

## Opportunities and Risk Factors in Public-Private Partnership on Energy: A Critical Analysis of Solar Photovoltaic Plant at Bahawalpur

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### Abstract

*This study delineates a 1000 Megawatt (MW) very large scale Photovoltaic (PV) system designed in three phases, from which 100 MW has functional and the remaining two phases of 300MW, 600 MW has yet to be functional at Quaid-e-Azam solar park (QSP) in Cholistan desert near Bahawalpur City of Pakistan. This study describes the opportunities and risks in the construction of solar PV plant (QSP), which is constructed through public-private partnership (3P). This study uses the case study as a part of research methodology. Firstly it explains about 3P's, their various types and necessity. Secondly, explores the critical factors in the construction of QSP PV Plant through PESTLE (political, economic, social, technological, legal, environmental) analysis. Thirdly outlines the effect of RE projects on the socioeconomic status of the periphery which is ignored in previous studies. The recommendations will guide the policymakers how they can embed social acceptance in RE projects.*

**Key Words:** Solar energy, Public-Private Partnerships, China Pakistan economic corridor, Quaid-e-Azam Solar Photovoltaic Park, Critical factors.

### Introduction

The “solar energy is a potentially clean renewable energy (RE) source. Solar power generation demand increases worldwide as countries strive to reach goals for emission reduction and renewable power generations. RE generally and Solar PV, in particular, can offer a societally constructive solution” (Breyer, 2017). A recent report on Global trends in RE investment 2017 by UN Environment, 2017 & Bloomberg New Energy Finance 2017; World Energy Council express that 75 solar GW were added first time rather than any other technology in 2016. The global trends in solar energy projects are very encouraging. Such as, in 2005, “global solar markets reached the US \$ 1.8 billion, up 55 percent than 2004. Solar installations provided 15 GW in 2010 versus 2.7 GW in 2006 (Sharma 2011). Worldwide total PV installations represented 1.8 GW in 2000 and 71.1 GW in 2011 with a growth rate of 44 percent. Global cumulative PV installations reached about 106 GW” (EPIA, 2013). “Mainly Japan, Germany, UK, China, Spain, and Italy have produced electricity with PV based power” (Celik 2006). In 2012, “European capacity for PV electricity was 17.2 GW, and it was 22.4 GW in 2011. It is expected 48 GW by 2017” (European Photovoltaic Industry Association, 2013). “With 37.007 GW of solar PV power installed in 2013, world solar PV power capacity increased about 35 percent to 136.697 GW. It is expected global PV installations to slow from over 20 percent annual growth in 2013 and 2014 to 16 percent next year, or 53 GW” (Ellabban, 2014). The “total global solar power capacity will grow from 98 GW in 2012 to 308 GW in

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2018” (Devabhaktuni, 2013). It is also notable that 197 countries worldwide have signed up to the Paris Agreement on Climate Change. It shows that the world has taken the initiative to opt RE sources by heart to the pursuit of clean energy for a better future of coming generation. The adoption of RE sources, such as fossil fuel to solar and wind energy is a key to achieve not only social and environmental but also economic development of the countries. The initiative of RE will change the life of 1.2 billion people around the globe who are struggling to get electricity. Further, it will open up new jobs and opportunities for new entrepreneurs. Moreover, it will clean the air which will save millions of lives each year.

The global trends in RE investment throughout the world show that it has the very potential to change the socio-economic and environmental lives of the people. The investment report also shows that private investors are also getting their confidence in RE projects. The global trend report demonstrates that the investment trend in RE projects continued in 2016 and the RE capacity over-seeded the fossil fuel generation in a continuation of the fifth year in a row. Among 138 GW of the new energy capacity, almost 111 GW has come to the system during the last twelve months excluding large hydro generation. Moreover, the cost of achieving the said energy capacity is 23 percent less than the cost in 2015. It is due to the falling cost of clean energy technology. Such as the average cost of solar photovoltaics and wind is dropped by 10 percent dollar capital expenditure per MW. The investor got more bang for their buck. The UN environment executive director Erik Solheim said, “Ever-cheaper clean tech provides a real opportunity for investors to get more for less. The investor hunger for existing wind and solar farms is a strong signal for the world to move to renewables” (UN Environment, 2017). A comparison of investment in various energy sources is shown in figure 1.

The “private participation in energy in emerging markets was US\$ 37.6 billion in 2015, 50 percent below the five-year average of US\$ 74.7 billion. The decline is largely due to both Brazil and India having the lowest investment in a decade; the Philippines hit an all-time high. In the year 2015, renewables made up almost two-thirds of investment in energy; solar energy investment was 72 percent higher than the five-year averages” (World Energy Council, 2016) shown in the table:

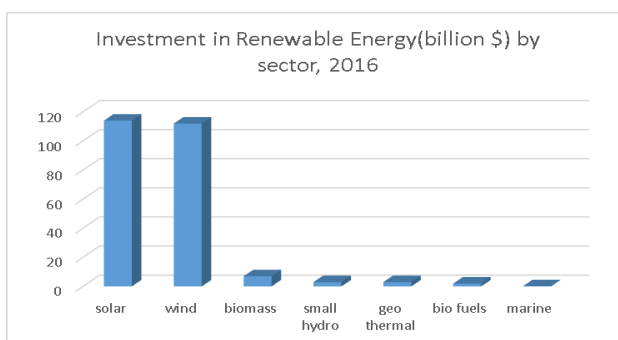


Figure 1: Global new investment in RE sector by the year 2016 (World Energy Council)

Table 1. Total investment in solar energy in 2015

Regions	Number of projects	Total investment (US \$ millions)	Percent of total	Percentage change from 5 years average
South Africa	8	2353	25%	+141%
Morocco	2	1800	19%	+515%
Chile	6	1293	14%	+26%
Regions	Number of projects	Total investment (US \$ millions)	Percent of total	Percentage change from 5 years average
China	18	1008	11%	-4%
India	17	841	9%	-25%
Other Countries	29	2096	22%	+46%
<b>Total</b>	<b>80</b>	<b>\$9389</b>	<b>100%</b>	<b>+72%</b>

So, “the high potential locations for solar power plants are United States of America Southwest, Mediterranean European countries, Middle East and Near East, Iran and India deserts, Pakistan, China and Australia” (Hosenuzzaman, 2015).

Despite “the huge potential of RE projects such as solar projects in developing countries to coping up its energy deficits, the budget constraints do not allow the public sector alone to close the gap between growing demand and projected supply (energy)” (Mohsen, 2015). Therefore, to get advantage of this promising technology otherwise would perish in a ‘valley of death’ between discovery and marketable viability because energy industry requires substantial capital venture beyond the research and growth part in order to market the novel technologies in detail discussed by (Hartley, 2017), it is the need of time to span this gap by developing new business models by attracting private sector participation in the RE projects in developing countries.

This study explores the insights of one of the largest RE project namely Quaid-e-Azam solar park(QSP) in the Cholistan desert near Bahawalpur city of Pakistan. The case study method is used to explore the risks and opportunities associated with this project. Further, this paper is conducted PESTLE analysis of the project with the help of available contents about the project. The paper finds the feasibility of different types of public-private partnerships that how it works for energy projects. Further, the study explores the critical risk factor associated with the construction of the largest solar power plant in Pakistan. Finally, the study explains how to measure the effect of the RE project on the innovation of the periphery?

### **Various Arrangement of PPP’s in Energy Infrastructure**

The “statements and definitions of PPPs between different countries and institutions are overwhelming and make it difficult to confine the concept of PPP in a unique manner. PPP depicts the opportunities associated with a variety of partnership arrangements and signifies how PPP will deliver real improvements to public services, for mutual benefits of both parties” (HM Treasury, 2017). The PPP “as a joint venture between the public and the private sectors depend on the expertise of each partner that best meets defined public needs through the adequate allocation of resources, risks, and rewards” (The Canadian Council for Public-Private Partnerships, 2016). The “term ‘public-private partnership’ describes a range of possible relationships among public and private entities in the context of infrastructure and other services. Other terms used for this type of activity include private sector participation and privatization” (Asian Development Bank, 2017). “PPP engages the financing, development, operation, and maintenance of infrastructure projects by the corporate sector which would otherwise have been provided by the public sector” (Economic Coordination Committee Government of Pakistan, 2016).

**Table 2.** Different types of PPP arrangements

<b>Name</b>	<b>Description</b>
BLT	Build Lease and Transfer
BLO	Build Lease and Operate
BOO	Build Operate and Own
BOR	Build Operate and Refurbish
BOOT	Build Operate, Own and Transfer
BOOTT	Build Operate, Own, Train and Transfer
BOT	Build Operate and Transfer
DBFO	Design Build Finance Operate
DBOM	Design Build Operate and Maintain
DBT	Design Build and Transfer
DOT	Design Lease and Transfer
ROO	Refurbish Operate
ROT	Refurbish Operate and Transfer

*Source: (Anwar, 2017)*

This study will contemplate the entire affirmations of the information regarding the evolution of public-private partnership as compared with Private Participation in Infrastructure (PPI). The contribution of the private sector into the PPP's began in the early 1990s. The pioneer countries which testified PPP's terminology in the initial stage were Argentina, Chile, Malaysia, and Mexico (Panayotou, 1998). Consequently, this theory had repercussions throughout the under-developed countries of the globe: Since the 1990s near about 137 under-developed states of the world has been executed PPP infrastructure projects theory in different sectors of their economy (Private Participation in Infrastructure Database, 2015). The governments persist the premier origin of the funding for the infrastructure development in the under-developed countries. The obligatory contribution of the government towards the project was 70 percent, the share allocation of the private sector was also played the dominant role which was 22 percent, furthermore rest of 8 percent shares furnished by the official development assistance. The current investments in infrastructure projects in underdeveloped countries by the governments are less than half of the essential. Though the slippage of financing into these type of projects, stimulate the government to adopt the strategy of public-private partnership for the construction of mega infrastructure (Rubino, 2015). This also endorsed by a recent study conducted in 2018 by Buso & Stenger that "use of PPPs as compared other public subsidies as policies whose purpose is increasing investments and determinations by private agents in terms of energy adaptation and energy efficiency projects. It illustrates the use of PPPs leads to greater outcomes/performances and lets governments to overcome incompleteness in agreements" (Buso, 2018). Brown in 2001 describes "PPPs in the energy sector as "government industry alliances" that comprise joint technology road mapping, collaborative implications for the growth of progressive energy-efficient and low-carbon equipment, and cost distribution" (Brown, 2001). Likewise, Burton in 2009 recommends "the usage of PPPs in climate change adaptation to achieve an effective and fair provision of risks and motivations among private and public players. In the energy division, most PPPs were established with the purpose of supporting energy-efficient tools for housing, schools, commercial and public constructions, vehicles" (Sperling, 2001).

## **Energy Sector in Pakistan**

This is unanimity true "in the understanding of the enormous deficiencies in infrastructure current needs and especially the energy sector in Pakistan. In Pakistan, energy demand has significantly increased in last 15 years. Supply has failed to match this growth; there is a huge energy supply-demand gap in Pakistan. It is one of the most populated nations in the south Asia region, contributing almost 2.56 percent of the total worldwide population" (Jaffe, 2005). "The country is anticipated to serve as a transnational trade and energy corridor due to its tactical location. The energy crisis affected the country's economic growth up to a significant level. The main institution of Pakistan is water and power development authority (WAPDA) managing the power sector. WAPDA has installed hydropower capacity of 20921 megawatts" (Siddiqui, 2004). Presently "four generation companies (GENCO) contributing 6481 MW and ten distribution companies (DISCO) are distributing the energy. However, independent power producers (IPPs) and Nuclear plants contributing 7,123 MW and 462 MW respectively energies in the national grid" (WAPDA, 2016).

"Pakistan has limited fossil fuels, and besides the price, import of expensive oil has many other issues such as environmental problems, carbon footprint and global warming. So, power generation should be moved to renewable energies. AEDB has estimated that Pakistan has almost 2900000 MW (2900GW) of solar power potential" (Farooqui, 2014). It has the potential of solar (PV & thermal) irradiation more than 5-6 KW h/m<sup>2</sup> /day. "Pakistan is not properly utilizing its vast indigenous energy sources due to the lack of effective project planning and implementation. The location of Pakistan is ideally situated in the highest solar isolation areas, and most of the populated urban areas and industrial estates receive high solar radiation throughout the year" (Hassan, 2017).

### Interpretation of PPP in terms of Resource-based view & Transaction cost theory

There has been significant research conducted on the potential of renewable energy technologies in Pakistan which seriously lacks in its implementation and currently, “it is a matter of governance and its institutional capacity to collaborate with private sector efficiently and gaining of effective results. In order to promote an effective and sustainable development of renewable energy, GOP should recognize its internal & external resources that how it can utilize them for optimum output” (Sahir, 2008). As “China is among the leaders of Solar technology countries and Chinese government has formulated a series of policies on renewable energy development, including laws, regulations, economic encouragement, research and development, industrial support and government renewable energy model projects” (Peidong, 2009). “It is concluded that such large-scale renewable energy development is possible if the Pakistani government develops strategies for integrating renewable in coherent energy systems influenced by energy savings and energy efficiency measures. Primary supply of energy is not sufficient to meet present demand of society” (Lund, 2007). This study also establishes a theoretical conceptual framework in which institutional environment can be developed by producing capacity of collaboration with private actors with cognizing their resources strengths and weakness and the ability to judge the transactions cost capacity which player can efficiently and effectively manage the require transactions.

Currently, the GOP is working on these renewable resources positively but lonely it does not have enough fiscal space to accommodate all priority projects. So many projects have been initiated with partnerships of Government of China through CPEC (China Pakistan economic corridor). Principally “economic corridor is being defined as, the culture of trade agreements and treaties, status, delegated legislation and customs that govern and guide trading relationships, institutions, and structures, or movement of products, services and information in a geographic vicinity among people in and across borders, according to a matrix” (Bernstein, 2008).

**Table 3.** Major Trade Corridors on Each Continent

Region	Corridor	Characteristic	Financing mechanism
Africa	Trans-Kalahari corridor	Economic development	Government, Private, world bank, Aid
South America/Latin America	Novadutra	Economic development, Trade integration	Government, private
Asia	North/South corridor	Trade integration, economic development	Public/Private partnership
Africa	North/South corridor	Trade integration	Public/private partnerships & Regional organizations initiatives
Asia	East/West corridor	Trade integration/economic development	Public/Private partnerships

Source: (Bernstein, 2008)

The central theme of all the corridors is to increase economic activities in the region and begin social development on massive scale benefitting all the segments of the society through public private partnership. Resultantly the whole society gets prosperous and peaceful. The people get involved in jobs, businesses. They enjoy new trends and themes. Thus the whole society thrives in peaceful co-existence.

Contemporary CPEC is developing as a megaproject connecting China’s northwestern area of Xinjiang with the Gwadar port of Pakistan through a network of railways, roads (2700kms) and conduits. The connectivity of CPEC with Central Asia, Africa, Middle East will shape entire area as well causes a confidence supporter for venture capitalist and fascinate investment from all other parts of the world including China. The overall building costs of CPEC are 46 billion USD which includes transportation, telecommunication, and energy infrastructure projects.

this study focuses only on one PV Solar project QSP of 1000MW among total 21 energy projects (Coal, Hydro, Wind) by CPEC have total estimated cost USD 33793 million (Corridor, 2016).

This study selected PV project as “it is one of the key technology selections for implementing the shift to a decarbonized energy supply and can be deployed in a modular way almost everywhere on the planet. Solar resources are abundant and cannot be monopolized by one country” (Corridor, 2016). Furthermore in Pakistan by comparing the cost-effectiveness and utility of different RE resources, which calculate solar is best among them.

**Table 4.** Cost-effectiveness and utility of different RE resources

	Price (USD)	Fuel (USD/h)	Maintenance Cost(USD/h)	Life(years)	CO2(£/t)	NO2(£/t)
Solar panel	632	0	0	25	0	0
1KVA Gas generator	1067.50	1.08	0.06	3-5	6.4	58
Wind turbine	1165.44	0	0.03	12-15	0	0

Source: (Khalil & Zaidi, 2014)

## Research Methodology

It is an exploratory study. The inquiry strategy of this study is based on interviews, case study, and content analysis. The focus of the study is to explore the critical risk factors associated with one of the largest solar power plant, i.e., Quaid-e-Azam solar park(QSP) in Cholistan desert near Bahawalpur city of Pakistan. The PESTLE (Political, Economic, Social, Technological, Legal and Environmental) analysis is conducted in the study to determine the opportunities and risks associated with the QSP. PESTLE framework is a “mnemonic used in strategic



**Figure 2:** Drone camera image of the Pakistan's first, and the world's largest, grid-connected solar power plant (100 MW), inaugurated on 5th May 2015.

management to group Macro environment factors to help strategic look for sources of general opportunity and risks” (Witcher, 2010). “The PESTLE framework analyzes the external business environment to understand the ‘big picture’ in which the organization operates thus enabling them to take advantage of the opportunities and minimize the threats faced by the organization’s business activities” (Chau, 2010). In this regard, “the PESTLE analysis is used in this research to allow the organizations to understand the big picture of adopting partnerships in the business environment and to realize the advantages, opportunities and to diminish the threats of this collaboration. The local community interviews further help us in understanding the Socio-economic impacts of RE projects in the under developing areas” (Witcher, 2010).

## PESTLE Analysts

From Pakistan's perspective, the PESTLE framework can be explained through a recent study by (Anwar, 2017) in which authors conducted the detailed survey from PPP experts about the sustainable execution of PPP projects in developing nation (Pakistan & Bangladesh). They found that most critical factors were the instability of the government which was due to the frequent intervention of military since its foundation.

Furthermore, political involvement is the key to successful implementation of the PPP projects, and it should be irrespective of a change of political government status mean there should be consistencies in policies. The PPP policy is still pending for approval at the parliament. Whereas the concern researched project is located at Punjab province of Pakistan which provincial assembly declared the Act IX of 2014 as "The Punjab Public-Private Partnership Act, 2014". Furthermore, the future of Solar energy in Pakistan is secure from political attitude as Pakistan's parliament is the world's first parliament which has completely powered by solar energy through the 80MW generation of electricity from which 62MW consumed by National assembly and 18MW contributed to the national grid.

The economic aspect is measured with cost-related matters (Witcher & Chau, 2010) . Here PPPs permitted government funds for other public primaries, so they will not essentially impact the economy without precise amalgam of elements . It is indicated that any nation holds larger number of PPP projects have higher growth rate of GDP. It can be demonstrated by an analysis that between 1990-2003 those countries having 70, PPP infrastructure projects or larger in numbers demonstrated 25 percent GDP growth rate.

It is due to the reason that such PPP projects have enormous activities which bring investment into the marketplace and create various employments. Furthermore, private investment of this nature will attract other private investors and promote economic growth with sustainability.

### **Value of PPP projects**

Higher value PPP projects inject more investments and commercial resources into the economy. As PPP's introduce additional monetary resources in the economy, therefore, government expenditures reduced. In response, public resources used before this for infrastructure development now can be channelized into a socioeconomic sector like schools hospitals, etc. Analyses determine that a 1 percent increase in PPP investment will increase gross domestic profit 0.3 percent per capita. It demonstrates that consistent investment in PPP's would enhance GDP level.

### **PPP Contract**

PPP contract various types as mentioned in below table 5, is the essential component which impacts the economic development. PPP contract nature depicts the intensity of the participation of the private sector.As the participation of private sector increases, it also increases the efficiency, technical skills, and resources.

**Table 5:** PPP impact on various indicators of economic growth

Catalyst of economic growth	Number of PPP projects	Value of PPP projects	Type of PPP projects
Affects economic growth	✓	✓	✓
Relative effect on economic growth			
Channel via which PPP aspects affects the economy	Increase the number of projects and increase jobs	A high flow of financial resources and investments with secondary effects on consumption, employment and well being	A higher level of private sector commitment regarding financial and technical resources
Comments	The number of PPP projects affects the availability of resources, the efficiency of services and creation of jobs.	The size of PPP projects has minor short-term effect on economic growth but will have a long-term accumulative effect	More private sector commitment via green field and concession projects implies great transfers of know-how and thus growth

The evidence of economic development can be illustrated by the World Bank first-quarter report 2017 in which Pakistan ranking is among the top five countries following Indonesia & Brazil concerning investment (Appendix A is attached).

### **Political**

The Government bears the political risk in solar PV projects. If the material of the project or some parts of the facilities is expropriated, then the government or contracting authorities are responsible for the loss. Also, if the facility gets nationalized, then it should be compensated by the contracting authority. In this case, the private parties issue a legal notice to the contracting authority to make remedy within a given period. However, in recent times, political risk is categorized into direct and indirect political risk events. The direct political events include the expropriation or nationalization of the material or facility. Whereas the indirect political risk events are wars, bombing or any event that occurred due to the involvement of the third party. Therefore, the contracting authorities apply different terms and conditions on the different type of political risk. Further, the change of laws is common in emerging market as compared to developed world. Therefore, the contracting authorities take all change in law risk under the power purchase agreement.

### **Economic**

Each PP project carries some financial and economic risks. The solar PV project also has some, such as exchange rate, interest rate, and inflation risk. In emerging markets, the devaluation of currency and interest rate fluctuation is a common phenomenon. The private parties make their arrangement to deal with these type of risks. The contracting authorities have no concern with all economic and financial risks associated with the project. Moreover, in emerging markets, the contracting authorities also not take the responsibility of insurance. Further, private parties must manage the insurance expense of the project. Law also requires it. However, in general, government agreements are silent on the remedy of insurance for a particular risk (Martins, 2011).

### **Social**

While Pakistan is emerging economically (GDP growth is 5.28 percent in 2016-2017 which is highest in 10 years according to ministry of finance), social expansion is not increasing at a similar swiftness resulting in segments of society that stay marginalized. Rapid growth has also instigated the social atmosphere to evolve and Pakistan, like numerous other nations are finding their dynamic social forces becoming gradually intricate. Regardless of various efforts all social problems cannot deal alone with the government by traditional methods, so PPP's are selected and if the selection is appropriate, they must have a corporate social responsibility aspect. Furthermore, this concept endorses that people accept RE, but with resistance to individual schemes on a more native level enduring common (West, 2010) especially with respects to "not in my backyard" condition" (Neumann, 2006). However, Wright in 2011 argues that the people get attached to the surroundings of where they live, don't like the "change". It may be more important as just a case of NIMBY. It is also interesting that most of the RE projects are located in remote areas. Further, the private investors also retain the responsibility of unavoidable social impacts which comes as a result of the development of the project. Its also reinforces the aim of the national policy for renewables energy development for power generation, provincial energy department of the government of Punjab (Energy department Government of the Punjab, 2016) and world bank group initiative to support for the sustainable energy for fall(SEFA), launched by United Nations Secretary-General Ban Ki-Moon in year 2011. It also demands from governments, businesses, and civil society to accomplish this objective by 2030.

With more deploying RE custom, the consumption of energy by per capita in Pakistan also increased (which was 484.44kg of oil equivalent in 2014). It equal rights to access to dean energy supply improved human development indicators, poverty reduction amongst deprived areas of the society as well also reduced load of using biomass fuel from rural women.



## **Technological**

Technology disruption is also a very critical issue in solar PV projects. The contracting authorities restrict the private parties to incorporate the latest technology whenever it is required. Such as installation of modern cloud monitoring system and more responsive inverters are demanded by the contracting authorities to increase the efficiency of the plant. The private parties also bear the disruptive technology risk (Martins, 2011). In the case of early completion or termination of the project, the cause of termination of early completion will be determined. If the termination of the project occurs as a result of contracting authority default, then the private parties are compensated against their debt and equity. However, if the private parties cause the termination, then it will be another way around.

## **Environmental**

Pakistan emitted only 0.9 percent greenhouses gases and in ranking at 135<sup>th</sup> among other nations, even that climatic variations affected Pakistan's economy dangerously. Pakistan is ranked 12<sup>th</sup> most exposed republic as far as climatic abnormalities are concerned. Environmental snags charge about 6 percent of the GDP of Pakistan's economy every year (Khan, 2004). Furthermore, energy sector contribution in CO<sub>2</sub> emission is the largest which is 74 percent globally. In Pakistan the largest share is also by energy which is 46 percent in the emission of 342 million metric tons (MtCO<sub>2</sub>e) in 2012, Pakistan submitted an "Intended Nationally Determined Contribution" (INDC), in which it planned to cut carbon emissions 30 percent from 2008 levels by 2025.

The most viable carbon reduction strategy is to promote RE sources, and this project is also one step towards achieving carbon reduction goal of the government of Pakistan.

The International creditors and renowned financial institutions across the world are very sensitive to the environmental risk related to any project, due to their commitment to the Equator principles. They minutely observe the technical proposal of the project in which they ensure that public and private parties managed the environmental risk of the project professionally. In most of the cases, private investors are responsible for managing the environmental strategies across the project (Martins, 2011).

## **Legal**

To increase investor's interest in RE projects it is certain that clear policies and legal framework create according to nature of RE. It is imperative for RE projects to provide a minimum market guaranteed for the consumption of the generated power. The generation characteristics of RE projects are much expensive as compared to other energy sources. Therefore, the absence of a market guaranteed for its production makes the RE projects financially non-viable.

The key risk factor in solar PV projects is the optimistic energy yield forecast. The contracting authorities assessed the initial energy yield for the chosen site and provided to private parties. However, it is recommended that the private parties should conduct an independent assessment of the energy yield to confirm the forecast of the contracting authorities. In some countries, the impact of climate change on climatic conditions varies which affects the energy yield assessment. Despite, the private parties are responsible for providing an uninterrupted supply of inputs and solar power. Further, they manage the costs of these inputs which are required for the project. The demand for the produced electricity by the solar PV project is a major concern for the contracting authorities. In advance, the contracting authorities are unable to predict the demand for electricity with accuracy. In most of the emerging countries, the electricity sector has yet to be liberalized. Therefore, the utility is vertically integrated. That is why the contracting authorities bear the demand risk. The power purchase agreement is based on a "must take" basis, as the produced electricity cannot be stored. In this case, the contracting authorities bear the risk to purchase the produced electricity which is not required by the system. The private parties are often compensated by the contracting authorities if the system operators constrain the project.

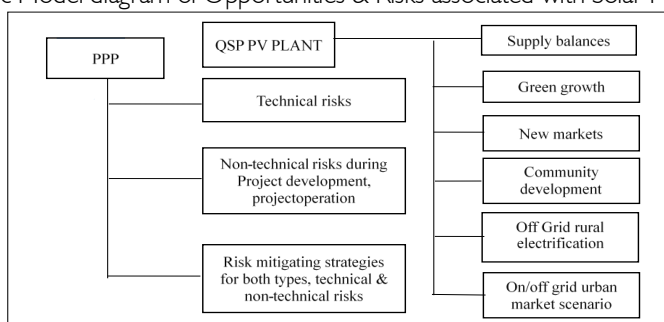
This problem can overcome by introducing legislative instruments which can provide help to stimulate RE market by different types of mechanism that may be categorized as legislations organizing the power purchase and procedures in facilitating grid access. There are different types of legislative mechanisms are available to monitor the power purchase and give support for a guaranteed RE market. There have been two main mechanisms which are adopted by governments such as, Feed-In Tariffs (FIT) and tendering arrangements. Furthermore, some new initiatives have taken recently to support electricity from RE sources such as Renewable Portfolio Standards (RPS), Green Pricing Schemes, etc.

Under the FIT arrangement, guaranteed prices will be offered to the RE generators, with a continuous supply and purchase obligation for a specific period such as 15-20 years. The pre-decided prices are higher than the market prices for RE fed onto the grid. The decided tariffs may vary depending upon the nature of the generated RE and the income stream of RE generators through different projects. The cost RE generations are commonly leveled to ensure the profitability of RE investment. This method is commonly used for FIT application in the world. By considering a Locational Marginal Pricing (LMP) formula, the estimated cost of the supplying electricity is determined, if it were done using other supply sources. The FIT mechanism works differently for households, farms and businesses as compared to independent power producer businesses.

### Construction-Related Risk Factors

Furthermore to endorse PESTLE findings, interviews of the technical managers of QSP are conducted for construction-related risk factors. The questions of the interviews are based on Meta literature review. A schematic model diagram of the opportunities and the risks associated with the solar photovoltaic plant are shown in Figure3.

Figure 3. Schematic Model diagram of Opportunities & Risks associated with Solar PV plant



Source: (Author's Self-Description)

Table. 6. Risk types and sharing in Solar Panel Energy Projects in emerging countries

Risk Type	Risk Sharing	Risk Type	Risk Sharing
Land purchase and site risk	Private	Performance/ price risk	Private
Construction risk	Private	Resource of input risk	Private
Completion (including delay and cost overrun) risk	Private	Strategic risk	Private
Maintenance risk	Private	Early termination (including any compensation) risk	Both
Force majeure risk	Both	Design risk	Private

Source: (Author's Self-Description)

In emerging markets, the land purchase and site risk for the solar panel energy project is different as compared to developed countries. The land records and registries are often not available in emerging countries. The contracting authorities should manage the problem regarding indigenous land rights and community engagement by the adoption of International finance corporation safeguards for the project.

The legislation in this regard is mostly not available in emerging markets. The private parties are also determined the site for solar PV project to maximize the energy yield, reduce the risk of negative impact on the electricity network and lower the connection costs. Further, private parties are fully responsible for the suitability of the site for the project, its geological, geotechnical and archaeological condition. Moreover, the private parties are responsible for getting the smooth possession of the project site by full filling all the requisite, access rights and servitudes.

The design part of the project is also very crucial. Localize part of the supply chain for the solar PV project is often required from the private investors. In many countries, like South Africa, the localization for the solar PV project is very successful. The contracting authorities are requiring private parties to install such equipment which moderates the impact of the project on the electricity network. Such as, install cloud monitoring equipment and inverters which provide support service to grid level, e.g., frequency response. In solar PV projects, the private parties are the sole responsibility for the design and its adequacy. Further, they ensure the compliance with the performance or output specification. The private investors require the consent of the contracting authorities for any change in design during the project. Further, the contracting authorities are not responsible for any inaccuracy in design or the risk of delays in approving the new design.

The private partners usually bear the constructing risk in solar PV project. The private parties are responsible for the project management and construction risk unless the nature of work related to contracting authorities. The private parties manage the labor dispute, IP rights infringement, the standard of construction and cost overrun in these kind projects.

In emerging markets, the completion risk of solar PV project is considered to be lower as compared to any other project. It is due to the nature of the technology and its simple construction design. It motivates contracting authorities to make a simple and short construction timetable and pass this risk to the private parties. However, any delays in construction will cause the loss of expected revenue and increase the ongoing cost of the financing which will bear by the private parties.

The contracting authorities verify the performance of the solar PV project by the independent consultant during the procurement phase. This phenomenon is relevant in many emerging countries. It has to ensure by the contracting authorities that whether the output of the solar PV project meets the customer load requirement. Therefore, in many cases, contracting authorities require private parties to make sure a minimum level of output from the solar PV project. In doing so, the performance risk of the project is fully transferred to private partners.

The installation of large-scale solar projects is a recent phenomenon in emerging markets. Less evidence is available regarding the maintenance issues in this kind of projects. However, it is assumed that less maintenance is associated with solar PV project as the limited evidence suggest. Despite, the private parties are responsible for any operational and maintenance problem by the applicable laws. The contracting authority inspects the project time to time and ensures that the facility is running well as per the standards.

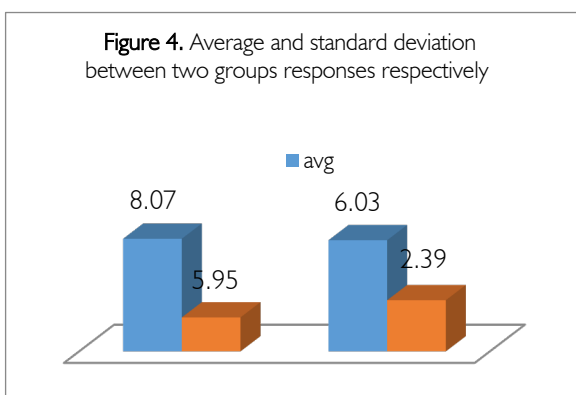
The force majeure risk is shared between contracting authorities and private parties in solar PV projects. There is some force majeure event which can insure such as flood, fire, storm, etc. However, some of the force majeure events which typically cannot insure such as strikes, protest, accidents, emergency, and the terror threat etc. The contracting authorities encourage private parties to rely on insurance against force majeure risk rather allocate all force majeure risk to the contracting authorities (Martins et al. 2011).

The strategic risk refers to the control of the solar PV project. It is common practice in emerging markets that the government ensures that private parties to whom project is awarded remain involved. If

the private parties want to change the control of the project, they are bound to take permission first from the government. The contracting authorities often restrict the change of control and shareholdings among the private parties for a particular project.

### Socio-Economic Development of the RE project on local Area

The impact of RE project on the socio-economic development of the region is determined by surveying the local community of Cholistan desert where the QSP is located. The survey is based on a questionnaire used by (Cebotari & Benedek, 2017) after necessary modifications (translated into national language Urdu as mostly persons are illiterate) and then after pilot testing on limited academicians taken responses from two groups (questionnaire in English attached in Appendix B). Firstly responses are taken from local engineers and labors working at the project and other responses from the vicinity which comprised on three villages (Dera Bakha ,7 BC , 10 BC) in the surroundings of the project location having roughly estimated population about 5000 inhabitants (Pakistan Bureau Of Statistics, 2016).



For this purpose performed the Run Test, Kolmogorov Smirnov Test on both group all factors obtained results as presented in table 7.

**Table 7.** Statistical description & Z test, K.S test from two group respondents feedback

Descriptive statistics	Project respondents		Run test		Community Respondents		K.S Test	
	Mean	STD.	Z	Sig	Mean	STD.	Z	Sig.
R1 contribution of solar power project towards the development of the region	9.62	0.55	-12.23	0.00	4.53	0.85	5.17	0.00
R2 project will contribute in the revenue of region	7.70	0.50	-12.21	0.00	4.60	0.70	5.46	0.00
R3 It will bring employment for the locals	9.29	0.73	-12.29	0.00	7.24	1.22	4.00	0.00
R4 energy prices will come down due to RE projects	8.41	0.59	-12.29	0.00	4.38	1.35	3.68	0.00
R5 Visibility of the region become more prominent due to project	9.02	0.87	-12.23	0.00	5.94	1.47	3.64	0.00
R6 More RE projects will come to region due to successful implementation of this project	9.70	0.86	-12.29	0.00	6.07	1.37	3.79	0.00

In this table the p values of all the responses of both groups in Run test as well in of K.S. test are less than 5 percent(0.00) which indicates the scores of all the responses does not follow either randomness nor normal distribution so for comparison between two group responses we applied Man Whitney u test. After conducting this test, it can be analysed the community responses are almost contradictory with the employees working at project.

The result of the survey suggested that a greater difference in perception of employees working on a project with the community. For example, this project has no benefits for them whereas local employees working on the project management have contradictory interpretations. Further, mostly community members responded that the energy produced from this project has not any direct benefit at all because the produced energy transmitted to the National grid. Whereas, project employees said due to the production of this energy shortage of load-shedding. Furthermore, those respondents who are not directly associated with the project think that the project did not create job opportunities for the local community. However, the respondents who are associated with the project contradicted the above statements. They said that we got employment opportunities with the project. However, these employments are based on daily wages or temporary contracts. The security concerns are almost similar in all responded, those who are associated with the project and those who are not. In their opinion, security is now tighter after the launching of the project. The local community passes through security check posts at least thrice in the day if they move toward the project site. To further analyze this situation we did discussions with some community elected members as well as project assistant managers and give recommendations that how harmony and social acceptance can be embedded in these types of projects.

## **Conclusions**

The cooperation of multilateral institutes is necessary for developing nations to accomplish the sustainable development goals issued by United Nations especially focusing on goal 7 i.e Sustainable energy affordable & reliable for all. The same approach endorsed by the world bank, according to which the great opportunity of our phase is the transition to cleaner energy track, and it requires its assistance for early achievement stories, solid front-runners that will establish representations for others.

Forwarding the recommendations, presently, the duct cleaning procedure is done by washing the solar plates (height of upper string 1.6m & lower string is 1 meter) by water bowsers. According to the land condition, it is recommended that less watered crops can be cultivated under the solar panels. The over grown grass beneath the solar panels can be eliminated by feeding the sheep over it so there will be an opportunity of live stock.

For social acceptance of the project following are the recommendations: Create awareness of the Renewable technologies through seminars at educational institutes, community meetings, providing solar home appliances to the surrounding community if direct transmission is impossible due to infrastructure constraints so that sense of engagement will generate.

For technical understandings of the project short courses about Solar PV can be introduced which creates capacity building & knowledge sharing among private and public sectors, turn into a long-term asset in terms of skilled human resources as well play a pivotal role in developing the local solar industry contemporary at the infancy stage.

For policymakers and Government, there should be a need of enhancement in solar planning and growth with innovative approaches like incentive schemes for households/businessmen on placement of solar, availability of financial institute loans at low markups as State bank of Pakistan initiated scheme for financing renewable projects standard operating procedures for net metering policy ( households, business or Industrial entity as National electric power regulatory authority set up in 2015 solar PV standards right from importation of solar equipment to installation and commissioning of solar equipment at national or local level.

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