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Impact of Affordable and Clean Energy (SDG 7) on Signifcant SDGs

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***Abstract*—** Energy is considered to be a vital part of the progress and prosperity of a nation. However, there are some parts of the world like South Africa, Nepal, Pakistan, India and other developing countries where some parts of people have do not access to electricity. Some of the people in the world even in Pakistan do not live a quality life and living theirs below the poverty line. There are people who do have access to electricity and quality education. They live their lives unhygienically and women are the victims of gender inequality. For this purpose, the United Nation gathers around and reached on common goals which are also called universal goals for the people and for the benefit of the planet, which are named as Sustainable Development Goals. These goals are agenda for 2030 that we together are going to achieve till 2030. One of the goals is Access to Energy of Sustainable Development Goals. SDG 7 stands for affordable and clean energy. Pakistan has remote areas, far away from the national grid, where there is no access to electricity. For this purpose, the government is electrifying those areas by using their indigenous resources. One of the best options is Micro and Mini Hydropower projects for the community. By providing the electricity we can improve their quality of life and they can play their part in a nation's economy. As these micro and mini-hydro projects are cheaper and friendly to the environment so they are the source of "Affordable and Clean Energy".
The study focused, on establishing pathways for SDG7 i.e. Affordable and Clean Energy and how this SDG7 affect other Significant SDGs in the area of Chitral. Thirteen sites of Chitral were visited and people were interviewed and investigate their lifestyle. So this study shows that this source of Affordable and Clean Energy is moving us towards achieving other Sustainable Goals. These goals can be achieved more effectively if the government organizations play their role to educate the people to make the most use of it.

***Keywords*—** Affordable and Clean Energy, Sustainable Development Goals.

I. INTRODUCTION

Energy is the engine to accelerate towards the prosperity and economy development of a country. Peoples have been living without electricity in the past, but the rate of economic development and industrialization is increased in the last couple of centuries due to an inventing of electricity. It is so true that the prosperity and progress of any country or a nation is calculated by how much per person energy is consumed [1]. For this purpose, the energy demand is increased and dependency on fossil fuel is increased in both developing and developed countries [2]. As energy is a fundament element of progress so its demand is going to be increased in the future. It is said that global energy demand to be increased from 14.5 x 10^7 GW in 2007 to 21.8 x 10^7 GW in 2035 [3] which is an increase of 49% of the total. There is a lack of electricity in developing countries in rural areas which exaggerates poverty in those areas due to the non-availability of electricity. International Energy Agency claims that about 1.3x 10^9 humanity still lives without electricity which is about 18% o of the total population [4]. Pakistan has been facing severe energy crises for couple of decades and the issue is still unresolved despite advancements in technologies[5]. Due to shortages of energy Pakistan is lacking behind in the race of progress. The actual demand for electricity varies from 16-19 Gigawatt [6]. We have sufficient installed capacity but due to losses and poor infrastructure, generation of power is too low. It's all because of poor planning and ill management. Due to advancement and rapid progress of human development the demand for power is increasing day by day and it's growing at a rate of 8% annually [7].

The world is moving towards renewable and sustainable options to generate power. Pakistan needs enough and surplus power to generate energy to accelerate its economy. As already stated that prosperity and progress of the country are calculated by per-person energy consumption in that country [8]. By looking the Figure 1, Pakistan's per capita energy consumption is very low in developing south Asian countries. Malaysia being the highest per capita consumption in South Asian developing countries. Pakistan's energy mix consists of 27% of indigenous natural gas, oil being highest of 36%, hydel instead of having

higher potential 32% and rest of 5% generated from other resources like nuclear and renewable energy [9]. Hydrocarbon imports are a huge burden on the economy of the nation as we are about diminished domestic gas reserves in the near future. Domestic gas is a big contributor to the energy mix of Pakistan [10]. Pakistan has rural areas where there are no transmission lines. They are far away from the national grid. Some of the rural areas have national grid accessibility but due to lower production of energy despite being higher capacity, there are power outages in those areas about 12-18 hours [11].

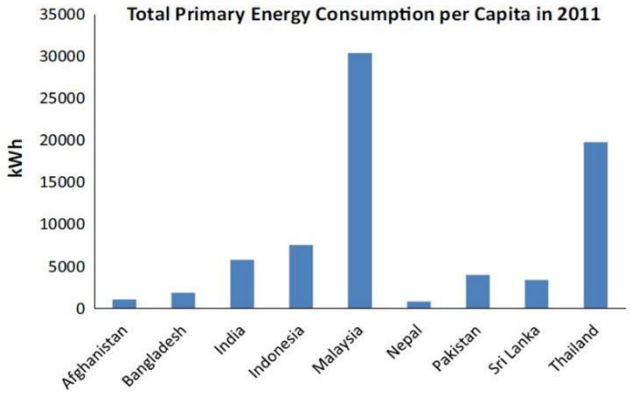

Figure 1. Comparison of different Asian countries in terms of per capita energy consumption in 2011 [9]

29.5% of the population of Pakistan lives below the national poverty line in 2013 [12]. We need affordable and clean energy in order to fulfill the basic needs of life. There are remote areas in Pakistan that have no access to the national power grid, small scale distributed energy system is the best option to give them energy. The Government of KP is installing mini micro hydropower with the help of the Asian Development Bank. These MHPs will provide affordable and clean energy which is fulfilling the SDG 7. But the question arises how this affordable and clean energy will impact on community, health and quality education. Among the most alarming of the severe impacts, is the emission of greenhouse gases methane and nitrous oxide of hydropower projects which greater global warming potential. According to one estimate, these gases have 25 and 300 greater global warming potential as compared to carbon dioxide respectively [13]. So these impacts must be analyzed that how much these projects are contributing their role to achieve Sustainable Development Goals.

It is a necessity of the day of a secure supply of resources of energy but they are not sufficient enough for advancement within society. Moreover, a development that should be sustainable requires a sustainable and consistent supply of energy resources which, in other words, should be easily available at a reasonable price at a consistent rate and can be exploited for fulfillment of daily needs which have no negative impacts on the society. The country has huge hydropower potential which should be utilized for the fulfillment of daily needs especially the northern part of Khyber Pakhtunkhwa. Those northern parts have remote areas have no direct access to the national grid or transmission lines. The country has a potential of more than 1200 MW of micro/mini hydropower which includes both mountainous regions of northern and plane areas of southern part from canal falls too [14]. So far, only 5% is being developed out of this potential [15]. Northern areas have estimated potential of more 300 MW and 400 MW through micro-hydel power plants with capacities 100 and 500 kW respectively [15]. So far, only 5% is being developed out of this potential [16]. These hydropower plants are playing their roles in achieving SDGs.

A. Sustainable Development Goals

Sustainable Development Goals called as global goals is the 2030 agenda for sustainable development of the world having different goals and targets. There are seventeen different goals in which were accepted by the world leaders in UN Summit in 2015 [17]. It ensures to eliminate all form of poverty and bringing prosperity to all and protect the environment [18]. It is a global call for action by each and every country, poor, rich to protect the planet and promote prosperity [19]. These seventeen goals addresses eradicating poverty should go on all over the globe in such a strategic way which build economic growth also solve a number of social needs like education for all, discriminating gender equality, hunger reduction, and different opportunities of earning while protecting the environment keeping in mind the climate change action [20].

Figure 2. Sustainable Development Goals [21]

Major contribution in the energy mix of Pakistan is the conventional source which is expensive [22]. Pakistan also import LNG fossil fuels to meet the requirement by producing electricity [23]. Electricity produced from conventional fuels are very expensive and not sustainable [24]. Per unit cost of the electricity generated from conventional are Rs.12/KWh and the rate of power produced from MHPs are very low [25]. Even some of the communities in Pakistan where MHPs are installed on community based give just Rs 200/monthly which is very cheap [26]. So Micro Hydro is a source of Affordable energy which compliant one part of Goal 7 of Sustainable Development Goals. The other part that energy should also be cleaned [27]. We have comparison of different technologies in Figure 3 which shows that hydro power is one of the clean energy and it does not contribute too much to carbon emission

as compare to other technologies. So in this study Micro Hydro power plants is the main role actor as it is affordable and clean energy and how it affect other SDGs.

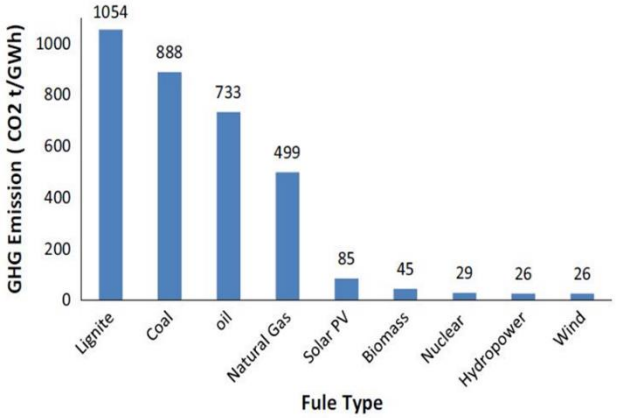

Figure 3. CO_2 emission by different technologies [9]

II. LINKING SDG 7 WITH OTHER SDGS

A. Energy Demand and Poverty Alleviation

Affordable and clean energy plays a vital role in poverty eradication. 1.3 billion people in the world have don not have access to electricity [28]. We have about 29.5% of the population which lives below the national poverty line in 2013 [29]. We need affordable and clean energy in order to fulfill the basic needs of life. Remote areas of Pakistan where there is no access to the national power grid, small scale distributed energy system is the best option to give them energy. Affordable and clean energy play a role in reducing poverty studied in Africa [49]. From the production of agricultural crops to the food we are getting in our kitchen, energy is required in every stage. The food system includes Agricultural production, Transportation, food processing and food handling. In this process, energy is a fundamental requirement. If the industries and households have access to affordable energy then everybody will be able to get food as it will be available at affordable rates and it will lead to progress towards SDG2 which is food security. There is a direct relation of energy and hunger [30] playing their part in eradicating it in South Africa. Energy supply has a direct impact on community health and wellbeing. Energy supply can reduce air pollution. As in many rural areas people use wood and conventional fuels for cooking and heating purposes which has a direct impact on the environment and mostly women, girls and children are affected by this pollution. 6 out of 10 affected deaths are found in women and girls [31]. Comfortable learning requires a comfortable atmosphere which requires well-lighted space, cooled and well-heated classrooms. These comfortable spaces can be achieved by energy. If there is no electricity in schools then classrooms or learning space will not be well lit which affect the education of students. Moreover, it is the era of science and students to be taught modern science and computer which requires power to be turned on. For example, the Government of Khyber Pakhtunkhwa education department has initiated a program for educating newly inducted teachers for their training by providing tablets [32, 33]. But these tablets require energy, if there is no electricity in remote areas then the teaching methodology of the teachers can be affected which will influence the quality education of the community. Thermal power plants produce pollution and affect the environment whereas hydropower plants produce clean and reliable energy. It is not only the cleanest but versatile energy too. It also provide side benefits other than clean energy. It is believed that small hydropower plants are cleaner and environmentally friendly than Mega hydro. It has no adverse impact on the environment but it has some negative impacts but these negative impacts are minimum .

B. Sustainable and Viable Energy Sources

Lack of access to moderate power and substantial dependence on the wasteful and unsustainable utilization of conventional biomass energizes (i.e., fuel wood, charcoal, agriculture waste and animal dung) are the two appearances and reasons for neediness. Power and other present day energy sources assume a basic part in economic and social improvement. Only they can't mitigate destitution however they are key to supportable improvement [17]. Present day energy administrations upgrade the life of the poor in incalculable ways. Electric light broadens the day, giving additional hours to perusing and work. Present day cook-stoves spare ladies and kids from every day introduction to poisonous cooking vapor. Refrigeration broadens nourishment freshness and dodges wastage. Centers with power can disinfect instruments and securely store prescriptions through refrigeration. Assembling and administration ventures with current energy can be more profitable and can expand the quality and scope of their items along these lines making employments and higher wages [9],. In numerous nations, neediness is drawn out especially by the unsustainable accumulation of biomass and its utilization in customary, wasteful stoves [18].This makes indoor smoke contamination prompting genuine wellbeing harm, for example, respiratory illnesses, obstetrical issues, visual impairment and coronary illness. It requires extensive sums of time for fuel gathering diminishing the time accessible for other profitable exercises, for example, cultivating and training . It causes biological harm (e.g. deforestation and soil disintegration) and nearby shortage of wood in a few regions. What's more, it draws horticultural deposits also, manure far from their utilization as compost, in this way decreasing agrarian profitability [18]. It is assessed that to accomplish the Millennium Development goals (MDGs), the quantity of individuals lacking power would require to decline to beneath 1 billion and those depending on customary biomass would need to tumble to 1:2 billion by 2015. Deliberate government activity with help from the industrialized nations is expected to accomplish these objectives, together with expanded subsidizing from both open and private sources [17]. Then again, arrangements need to deliver obstructions to access, reasonableness and supply of power and elective energizes, which are as of now accessible at sensible cost, e.g. gas-let go stoves and barrels. Access to practical energy sources should shape a focal part of more extensive advancement methodologies [19], [20], [21].

III. PAKISTAN POLICIES AND CONTRIBUTION TO RENEWABLE ENERGY

A. Transformation of economic instruements

Pakistan gave the first-ever hydel power policy in 1995 to encourage private sector contribution in meeting the energy demands by giving them a choice of site selection, giving them incentives, security packages, and fiscal incentives, etc.[34]. As global fossil fuel prices continued to increase, Pakistan gave Renewable Energy Policy 2006 to encourage development in small hydro, solar and wind technologies to overcome facing significant energy crises [35]. An organization was made (AEDB) by the Federal government in 2003 to facilitate the progression of renewable energy in the country. The objective of this organization was facilitation, promotion, and encouragement of alternate energy technologies to produce power and contribute to the overcoming of energy shortfall. Alternative Energy Development Board set up different renewable energy projects in several areas of Pakistan keeping in view the increasing demand for energy and shortfall and progress in solar energy technologies by utilizing environment-friendly energy. To alleviate the crisis of energy in the country, AEDB executed several projects. The organization has current projects of Solar Photovoltaic technologies having a capacity of 556.8 MW while there are other about twenty-eight projects which are in the development phase having installed capacity 956.8 MW [36]. Pakistan is also focusing on wind energy to make the best use of it where there are existing projects which are installed at Gharo, Jhimper area having a capacity of installation of 308.2 MW. There are other projects in these areas which are still in the development phase of 447 MW for the local area. As Khyber Pakhtunkhwa is enriched with hydropower sources, Different organizations like NGOs, a supporting program for local areas named as Sarhad Rural Support Program (SRSP), have installed about 189 MHPs (Micro-hydro projects) in the northern part of Khyber Pakhtunkhwa province electrifying different villages in which 365000 people are making benefits of these projects [37]. The province of Khyber Pakhtunkhwa has a huge potential of hydropower by which energy can be generated to overcome the energy crises in the country and meet the energy demands. For this purpose, a provincial organization named PEDO (Pakhtunkhwa Energy Development Organization) is working hard to implement mini and micro hydropower projects in the province. The organization has the vision of developing a thousand projects to promote the development of hydel potential on small rivers and canals. 356 micro-hydro plants have been initiated in the first phase in which about than 200 projects are already completed while rest of them are under development and some are still in planning phase. The purpose was to electrify the remote areas of KPK. About 2,500,000 will take the benefit of these projects. Rural areas have the main source of using energy of Biomass in which 62% are living in rural areas that use Biomass energy. There are 24% of population living in rural areas that are using or buying wood [38].

B. Potential for MMHPs in Pakistan

Our country has a huge potential for hydropower. Pakistan is an irrigation-based country with having a lot of water resources, but these resources need to be addressed to make use of it in a positive and optimum way. The country has a huge energy crisis that needs to be addressed by using the resources available in the country. Hydropower is a clean and environmentally friendly energy. The country has remote areas which are not accessible and there no electricity available. To build a transmission especially for those remote areas is not an economical way to handle the situation. The best option is to use the indigenous resources over there. One best option is the installation of mini micro-hydro projects in those areas where the community can have electricity and they are not burdened on the national grid. As the country has large hydropower systems but besides that, there are positive prospects of development of micro/mini/small hydropower. Micro/Mini/Small hydropower is one of the productive ways of generating electric power. These schemes of mini and micro hydropower can be utilized to electrify them in an economical way.

Table 1. MMHPs Potential in Pakistan [39]

No	Zone	Potential Sites	Total Potential (MW)	Range of Potential (MW)
1	AJK	40 sites	280	0.2-40
2	Gilgit Baltistan	200 sites	1300	0.1-38
3	Punjab	300 sites	560	0.2-40
4	KPK	125 sites	750	0.2-32

IV. METHODOLOGY

A. Introduction

Pathways were established keeping in mind the previous patterns that were followed in the rest of the world. The Pathways established of SDG 7 (Affordable and Clean energy) which impact other Sustainable Development Goals, addressed the research questions and the whole list of intersection of Sustainable Development Goals with electricity provided by these schemes of mini and micro hydropower. In order to collect the information and getting the knowledge of those pathways surveys and visits were conducted in the Chitral area. Chitral was so selected as it is located in remote areas of the northern part of Pakistan has a lot of villages far away from the city. Pathways were so established that covers data and information both qualitatively and quantitatively. Those pathways were established from the site visits and surveys and previous trends carrying on in the world. Surveys and visits comprise interviews, questioners, and observation of those communities. Operators of plants, heads of the community,

owner of the plants, technical experts and expertise were interviewed in the field visits.

B. Research Methodoogy Framework

Different techniques having various steps were followed in order to carry out the study. Different villages from a different source of MHPs were selected so as to study the impact of community-owned projects, NGOs owned and Government running projects.

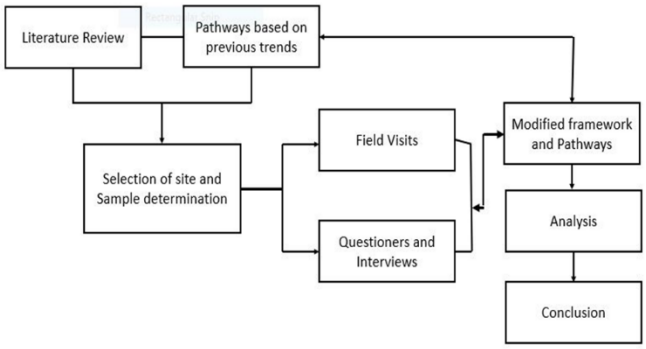

Figure 4. Research Methodology

C. Established Pathways

Pathways were established which identify the impact of Affordable and Clean energy considering the aspects of environment, good health and well being and community and other significant SDGs as mentioned below,

- Impact on deforestation of MHPs by replacing conventional fuel
- Impact on flooding in those areas
- Noise pollution due to operation
- CO2 emission due to the construction of dams (transportation used by carrying construction materials like cement etc.).
- Impact on agriculture either it may be positive or negative due to flooding or decrease in flooding caused by MHPs
- Impact on archaeological and conservation sites
- Impact of fish species as the alteration of water flow, such as broadening of stream bed and reduction of current may lead to indigenous fish species being reduced or replaced
- Impact on water pollution because wastes from running the plant during pipe cleaning
- Reduction in greenhouse gas emission
- Reduction in labor work regarding cutting wood
- Impact on quality of air in the house if conventional fuel is replaced by electric heaters
- Impact on the number of health units and their quality
- Impact on cooking either it's clean or not. (if clean cooking fuel is provided)
- Impact on births attendant by skilled personnel
- Impact of MHPs on recreational activities and sports
- Impact on life standard in terms of energy usage
- Safety precautions
- Impact on number of schools
- Impact on the standard of education if schools are electrified
- Impact on number of women education
- Impact on social interaction
- Impact on gender equality in terms of education
- Impact on opportunities of jobs
- Impact on Working Hours

D. Research Design

This analysis is established in a descriptive investigation scheme. The research is focusing on the socio-economic aspect of micro-hydro projects in remote areas. This research shows how benefit takes benefit from the project and use energy for economic activities. The study is focusing on the social and environmental impacts of distributed energy before and after the installation of micro hydropower projects. Energy is not only part of our society but nowadays it is considered as a multitrillion-dollar business hub.

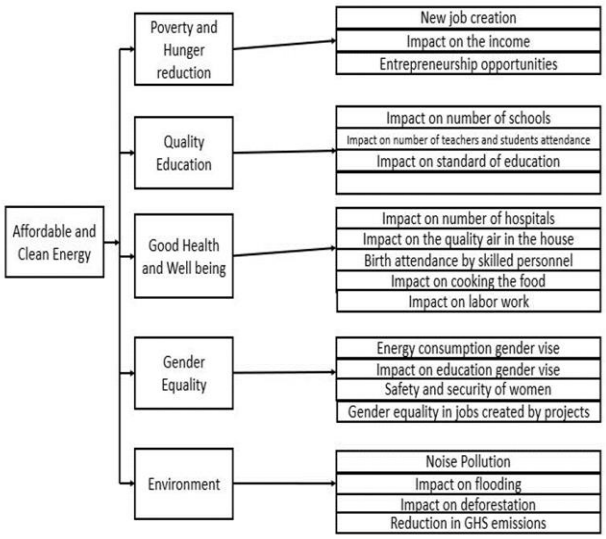

Figure 5. Established Pathways

In rural areas, there is no productive use of energy mostly people use electrical energy for lighting and cooking purpose. The projects installed by the PEDO and SRSP are less effective and has no sustainability. The community involvement is the basic issue and also the financial and social structure is not defined. Linking the community involvement (affordable and clean energy) with the social and economic analysis (SDGs 1, 2, 3, 5, 8, and 9) is the basic framework and the baseline for the social value of energy services. By bringing full time solar energy and environmentally friendly storage to villages the project offers affordable and clean energy (SDGs 7 and 13). Using local renewable energy sources keeps money in the community that would otherwise be spent on the purchase of power and fuels elsewhere. Harvesting local energy will reduce poverty in the community (SDG 1). The revenues generated and the availability of power will allow for economic growth and work in appropriate, well-lit and heated or cooled, depending on the season, circumstances (SDG 8) while training young

people to help multiply the concept. Being able to work in decent circumstances will help maintain health and well-being, while the electrification of the local health centers for people as well as animals will help to improve general health in the community (SDG 3). Electrification of the local schools will allow for quality education, while the training programs necessary to build, operate and maintain new microgrids increase education leading to good jobs (SDG 4). Better chances for education improve the chances of girls and women to participate in social life and employment (SDG 5). Decreasing the dependency of power and fuels imported to the community reduces the risk of conflicts and increases the chances of peace (SDG 16). The availability of power will likely reduce the risk of food perishing, reducing the risk of hunger (SDG 2). The introduction of solar based microgrids combines with storage provides the necessary energy infrastructure for rural communities to thrive (SDG 9). Thriving create space for support to the marginalized and disadvantaged (SDG 10). The availability of power might create an opening for two-, three- or more wheeled electric mobility, allowing the community to leapfrog the use of combustion engine vehicles (SDG 11) and the noise, heat and exhaust fume pollution related to them (SDG 15).

V. EXPLANTORY ANALYSIS

Some of the sites have improved marginally because there was grid connectivity over there but most of the sites where there was no electricity before, a lot of improvement was shown. At the start when these villages were given electricity, there was a positive change in the life and lifestyle of villages in terms of using it for lighting, entertainment purposes like radio, television and some opportunities for livelihood. Later on, tourism-based activities like hoteling, tea stalls, pressing clothes for tourists and restaurants received a boost.

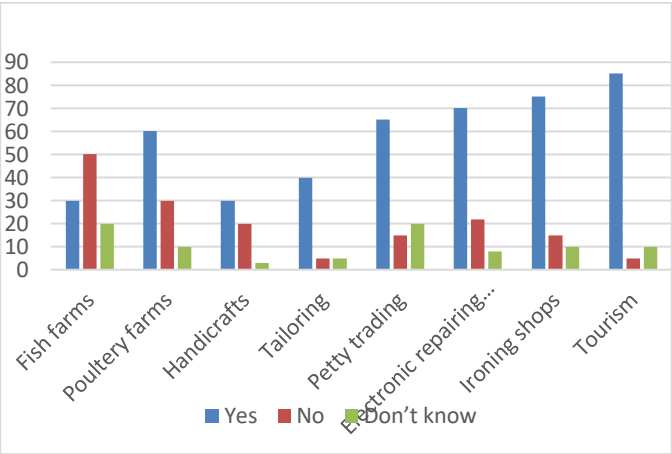

Figure 6. Results of Questioners about impact on business activities at Chitral

Some of the areas where there were no micro-hydro projects and connections were from the grid but there were power outages and lower voltages for few hours, they were improved a lot in terms of those activities after the installations of micro-hydro projects. The respondents were asked about the impact of the MHPPs in terms of social, income and other benefits.

A. *Financial Capital*

The main purpose of the micro-hydro scheme is the electrification of those communities and boosts their economic activities. During the study, surveys were carried out and respondent were asked about the impact on new job creation in the area. Some of the areas where there were no micro-hydro projects and connections were from the grid but there were power outages and lower voltages for few hours, they were improved a lot in terms of those activities after the installations of micro-hydro projects. The respondents were asked about the impact of the MHPPs in terms of social, income and other benefits like ironing shops, petty trading, handicrafts, poultry farms and fish farms. It has been witnessed that those projects have positive impacts on the activities which are home-based generating income operated on electricity as the spinning of wool and machines churning milk. Although these practices are followed from the past the availability of electricity has increased its productivity, efficiency and time-saving. These remote areas are also blessed with landscaping views and are famous for tourist attractions like Chitral etc. Tourist's activities have been increased after the availability of electricity as people are coming by enjoying those facilities of hoteling, restaurants and charging their cameras and phones. The other main financial benefit of those hydropower projects is the employment created over the community. Those plants need technical personnel to run the plant. So community hires diploma holders which is employment opportunity created by the scheme.

B. *Natural Capital*

It has been seen from the history that building a dam or hydropower affects the access to natural resources in several ways by stakeholders. The main advantage goes to the sponsor of the project or the owner of the project and the rest of the community is affected by them in a negative way. Even some of the populations are forced to migrate too. But here comes the story of Chitral MHPs where communities are not migrated because these are on small scale. Although some of the households lost their access to clean drinking from those rivers due to wastages stored at the powerhouse. But they manage to take water at another nearest point which is not a big issue. In those remote areas, water is used mainly for domestic use, irrigation, milling and fish farms. Building a small micro hydropower plants can impact the financial capital of those communities by interrupting the water flow direction.

C. *Social Capital*

One of the successful micro-hydropower projects is the ownership of the project by the community. There are different case studies that were run by some government organizations and some were developed by the locals. Some were installed by the Non-Government Organizations. But when people over there were that who owns the project. Their answer was that we own the project and on the other government organization or NGOs claims it. The social life of the people is changed to

MHPs. People can interact with each other due to the availability of communication networks over there. People can go out at night due to lighting and can chant with each other and solve their concerns.

In this analysis, the percentage of households in government service or labor is greater or less equal. Actually, the MHP homes are situated relatively in the far-flung and mountainous area; as a result of the people over, there are not reachable to the commercial and colonial work. On the other hand, the grid-connected households are reasonably thriving in terms of productive use of energy like job opportunities, business, and overseas employment. If we talk about the ownership arrangement with respect to agriculture lands here both micro-hydro users and grid-connected households are changed. Households connected to the MHP are agriculture than grid-connected households.

D. Physical Capital

The supply of electricity has the potential to increase the physical potential of households as electrical appliances are more used by the locals. The people over the remote areas cut the wood for food cooking and heating purposes. It is a very hard task to climb up the mountains and collect the woods and bring it back home by carrying a heavy load. The availability of electricity has decreased their burden of carrying heavy woods by using electric heaters. However, most of them still use wood and animal manure for cooking and heating purposes as power voltages in some areas do not allow for an electric heater.

E. Human Capital

Human capital is positively influenced by increased use of electronic media like radio, recorders, televisions and mobile phones due to continuous and stable electric supply. In those areas, students were interviewed about their studies. Students now study even in the night due to the availability of light and complete their homework on time. It has also impact on the attendance of the students as teachers now come to schools and charge their phones and tablets at electrified schools. WAPDA and other organizations give scholarships to sons of the employers and brilliant students in the area. The Figure 7 shows the impacts on education after the implementation of projects.

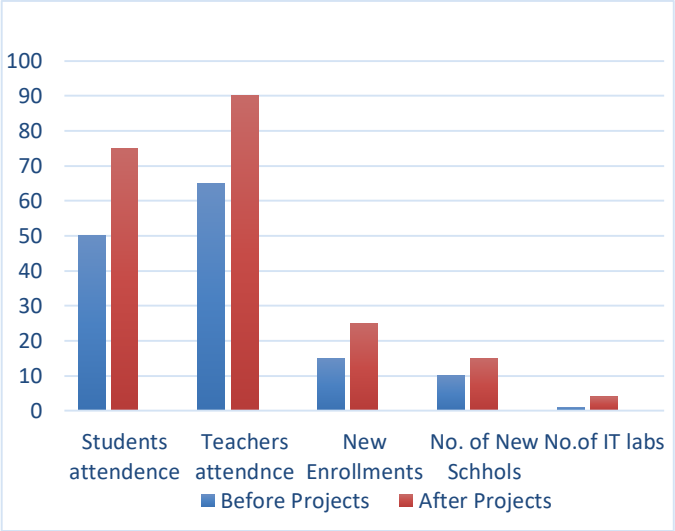

Figure 7. Impact of education

F. Gender Equality

Consistent supply of electricity in remote areas has a direct impact on gender equity especially the workload of women is affected and the impact on women's roles in the families. The correspondents were asked about the workload of the women. We came to know that most women collect fuel wood but the availability of electricity has decreased their workload. Women also participate in the financial support of the family by doing work of wool spinning and milk churning even at the night due to lights.

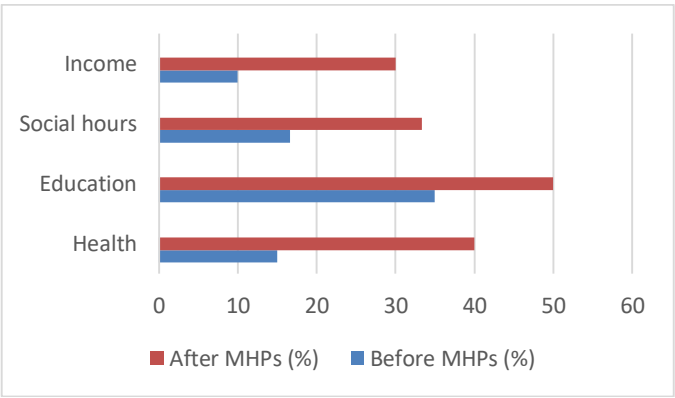

Figure 8. Impact on Gender Equality

Women feel safe during the night and lighting provides security and confidence to do work at night. Girl's participation in school and education has also been witnessed. The Figure 4.5 shows the participation of women in the income of the household, the impact on their social hours in percentage was increased from 4 to 8 hours. They can now finish their work on time and have much time for social activities. The availability of electricity also increased the enrollment of girls in schools after the installation of MHPs.

G. Case Study

In Singhor, 1 MW plant is installed by WAPDA which is a government body. Singhor, the village lies in the outskirts of the main Chitral city. An MHP with a capacity of 1 MW was installed in 1975 by WAPDA. The total cost incurred on this project was 350 million Rupees. The MHP has a total of four turbines installed. All the turbines are manufactured in Germany. The type of turbines installed are Francis and Crossflow turbines. The first two turbines having the generation capacity of 200 KW were installed in 1975, later on, the other two turbines having a generating capacity of 300 KW. The manufacturers of generators are Siemens and PEL. It has 4 step-up transformers. The two transformers have a capacity of 275 KVA & 375 KVA respectively. The electricity is distributed through 28 step down transformers. The overall head of the plant is 112 ft. It has two penstocks with diameter 33 and 45 inches respectively. The total length of the channel is 1250 ft. The forebay tank has a dimension of 25 x 15. It has mechanical governors to maintain the stability of turbine and generators speeds. The power plant has two outgoing feeders electrifying 10 villages of Chitral.

The total number of personnel carrying out operations and maintenance of the power plant are 46. Initially, the staff is trained at Mangla powerhouse. The salaries are paid by WAPDA. The amount paid in salary heads is 16 lac/month approx. The tariff rate of WAPDA is implemented for bill collection. There are no water flow issues though out the year. The plant is shut down for maintenance for 40-50 hours per month. No fluctuations issues are reported until now, however, in winters short-circuit issues occurred. Overloading has been reported during peak demand in summer and winter seasons. It generates about 3 lac kWh per month. The plant runs at a power factor of 0.8. The appliance being used by consumers are lights, fans, washing machines refrigerator. The plant also electrifies commercial shops including welding shops, carpenter shops, restaurants, mosques, and schools. The plant is standalone but can be synchronized with the grid as well. Cooking and heating is the expensive and main reason for overloading of plant. It can be solved through a gas connection to these villages. The civil structure is well maintained and was built according to the feasibility report. The operational personnel is happy because of the service structure implemented by the WAPDA. The plant to be upgraded to 5 MW generation capacity. The plan is already prepared and consultation is underway in this regard.

CONCLUSION

The impact of affordable and clean energy has proved that it plays a vital role in attaining all the seventeen goals of Sustainable Development Goals. Without accomplishing Goal 7 which is affordable and clean energy, other goals are impossible to achieve. Affordable and Clean energy becomes a hurdle in attaining other sustainable development goals and it becomes a key driver to achieve other sustainable development goals. By focusing on this goal other goals can be achieved easily. Sustainable Development Goals are in perfect form to be achieved but the only thing which comes to know after the study that it has not focused or touched the population of human being which is major lack of these goals. The human population is going so fast and so is the reason for miss management and resource distribution of huge populations. However, prosperity can be brought up by giving access to clean, reliable and affordable energy to all. The impacts of these projects like mini and micro-hydro projects for the remote areas can be increased if proper training is giving to the people about the operation and maintenance. The impact can be further enhanced positively if the community is given awareness about energy use. If the awareness about how to make productive use of energy is given and some training and local seminars and gatherings are arranged about the entrepreneurship opportunities by giving loans and grants then its impact will be further increased. Tourism based activities like hoteling, tea stalls, pressing clothes for tourists and restaurants received a boost. Some of the areas where there were no micro-hydro projects and connections were from the grid but there were power outages and lower voltages for few hours, they were improved a lot in terms of those activities after that when the project is hand over to the community and then installations of micro-hydro projects.

REFERENCES

[1] (December 18, 2018). U.S. energy information administration. International energy statistics. Available: www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=44&pid=44&aid=2.

[2] P. Carneiro and P. Ferreira, "The economic, environmental and strategic value of biomass," Renewable Energy, vol. 44, pp. 17-22, 2012.

[3] M. Hasanuzzaman, N. Rahim, M. Hosenuzzaman, R. Saidur, I. Mahbubul, and M. Rashid, "Energy savings in the combustion based process heating in industrial sector," Renewable and Sustainable Energy Reviews, vol. 16, pp. 4527-4536, 2012.

[4] R. Raza, S. Hayat, M. Ashraf Chaudhry, and J. Muhammad, "Development and study of PEMFC in Pakistan," in The 3rd international conference of materials for advanced technologies (ICMAT 2005), 2005.

[5] S. Z. Farooqui, "Prospects of renewables penetration in the energy mix of Pakistan," Renewable and Sustainable Energy Reviews, vol. 29, pp. 693-700, 2014.

[6] M. Arshad Khan and U. Ahmed, "Energy demand in Pakistan: a disaggregate analysis," 2009.

[7] A. Raheem, S. A. Abbasi, A. Memon, S. R. Samo, Y. Taufiq-Yap, M. K. Danquah, et al., "Renewable energy deployment to combat energy crisis in Pakistan," Energy, Sustainability and Society, vol. 6, pp. 1-13, 2016.

[8] F. M. Hossain, M. Hasanuzzaman, N. Rahim, and H. Ping, "Impact of renewable energy on rural electrification in Malaysia: a review," Clean Technologies and Environmental Policy, vol. 17, pp. 859-871, 2015.

[9] K. Harijan, M. A. Uqaili, and M. Memon, "Renewable energy for managing energy crisis in Pakistan," in International Multi Topic Conference, 2008, pp. 449-455.

[10] S. N. Malik and O. R. Sukhera, "Management of natural gas resources and search for alternative renewable energy resources: A case study of Pakistan," Renewable and Sustainable Energy Reviews, vol. 16, pp. 1282-1290, 2012.

[11] H. B. Khalil and S. J. H. Zaidi, "Energy crisis and potential of solar energy in Pakistan," Renewable and Sustainable Energy Reviews, vol. 31, pp. 194-201, 2014.

[12] M.-B. O. Yusuf, N. S. Shirazi, and G. MatGhani, "The impact of Pakistan poverty alleviation fund on poverty in Pakistan: An empirical analysis," Middle-East Journal of Scientific Research, vol. 13, pp. 1335-1344, 2013.

[13] I. C. Change, "The physical science basis," Contribution of Working Group I to the fourth assessment report of the Intergovernmental Panel on Climate Change, vol. 996, 2007.

[14] M. A. Sheikh, "Energy and renewable energy scenario of Pakistan," Renewable and Sustainable Energy Reviews, vol. 14, pp. 354-363, 2010.

[15] M. Umar and A. Hussain, "Micro hydro power: a source of sustainable energy in rural communities: economic and environmental perspectives," The Pakistan Development Review, pp. 487-504, 2015.

[16] (22 February, 2019). UN Sustainable Development Goals. Available: https://sustainabledevelopment.un.org/sdgs.

[17] D. Griggs, M. Stafford-Smith, O. Gaffney, J. Rockström, M. C. Öhman, P. Shyamsundar, et al., "Policy: Sustainable development goals for people and planet," Nature, vol. 495, p. 305, 2013.

[18] R. Costanza, L. Fioramonti, and I. Kubiszewski, "The UN Sustainable Development Goals and the dynamics of well-being," Frontiers in Ecology and the Environment, vol. 14, pp. 59-59, 2016.

[19] F. Biermann, N. Kanie, and R. E. Kim, "Global governance by goal-setting: the novel approach of the UN Sustainable Development Goals," Current Opinion in Environmental Sustainability, vol. 26, pp. 26-31, 2017.

[20] (06 Jan, 2019). Sustainable Development Goals. Available: https://sustainabledevelopment.un.org/?menu=1300

[21] A. W. Bhutto, A. A. Bazmi, and G. Zahedi, "Greener energy: Issues and challenges for Pakistan—Biomass energy prospective," Renewable and Sustainable Energy Reviews, vol. 15, pp. 3207-3219, 2011.

[22] G. D. Valasai, M. A. Uqaili, H. R. Memon, S. R. Samoo, N. H. Mirjat, and K. Harijan, "Overcoming electricity crisis in Pakistan: A review of sustainable electricity options," Renewable and Sustainable Energy Reviews, vol. 72, pp. 734-745, 2017.

[23] A. Mahmood, N. Javaid, A. Zafar, R. A. Riaz, S. Ahmed, and S. Razzaq, "Pakistan's overall energy potential assessment, comparison of LNG, TAPI and IPI gas projects," Renewable and sustainable energy reviews, vol. 31, pp. 182-193, 2014.

[24] M. K. Farooq and S. Kumar, "An assessment of renewable energy potential for electricity generation in Pakistan," Renewable and Sustainable Energy Reviews, vol. 20, pp. 240-254, 2013.

[25] U. K. Mirza, N. Ahmad, and T. Majeed, "An overview of biomass energy utilization in Pakistan," Renewable and Sustainable Energy Reviews, vol. 12, pp. 1988-1996, 2008.

[26] M. Acheampong, F. C. Ertem, B. Kappler, and P. Neubauer, "In pursuit of Sustainable Development Goal (SDG) number 7: Will biofuels be reliable?," Renewable and sustainable energy reviews, vol. 75, pp. 927-937, 2017.

[27] N. P. Bhattarai, Hydropower Development in Nepal: A study of Demand for Electricity and Financial Requirement up to 2030: Devi Kumari Bhattarai, 2005.

[28] C.-W. Shyu, "Ensuring access to electricity and minimum basic electricity needs as a goal for the post-MDG development agenda after 2015," Energy for Sustainable Development, vol. 19, pp. 29-38, 2014.

[29] O. P. Mathur, "Urban poverty in Asia," Asian Development Bank, Metro Manila, Philippines, pp. 1-122, 2013.

[30] A. M. Ansell, Zero hunger: political culture and antipoverty policy in Northeast Brazil: UNC Press Books, 2014.

[31] U. DESA, "The Sustainable Development Goals Report 2018," United Nations, 2018.

[32] N. Habib and I. Wazir, "Role of education and training in the successful implementation of business process reengineering: a case of public sector of Khyber PakhtunKhwa (KPK)," World Journal of Social Sciences, vol. 2, pp. 172-185, 2012.

[33] (25April, 2019). Elementary & Secondary Education Department Government of KhyberPakhtunkhwa. Available: http://www.kpese.gov.pk/.

[34] U. K. Mirza, N. Ahmad, T. Majeed, and K. Harijan, "Hydropower use in Pakistan: past, present and future," Renewable and Sustainable Energy Reviews, vol. 12, pp. 1641-1651, 2008.

[35] M. Amer and T. U. Daim, "Selection of renewable energy technologies for a developing county: a case of Pakistan," Energy for Sustainable Development, vol. 15, pp. 420-435, 2011.

[36] M. Kamran, "Current status and future success of renewable energy in Pakistan," Renewable and Sustainable Energy Reviews, vol. 82, pp. 609-617, 2018.

[37] M. H. Khan, "Participatory Rural Development in Pakistan: Experience of Rural Support Programmes," ed: SAGE Publications Sage India: New Delhi, India, 2013.

[38] I. Jan, "What makes people adopt improved cookstoves? Empirical evidence from rural northwest Pakistan," Renewable and sustainable energy reviews, vol. 16, pp. 3200-3205, 2012.

[39] A. Ghafoor, T. ur Rehman, A. Munir, M. Ahmad, and M. Iqbal, "Current status and overview of renewable energy potential in Pakistan for continuous energy sustainability," Renewable and Sustainable Energy Reviews, vol. 60, pp. 1332-1342, 2016.

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