



**Islamic Republic of Afghanistan
Ministry of Finance
Directorate General Public Private Partnership**

HISAR SHAHI SOLAR POWER PLANT PROJECT SUMMARY



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Disclaimer:

The data presented here is a summary from the information in the process of the project documentation and those data that we deemed we are at liberty to share. We take this issue at hand that we will be able to share, and any unauthorized use is strictly forbidden.

Abbreviations

ADB	Asian Development Bank
AISA	Afghanistan Investment Support Agency
CAPEX	Capital Expenditure
DABS	Da Afghanistan Breshna Sherkat
DG	Diesel Generator
DPR	Detailed Project Report
EPC	Engineering, Procurement and Construction
GWh	Giga Watt Hours
HIP	Hisar-e-Shahi Industrial Park
HOMER	Hybrid Optimization for Multiple Energy Resources
kV	Kilo Volt
kW	
kWh	
kW	Kilo Watt
kW	
kWh	Kilo Watt Hours
LCOE	Levelized Cost of Energy
MEW	Ministry of Energy and Water
MVA	Mega Volt Ampere
MW	Mega Watt
MWh	Mega Watt Hours
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Protection Agency
NGO	Non-Governmental Organizations
NOCT	Normal Operating Cell Temperature
NREL	National Renewable Energy Laboratory
OPEX	Operational Expenditure
PPA	Power Purchase Agreement
PV	Photovoltaics
RE	Renewable Energy
RED	Renewable Energy Department



Figure 1 Hisar Shahi Industrial park Plan

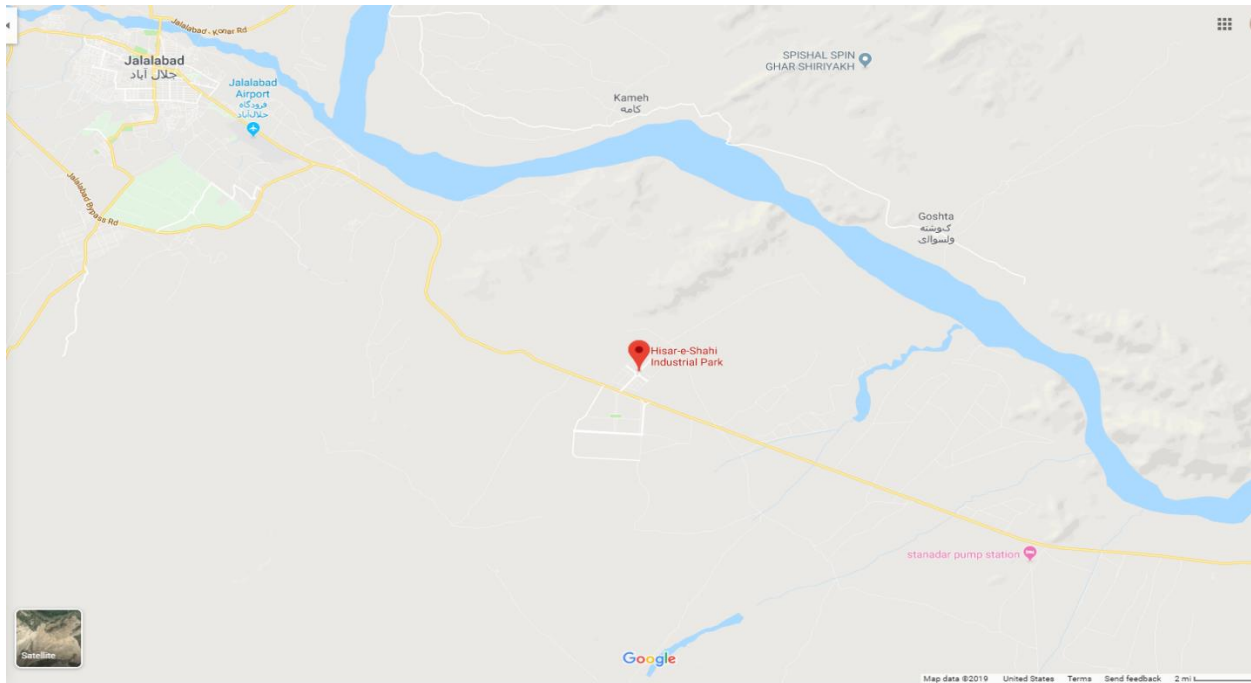


Figure 2 Hisar Shahi Location

Introduction

This document aims to give a note on the project as deemed essential for public awareness purpose. The details of the project for the technological aspects and essentiality has been discussed. In line with this narrative most relevant aspect of the project will be detailed, put forward and elaborated.

It should be mentioned here that the projects, although much detailed, only parts that will elaborate on the aspects that general public need to know will be put out in here in form that is understandable away from much technical jargon.

The author of this document extends the point that although it is a technical matter, much effort has been in place to make it more understandable to those who are not directly involved in the sector and any discrepancy might be due to non-timelessness of the studies at hand.

Preliminary Study

The project work started with site surveys and stakeholder consultations to collect information and data on Hisar-e-Shahi Industrial Park. The main idea behind the stakeholder consultation was to understand their concerns and take their feedback. Some of the major outputs from the site surveys and stakeholder consultations were:

- Enough land inside the park is available and AISA as well as Land Authority has given assurance of making it available
- Infrastructure including boundary walls, asphalted roads, electrical network and wastewater treatment facilities have completed
- No proper electrification planning is in place for the Hisar-E-Shahi Industrial Park for short term as well as for the long term
- There is huge demand and interest for the purchasing of electricity inside and outside the park

The project area is elevated from 465 m to 545 m from the sea level with a gradient of 1.5 to 2 % and the land being almost flat. The climate of the area is typical of a semi-arid steppe climate having mean temperature of the area varying between 0°C to 48°C. Much of the rain falls during the winter season (December to February) and some in summer season (July-September). Site is well connected by roads on the outside and inside of the park. Internal electric distribution network has been constructed however, it is not connected with the city grid. Electricity grid is located at a distance of 30 Km in Ghawchak Substation having a voltage of 20 kV and capacity being 84 MW.

The total electricity demand, based on a survey, is estimated to be a total of 82 MW for the Hisar-e-Shahi Industrial Park of which the 40 MW is estimated for the first phase and rest for the second phase. It has been proposed that the power plant will only cater to the industries working from 7:00 AM to 5:00 PM. Based on the survey, it was found that 25 industries having minimum electric load of 100 kW and maximum load of 2000 kW will shift to Hisar-e-Shahi industrial park immediately after electricity is made available. There will be further addition of industries totalling up to a demand of 40 MW. For the technical analysis, hourly load profile for Hisar-e-Shahi Industrial Park is generated in HOMER for a peak load of 40 MW with daily and hourly randomness added to generate realistic profile. The annual energy demand is estimated as 308 MWh/day and peak load as 39.97 MW with load factor of 0.32.

Solar PV project development in Hisar-e-Shahi will be divided into stages and will require different types of work to be done. Various stages of development include Site acquisition, DPR preparation, Clearances and approvals, Tendering & appointment of EPC contractor, Procurement, Installation & Commissioning, Tariff agreement, O & M.

The social impacts from the project are evaluated to be generally valuable in terms of overall economic development. During the construction phase, the majority of low-skilled employment opportunities associated with the project are likely to benefit members from the local community. It will also create an opportunity for skill development and On-site training. The shifting of industries in the HIP will benefit the industries with high quality infrastructure, reliable power supply and a professionally managed modern industrial park facility. Increased product output from the industries will spur in economic growth in the area and in Afghanistan as a whole. Also the community people where these industries are operating from, will be benefitted with cleaner and quieter environment after this shift. The proposed project will have no significant negative impacts on the nearby populations as there will be no displacement of people. On the other hand, there is high positive impact on the social environment as the level of employment rises tremendously as a result of new Industrial establishments in HIP. The proposed development also represents an investment in infrastructure for the generation of clean energy, which, given the challenges created by climate change, represents a positive social benefit for society as a whole.

Implementation of project requires skilled manpower at project planning, project installation and project monitoring stage. Installation of the project and setting up a connection to the

substation requires both skilled and unskilled workers. Capacity building program through training, education and hands-on training to generate trained and qualified manpower is required.

Consultation with various stakeholders was carried out alongside the preliminary survey. The idea was to understand their concerns and take feedback. The process helped in getting more information on Hisar-e-Shahi and improving the project design.

Summary

The Project was initially studied for 40 MW Solar PV hybrid with Diesel generator but based on later modification it was agreed on a grid connected solution for the location. The project received proposals previously but currently the project is now in procurement stage. The initial study focused on only the industrial park and the activities and their energy needs but with the feasibility study it is assessed that during the second phase residential homes should also be taken into consideration.

The development activity at Hisar-e-Shahi will be done in two phases and accordingly the land has been divided. The 125 hectares is allocated for the first phase and rest for the second phase. Infrastructure development for the first phase is completed.

Since the project went to subsequent announcement there were some changes in scope and implementation model. We can only rely on a feasibility study from 2016 but for the purpose of this document only the industrial park has been considered and the rated power at 40MW.

Project Scope

Afghanistan is rich in energy resources, both fossil fuels based and renewables. However, it still depends heavily on imported electricity and fuels and has one of the lowest per capita consumption of electricity in the world. Renewable energy sector development is one of the priority areas for the government, for immediate purpose of providing access to modern energy to remote and rural population and for medium to long term purpose of providing energy security to the country.

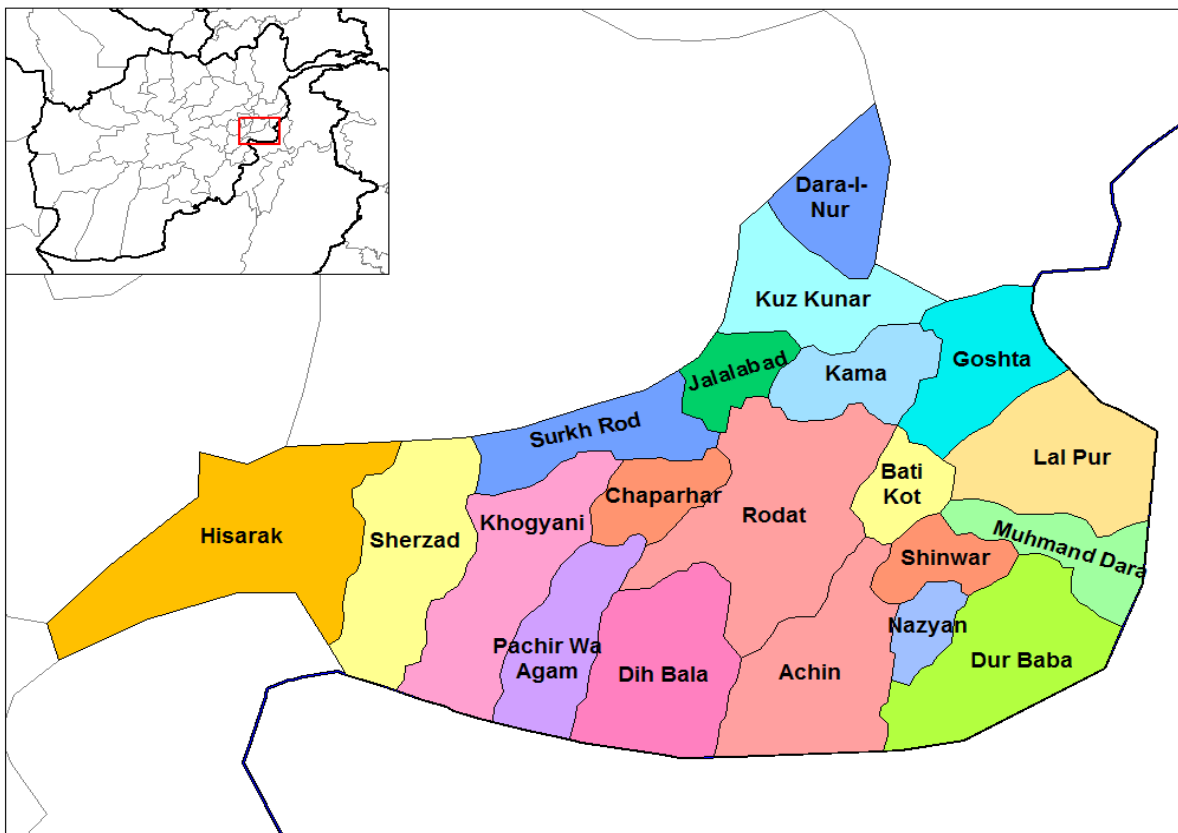
Over the past decade, movement in the renewable energy space has been towards greater presence of renewable energy as a means to solve livelihoods and economic crises, as well as a

shift towards supporting enterprise demand. There is a palpable shift towards MW scale interventions that can not only meet consumptive loads but also drive productive loads.

Nangarhar is one of the 34 provinces of Afghanistan, located in the eastern part of the country bordering with Pakistan at the east. It is divided into twenty-two districts and has a population of about 1,436,000. The city of Jalalabad is the capital of Nangarhar province and is one of the four big city of the country in term of population, economy and its strategic location. There are more than 200 medium and small size industries functioning near and inside the Jalalabad city, where electricity is considered as a vital problem for sustainable operation of the industries.

None of the industries is established in the Hisar-E-Shahi Industrial Park. The main barriers to development have been the lack of electricity and security. Since the industries has the assurance on security provision, they want electric power in the area for establishment of industries.

The site is located on Jalalabad-Torkham Highway and it is well connected by roads on the outside and inside of the park. Internal electric distribution network has been constructed however, it is not connected with the city grid. Electric power (two sets of Diesel Generators of 250kW) for site development work is also existing in the area.



It should be mentioned that, four categories of applications/ markets are considered to be important for project development in Afghanistan - a) in provinces which are not near the grid,

b) industrial parks/clusters that are deprived of energy or are dependent on diesel, c) urban areas where roof-tops can be utilized, d) 54 border districts that are completely off-grid and remote

In this regard, a long-list of 10 projects was provided by RED after discussions with DABS that was considered for further shortlisting of projects for development. Four project sites were shortlisted on the basis of following criteria:

1. RE resource availability
2. Security Issue
3. Potential Power loads available
4. Land availability
5. Private companies interest
6. Level of commercial activity
7. Consumers paying capability
8. Terrain & Geology
9. Access (Roads etc.) to the site

Nangarhar is one of the 34 provinces of Afghanistan, located in the eastern part of the country bordering with Pakistan at the east. It is divided into twenty-two districts and has a population of about 1,436,000. The city of Jalalabad is the capital of Nangarhar province and is one of the four big city of the country in term of population, economy and its strategic location. There are more than 200 medium and small size industries functioning near and inside the Jalalabad city, where electricity is considered as a vital problem for sustainable operation of the industries.

Hisar-e-Shahi Industrial Park is one of the selected project sites for project development in Afghanistan. The purpose of developing a renewable energy power project at Hisar-e-Shahi is mainly due to absence of electricity and thus none of the industries has established although plots have been allocated for them. In order to sustain expansion, a reliable and ample power supply will be necessary in the area.

Hisar-E-Shahi Industrial Park is located at 34°19'22.86"N latitude and 70°39'32.23"E longitude in Nangarhar province, 22 km southeast of Jalalabad City, on Jalalabad-Torkham Highway. The industrial park is spread over an area of 207 Hectares. It is a property of the Government which is partly used as a temporary refugee camps. There are 295 plots for industries which has been

allocated to proposed industries. The categories of industries that are proposed to come in HIP are:

1. Light Engineering.
2. Food processing companies.
3. Leather and Garments manufactures.
4. Carpet Washing and cleaning companies

None of the industries is established in the Hisar-E-Shahi Industrial Park. The main barriers to development have been the lack of electricity and security. Since the industries has the assurance on security provision, they want electric power in the area for establishment of industries.

The development activity at Hisar-e-Shahi will be done in two phases and accordingly the land has been divided. The 125 hectares is allocated for the first phase and rest for the second phase. Infrastructure development for the first phase is completed.

Climate

The climate of the area is extreme. In general, it has normal winters and hot summers, typical of a semi-arid steppe climate. The mountainous areas far from the proposed site are much colder than the plain areas. Usually raining season begins between December and April. Climate of the area varies considerably from season to season.

Much of the rain falls during the winter season (December to February). Flow of rain fed rivers crossing the area is due to these rains and the melting of snow during the spring season. Area is not exposed to flood.

The mean temperature of the area varies between 0°C to 48°C. During the winter, from November to February, the wind blows steadily from the west, often bringing dust storms.

Electricity Demand

The total electricity demand, based on a survey, is estimated to be a total of 82 MW for the Hisar-e-Shahi Industrial Park of which the 40 MW is estimated for the first phase and rest for the second phase. It has been proposed that the power plant will only cater to the industries working from 7:00 AM to 5:00 PM. Based on the survey, it was found that 25 industries having minimum electric load of 100 kW and maximum load of 2000 kW will shift to Hisar-e-Shahi industrial park immediately after electricity is made available. There will be further addition of industries

Solar PV project development in Hisar-e-Shahi will be divided into stages and will require different types of work to be done. Various stages of development include Site acquisition, DPR

preparation, Clearances and approvals, Tendering & appointment of EPC contractor, Procurement, Installation & Commissioning, Tariff agreement, O & M.

The average annual solar resource in Hisar-e-Shahi industrial area is very good with an annual average of about 5.3 kWh/m²/day. Sun shines on an average, for 10 hours daily in December and 14 hours daily in June. The longest day is 4 hours longer than the shortest day. There is an average of 3085 hours of sunlight per year.

Energy Analysis

For Hisar-e-Shahi industrial area, HOMER simulations have been carried out for three hybrid system configurations comprising of PV with Battery/Generator/Grid system of different capacities. Based on the different input parameters, created load profile and solar resource data, HOMER simulates numbers of system configurations and helps select the one that satisfies the technical constraints at the lowest life-cycle cost. It should be stated here that Homer is a internationally recognized energy and power capacity and profile assessment software.

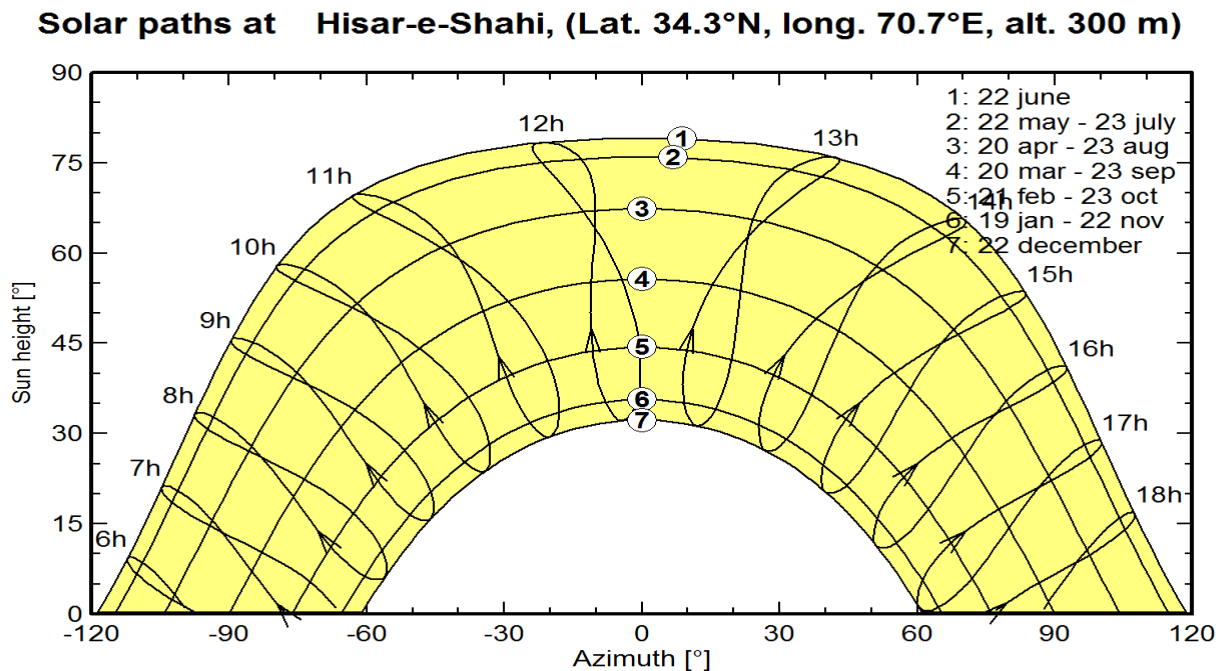


Figure 3 Solar Path Hisar Shahi

The clearness index, a measure of clearness of sky, in HIP has an average value of 0.68. The clearness index varies from around 0.8 in the clearest conditions to near zero in overcast

conditions. Thus, in HIP there is clear sky at most of the time. There are also decent wind speed values in Hisar-e-Shahi which can be explored for future energy demand in the area. Wind blowing over the solar panels also helps in cooling of PV modules through natural convection.

While modelling in HOMER, we input the site details (Latitude and Longitude) and then select the weather file (NASA or NREL) to download the monthly solar resource data (global horizontal radiation and clearness index), wind speed and temperature. HOMER, then generates synthetic hourly global solar radiation data using an algorithm developed by Graham and Hollands giving an 8760-hourly data set with statistical characteristics similar to those of real measured data sets.

The hybrid system comprises of solar PV plant connected to the electric grid. In this configuration, excess electricity production from PV panels can be fed into the grid and can be imported in case of shortfall. This system is the most preferred option for MW scale power plants as they require no backup systems like Diesel Generator and storage systems like battery bank/ flywheel. HOMER models the grid as a component from which the power system can purchase or sell AC electricity.

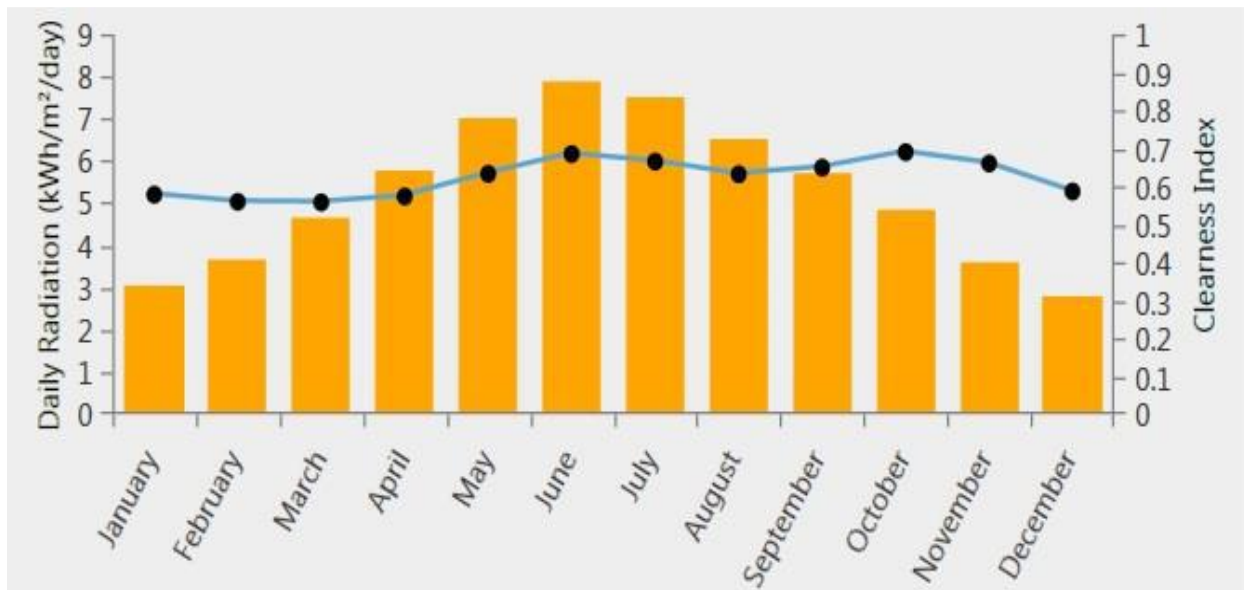


Figure 4 Solar Energy Profile

S. No.	PV MW	Grid	Inverter MW	Total electric Load served GWh/yr.	Total PV production GWh/yr.	Total purchase from Grid GWh/yr.	Net Present Cost Million US\$	Capital Cost Million US\$	LCOE cents/kWh	Annual Unmet Load GWh/yr.	Excess electricity %	CO ₂ emission Million kg/yr.
1.	50	-	55	112.4	86.6	38.3	217	90.4	13.3	0.0	0.0	20.6
2.	40	-	45	112.4	69.3	50.6	212	72.4	13.4	0.0	0.0	30.7
3.	35	-	40	112.4	60.6	58.1	209	63.4	13.3	0.0	0.0	35.7
4.	30	-	35	112.4	52.0	65.9	205	54.4	13.1	0.0	0.0	40.8

Figure 5 Energy Analysis

The social impacts from the project are evaluated to be generally valuable in terms of overall economic development. During the construction phase, the majority of low-skilled employment opportunities associated with the project are likely to benefit members from the local community. It will also create an opportunity for skill development and On-site training. The shifting of industries in the HIP will benefit the industries with high quality infrastructure, reliable power supply and a professionally managed modern industrial park facility. Increased product output from the industries will spur in economic growth in the area and in Afghanistan as a whole. Also the community people where these industries are operating from, will be benefitted with cleaner and quieter environment after this shift. The proposed project will have no significant negative impacts on the nearby populations as there will be no displacement of people. On the other hand, there is high positive impact on the social environment as the level of employment rises tremendously as a result of new Industrial establishments in HIP. The proposed development also represents an investment in infrastructure for the generation of clean energy, which, given the challenges created by climate change, represents a positive social benefit for society as a whole.

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Socio-Economic Review

To assess the socio-economic conditions in Hisar-e-Shahi Industrial Park, site survey and stakeholder consultation was conducted. The parameters like user profile, economic activities in the area, target population, energy demand, load profile, consumer interest, energy unit cost were studied. The survey also assessed the potential for future electricity use along with user perceptions and expectations from the system. A critical component of the survey was to assess

the users' willingness to pay for electricity under different scenarios of provision, quality and usage.

The Jalalabad plain is the principal agricultural areas of Afghanistan. The strong agricultural base, coupled with the crucial trade route connecting Kabul with Peshawar, makes Nangarhar more economically diverse and functional province of Afghanistan. Torkham is one of the major border crossings between Afghanistan and Pakistan. It is the busiest port of entry between the two countries, serving as a major economical hub for the province.

Despite significant challenges and problems, there are still more than 200 medium and small size industries are functioning near and inside the Jalalabad city, where electricity is considered as a vital problem for sustainable operations of the industries.

In Hisar-E-Shahi Industrial Park, there are 295 plots for industries, which will directly hire 30-50 persons per factory when the industry starts running. The total employees are expected to be around 12,000, and the kind of industries that has been proposed in the area will be of the four above categories:

There are, at present, no renewable energy development programs operating at the site or near the site. The area is totally safe and the local government has promised to provide any type of security if required. Local labor for project development is also available.

The electricity tariff for industrial and commercial as proposed by DABS in Afghanistan ranges from 12 - 14 cent.

Determining the best combination of energy systems for the Hisar-e-Shahi Industrial Park required estimates on electricity demand for the area. These demand estimates not only helped determine the necessary size and capacity of the system, but also informed the energy output that could be expected

The total electricity demand, based on a survey, is estimated to be a total of 82 MW for the Hisar-e-Shahi Industrial Park of which the 40 MW is estimated for the first phase and rest for the second phase.

The renewable energy project proposed for electricity generation will only cater to the industrial park. Power is required by the industries from 7:00 AM to 5:00 PM on all days in a year. Based on the survey, it was found that 25 industries having minimum electric load of 100 kW and maximum load of 2000 kW will shift to Hisar-e-Shahi industrial park immediately after electricity is made available. There will be further addition of industries totalling up to a demand of 40 MW.

Costs of the Project

The Project for which the feasibility study was conducted has changed the below tables show the financial information about the current status of the project. It should be made clear that these costs has been assumed per market data and status of such previous projects. As such, there is no clear indication that these project data will be final. Perhaps, there will be cheaper alternatives and agreements to another modality but to give an overall picture the below will suffice.

General Information of the project		
Particulars	Values	Units
Project Capacity (AC)	40.00	MW
Life Cycle of Solar	25	Years
CUF of the Project	22.00%	
Auxillary Consumption	0.00%	
Annual Energy Generation	63360000	KWh
Annual Energy Generation	63360	MWh
Financing Cost	0.00%	
Accelerated Depreciation	Y	
Salvage Value	0.00%	
Accelerated Depreciation (taken as Building)	4.0 Yrs	
Accelerated Depreciation Rate	25.00%	
Depreciation (as per Useful Life)	4.00%	
Total Depreciation	36090211	
Performance of Module in 1st Year	100.00%	1
Performance of Module in 1st 10 Year	90.00%	10
Performance of Module at the end of project life	80.00%	25
CUF at the end of 1st FY	22.00%	
CUF at the end of 10th FY	19.80%	
CUF at thr end of 25th FY	17.60%	
Degradation rate in 1st 10 years	-1.16%	10
Degradation rate in next 15 years	-0.78%	25

Total Project Cost	
Particulars	USD
Solar Panels (325 WATT)	22,931,908
Land Cost	-
Civil and General Works	3,200,000
Inverters	2,714,290
Mounting Structures	1,888,600
Cable & Transformers	-
Evacuation Cost up to Inter-Connection Points (Cables & Transformers)	3,500,000
Preliminary and Pre-Operative Expenses	1,490,000
Total Project Cost (Ex-Financing)	35,724,798
IDC	365,413
Total Project Cost	36,090,211

Tax Assumptions	
Tax Rate	20.00%
Loss Set-off expiry	3.0 Yrs
BRT	4.00%

Conclusion

This project aims to provide for the industrial needs of the part of Jalalabad City in vicinity of which this industrial park will be functioning.

The project feasibility study has had discrepancies and were conducted some time back whilst the project is in the prequalification phase for the second round as of now and any development and improvements and technical soundness will be evaluated based on the bids the Ministry of Energy receives.

The project will facilitate smoother implementation of solar park for which the land is already in grasps and once completed will provide for energy use of the park in a manner which is connected to grid.

The benefits will be revitalization of local industries, benefit for employment of local workforce and income generation both during project implementation and during project operation, among many.