for the sake of better understanding and getting results.

A. MEGA-HYDRO ENERGY (TARBELLA DAM)

Mega hydro energy projects require huge reservoirs for water storage which have impacts on a society and economy, in terms resettlements, irrigation, water storage and energy generation. Land acquisition act of 1894 was enforced while erecting tarbella dam upon the affected people of the Tarbela dam site. The act was some 100 years old and designed for a colonial India. Modern age crises of land acquisition were not properly addressed by that act as Pakistan was a free land by then.

B. RESETTLEMENT

Initial migration was predicted to be 80,000 persons and 100 villages were predicted to be submerged. Decision was taken in 1967 that individual with minimum 0.2 hectare irrigated land or 0.8 hectare on irrigated land would be provided substitute land. Each affected person, maximum of 20 hectares and minimum of 0.2 hectares will be allotted to the eligible people. The minimum was 6.5 hectares in Sindh, but affected people were given a choice to buy additional property. Whole of entitled affected people included 5,317 persons belonged to tribal regions. The displaced people were to be relocated in nearby settlements and in substitute terrestrial in Punjab and Sindh.

C. AREA AND POPULATION AFFECTED

The dam affected, the land of around 33,200 hectares in 135 villages. A whole of 96,000 individuals, i.e., nearby 10,000 families were evacuated, and 120 villages submerged. These figures can be compared to the forecasted figures at the time of design which were of 80,000 persons and villages numbering up to 100. All-out populace at most was of 2,000 individuals of any village affected by the construction of Tarbela dam. Whereas the lowest number was 150 persons. Affected individuals under 20 years were 45% of the total affected people, age group between 20-60 years made up to 35% of total affected people. Chief profession of evacuated people was husbandry, 5% functioned as skilled workforces and 2% used to drive boats, shipping persons and things amid river sides. The construction is mountainous, so estimates showed that merely 46% of the land can be cultivated and supportive to humans. To relocate the evacuated people around 12,000 hectares were allocated to displaced people in Sindh and Punjab. Cash compensations were given to individuals who possessed less than 0.2 hectares of irrigated land and 0.8 hectares of rain fed land. 5 hectares of canal irrigated land shall be provided to those above these limits.

D. OUTCOMES OF MIGRATION QUESTIONS

Initial approximations about 80,000 persons evacuation and effacing of villages about 100 were surpassed. 96,000 people were displaced, and 120 villages submerged. Substitute land formula only benefited 2/3 of the affected people. 1,953 families didn't acquire ownership of land in eligible 5,317 families

largely due to the Sindh government decision taken in 1974 to deny committed land to the affected people. For resettlement, commission was set up to evaluate unresolved land allotment cases. Merely 4.4% of contenders, who answered to announcement, were given positive response in 19,803 applications while other applications were rejected due to the absence of proofs to their claims vibrant strategy absence for relocation produced many difficulties, together for displaced people and the state. Lack of supervision created a mess, so some people benefited, and some didn't.

Deficiency of capital created grave issues in resettlement program. Because of delayed compensation most of the affected people were not prepared to move since the substitute preparations were not prepared on time. Dearth of plots in residential housing schemes have halted in resettlement. Resettlement took ages and due to inflation, the allocated budged value was abridged and a lot more money was required for resettlement which also played a vital role halting the process. Inflation had risen the capital required for land acquisition and resettlement. Furthermore, linguistic challenges were faced by the migrated people to Punjab and Sindh.

E. REAL CAPITAL AND FUNCTIONING COSTS

$1,136.4 million ($5 875million 1998 prices) was the real cost estimated as capital cost for the generating capacity of 2,100. After the complete functionality and implementation of the project different aspects came into play and resulted into a much higher cost than estimated. Which was $8,800 million in 1998 terms. Real O&M cost of WAPDA in present rates for together power infrastructure (Power Wing) and reservoir works (Water Wing) were Rs.21 526 million. Rs 10.4 million for the O&M charges specified in the report of Lieftinck were presumed in 1965 rates and will begin happening in 1972. After 27 years the estimation saw a huge increase, jumping from Rs 10.4 million to 280.8 million. In 1998 rates the real O&M charges for irrigation and power were around $1,234 million. These figures shows that planning was weak and there was an immense under estimation in every regard while planning.

F. WATER RESERVOIR

Pakistan faced devastating floods in 2010. We can avoid such situation in Pakistan again if we build huge reservoirs for the storage of water. Tarbela had the capacity for storing water up to 9.679 MAF. However, this capacity has decreased by 33.5 percent because of sedimentation. Such a huge capacity for the storage of water will serve two purposes. Reservoir will save Pakistan from severe floods in future and as Pakistan is also going towards a water scarcity so the water can be used for Irrigation purposes as Pakistan is an agrarian country.

G. WIND ENERGY

It's a very costly form of energy in its installation. It requires high level of technical expertise and skills to install it and maintain it. The initial investment is huge as the area around the wind farm will also require connectivity links which also requires huge chunk of money

H. ADVANCEMENT IN TECHNOLOGY AND EFFECTS ON COST

Researchers in Massachusetts university from lab of Berkeley, Conducted by NREL (National Renewable energy laboratory). 163 participants in IEA wind technology task 26 collaboration programme assessed about the advancement in Wind energy technology and its direct relation with the cost. On shore wind turbine hub height was 82m in 2015 which will be 115 m by 2030. Diameter of rotor was 102 m which will increase up to 135m by 2030 and the power output will witness the increase from 2 MW in 2015 to 3.25 MW in 2030.

In offshore, height of hub will increase from today's 90 m to 125 m in 2030. Diameter of rotor will increase from today's 119m to 190m. Likewise, power output will increase from 4.1 MW to 11 MW. Such rapid and huge advancement in wind technology will result in the production of more power. So wind energy cost will be reduced by 24%-30% by 2030.

I. FAUJI FERTILIZER COMPANY ENERGY LIMITED

In May 2007, the land was allocated by AEDB for 50 MW wind energy project in Jhampir, Thatta Sindh. A German consultant, Lahmeyer International completed the feasibility report in January 2008. Tariff of 16.1 US$ cent (PKR 13.7) per unit by NEPRA in August 2010. The Plan has been established at a cost of 134 million US$. The Development is financed through 80 % debt by Indigenous Banks and 20 % equity by FFC. NTDC purchase the electricity being generated by FFCEL. The agreement is for 20 years.

Commissioning of complete separate of Electrical Equipment and Wind Turbines finished in November 22, 2012. It helped indigenous manufacture companies like DESCON Manufacturing Facility at Karachi as it was manufactured over there. It's the first 49.5 MW grid connected wind energy project.

J. FFCEL PLANT OPERATIONS

1,283 Acres of land has been occupied the FFC wind farm in wind corridor at Jhampir, Thatta Sindh. The average wind speed in that particular corridor is 7.3m/s. It has 33 wind turbine generators (WTG's) each of 1.5 MW generating electricity at 3.5 m/s and can operate safely up to wind speed of 25 m/s. The O&M is outsourced. Annual Benchmark for the production was 143,559 MW while the production in 2016 was 130,827 MW. 96% was due to low wind speeds and the remaining 4% was due to unplanned maintenance.

K. FFCEL WIND ENERGY INTERMITTENCY

Wind energy shows intermittency, data of FFCEL has been collected for gauging the intermittency show by the wind power plant. Which is depicted in the following table and figure

Table 1: FFCEL wind energy intermittency

Year	**Actual generation in MWh**	**Benchmark generation in MWH**	**Difference in Percentage**
2014	142000	155916	9.8
2015	112,491	143559	21.6

2016	130,827	143,559	8.86
2017	132,865	143,559	7.44
2018	122,657	143,559	14.5

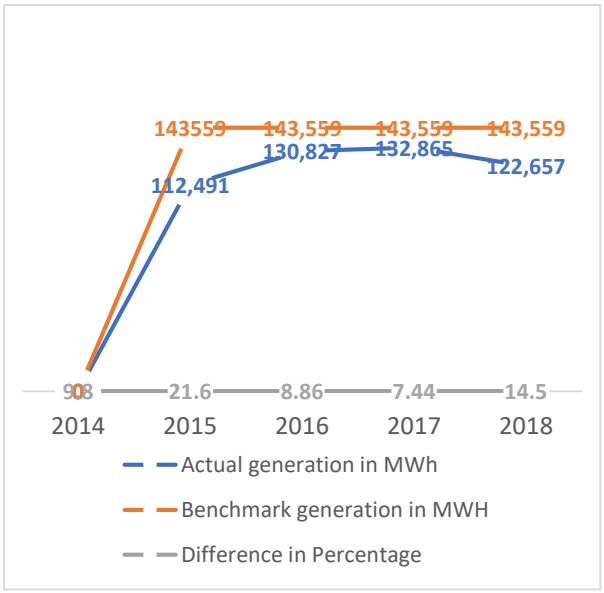

Figure 1. FFCEL Wind Energy Intermittency

I. COMPARISON

Based on the data being collected from FFCEL plant and Tarbella dam for different parameters mentioned in the table below; the comparison has been carried out in the table below based on which the graph is generated which helps in concluding the research work.

Table1: Comparison of Tarbela vs FFCEL wind energy project

parameters	**Wind energy FFCEL**	**MEGA hydro (Tarbela dam)**
Capital cost in millions/MW (US $)	2.7	0.712
Useful life (Years)	20	85
Energy Production (MWh)	43,600	42818880
O&M Cost (US$ million/annum)	3	12.5
Levelized Tariff(BY NEPRA in RS per KWh	14.5	0.030
Annual Net Profit (millions in Rs)	391	30700
Payback period (Years)	6	8
Capacity (MW)	49.5	4888
MW produced in 1 Sq.Km	9.33	19.552

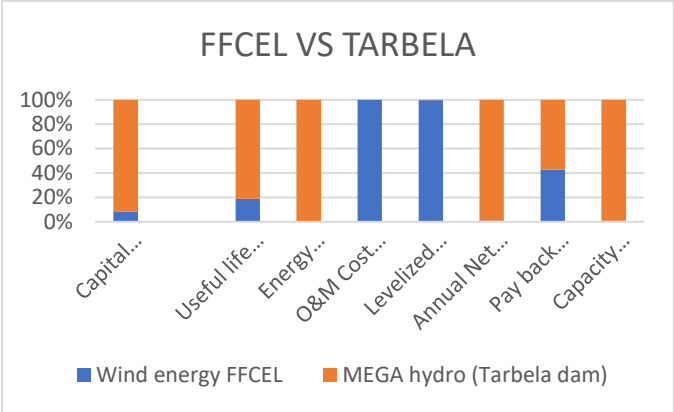

Figure 2. FFCEL Wind Energy Intermittency

II. ANALYSIS

Mega hydro projects proved to be disastrous when it came to the land acquisition it displaced 96,000 people and effaced 120 villages. Waterlogging and salination are the products of huge dams in surrounding areas of dams. On the contrary, it has some positive aspects on the social analysis such as irrigation and generation of electricity and storage capacity of water which is vital for the water crises of Pakistan and flood control in Pakistan. Pakistan can avoid floods in future due to huge reservoirs. Cheap electricity will stimulate social sector development such as health and education. While the social impacts of wind energy include the complications in land acquisition, but it doesn't create huge crises of forced migrations. Noise pollution is the part and parcel of wind energy projects. Population also opposes it due to aesthetic reasons. Social analysis makes the wind energy favourable.

WAPDA has implemented the Tarbela dam project which is one of the biggest dams across the world. Which shows Pakistan has technical expertise in building big dams. Although, Pakistan has the expertise of building wind farms as well but the intermittency in wind energy makes it least favourable as the graph for the intermittency of the FFCEL has been generated above. We have a stable power output from the hydro power projects. Technically mega-hydro projects are more favourable

The technological advancement in wind power sector has reduced its cost drastically but it is still considered to be costly for Pakistan's economy. Bearing in mind that the useful life of hydropower is more than the wind power projects; Pakistan has to opt for the hydro power projects in a current scenario after detailed assessment.

The graph generated above, shows that Mega hydro projects are more favourable than wind energy projects. Capital cost per MW, Tariff, Annual net profit and capacity etc. makes mega hydro energy the most favourable as its useful life makes it considerably favourable. It has been shown in the graph as well that economic impacts of Tarbella Dam are favourable than wind energy project. The production of cheap electricity for longer period will help the economy of Pakistan and will flourish the industry in Pakistan. Flourishing industries of Pakistan with help in creating jobs and increasing the exports of Pakistan.

CONCLUSION

All the discussion brings us to the conclusion that if the migration is looked after properly then mega hydro projects are better than wind energy projects in current scenario of Pakistan. It is also a clean form of energy and along with clean energy it gives different option to the society such as irrigation as Pakistan is an agrarian country. Pakistan also faces floods after regular intervals so mega hydro projects will be vital for the storage of water which will prevent the future floods. Pakistan is on a road towards water scarcity, so a reservoir would help in preventing Pakistan from water scarcity. The capital cost on building mega-hydro power project is less than the projects of wind-power as the life span of hydro project is more than wind power projects. Hydro power projects also supply a stable power while wind energy projects supply intermittent supply. Any plan's end beneficiary is supposed to be the end consumer and the tariff will have a direct impact on the end consumer. There is a huge difference between the tariff of mega hydro energy project and wind energy project. The cost per unit in mega hydro energy project is 0.030 KWh Rs while of Wind energy is 14.3 Rs per KWh. Keeping all this in mind Pakistan should focus on mega hydro energy projects due to current economic situations and the expected rise in demand.

REFERENCES

[1] M. A. Javaid, S. Hussain, Z. Arshad, Ma. Arshad, and M. Idrees, "Electrical Energy Crisis in Pakistan and Their Possible Solutions," Int. J. Basic Appl. Sci. IJBAS-IJENS, vol. 11, no. 5, pp. 5–38, 2011.

[2] A. N. Khan, T. Begum, and M. Sher, "Energy Crisis in Pakistan : Causes and Consequences," Abasyn J. Soc. Sci., vol. 4, no. 2, pp. 341–363, 2010.

[3] F. Hvelplund, "Renewable energy and the need for local energy markets," Energy, vol. 31, no. 13, pp. 2293–2302, 2006.

[4] U. K. Mirza, N. Ahmad, K. Harijan, and T. Majeed, "Identifying and addressing barriers to renewable energy development in Pakistan," Renew. Sustain. Energy Rev., vol. 13, no. 4, pp. 927–931, 2009.

[5] K. Harijan, M. A. Uqaili, and M. Memon, "Renewable energy for managing energy crisis in Pakistan," Commun. Comput. Inf. Sci., vol. 20 CCIS, pp. 449–455, 2008.

[6] I. Dincer, "Renewable energy and sustainable development: a crucial review," Renew. Sustain. Energy Rev., vol. 4, p. 157±175, 2000.

[7] F. U. Qureshi and B. Akıntug, "Hydropower Potential in Pakistan," IEEE 11th Int. Congr. Adv. Civ. Eng., no. November, pp. 1–6, 2014.

[8] D. Moore, J. Dore, and D. Gyawali, "The World Commission on Dams + 10: Revisiting the large dam controversy," Water Altern., vol. 3, no. 2, pp. 3–13, 2010.

[9] M. Umar and A. Hussain, "Micro hydro power: A source of sustainable energy in rural communities: Economic and environmental perspectives," Pak. Dev. Rev., vol. 54, no. 4, pp. 487–504, 2015.

[10] A. and Z. A. Gillani, "Fulfilling Environment Related International Commitments Through Implementation of (Meas) in Pakistan," vol. 18, no. 1, 2012.

[11] M. S. Rahman, I. M. Nabil, and M. M. Alam, "Global analysis of a renewable micro hydro power generation plant," AIP Conf. Proc., vol. 1919, no. December, 2017.

[12] A. Mahmood, N. Javaid, A. Zafar, R. Ali Riaz, S. Ahmed, and S. Razzaq, "Pakistan's overall energy potential assessment, comparison of LNG, TAPI and IPI gas projects," Renew. Sustain. Energy Rev., vol. 31, pp. 182–193, 2014.

How to cite this article:

Junaid ur Rehman , Haseen Ullah, Asfandyar Khalid, Zeeshan Ahmad "Socio-Economic Assessment of Mega Hydro Project and Wind Energy Project", International Journal of Engineering Works, Vol. 9, Issue 03, PP. 51-56, March 2022, https://doi.org/10.34259/ijew.22.9035156.