PRE-PROJECT EVALUATION REPORT OF SOLAR POWERED COMMUNITY MICRO-IRRIGATION PROJECT IN KANDI BELT OF TALWARA AND HAJIPUR BLOCKS OF HOSHIARPUR DISTRICT IN PUNJAB

FOR

Department of Soil and Water Conservation, Govt of Punjab

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Prepared by

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INTRODUCTION

1.1 The proposed Community Micro Irrigation project falls in the Kandi belt; Talwara and Hajipur blocks of district Hoshiarpur. Kandi area of Punjab which comprises of 10% geographical area of the State has an undulating topography with the problems of soils erosion, frequent floods, poor productivity etc. The proposed project area is mainly rainfed with small land holdings. The Kandi Canal, which is a branch of Mukerian Hydel channel, passes nearby and provides flow irrigation to the area falling on its right side being at a lower elevation. The area falling on the left side of the Kandi Canal which is at a higher elevation can only be irrigated through lift irrigation. Therefore, the Project aims at lifting Kandi Canal water and proposes to use it for irrigation through solar powered Micro Irrigation (Drip and Sprinklers) in the fields of farmers falling on the left side of Kandi Canal, hereafter referred as project area, for its efficient utilization. Micro Irrigation system not only improves the irrigation efficiency but also helps in crop diversification with optimal utilization of land resources. Agriculture in the proposed area continued to be dependent on the monsoon that extends from June end to September.

1.2 The only solution for providing irrigation water to the fields in the project area is through lifting the canal water to the farmers' fields. The power source for the lift irrigation scheme can be either grid based electricity, fossil fuel or solar power. Most of the community lifts irrigation schemes are normally hampered once the implementing agency moves out of the project due to lack of maintenance personnel and pumps become non-functional for want of fuel/electricity. . In such areas there is need to explore the non-conventional energy resources. Solar power is one such renewable energy source which can provide a solution for such issues. The Solar Photo Voltaic Pumping System can play an important role in such lift irrigation projects because it is not dependent on the agencies for energy costs. The use of solar pumps is a direct saving of electricity/fuel costs and the state government will save on the high cost of buying power and/or gain more revenue by selling the saved electricity to industrial sectors willing to pay the relatively higher cost. Since diesel pumps are typically characterized by a lower installation cost but higher and ever increasing

operation and maintenance cost, this system will benefit the project in the long run despite higher installation costs.

1.3 Solar pumps are the diametrically opposite to fuel-dependent irrigation methods, with high initial cost and very low or negligible operation and maintenance costs. The reliability and life of Solar Pumping System is much better than that of diesel/electric pumping systems. The Solar Pumping System is highly effective with drip irrigation systems as it gives farmer the ability to manage precision irrigation with certainty of power availability at the time of real need. Hence it is the technology which increases the water use efficiency thereby conserving the precious natural resource.

1.4 Solar Photo Voltaic (SPV) Pumping system will not only help with substantial saving in state exchequer during peak summer months but will also help in enhancing production levels. Combining micro irrigation with solar power system will save about 40-60% water. This technology will help in bringing more area under cultivation and will raise the prosperity of the area.

1.5 Micro Irrigation prevents water wastage and subsequent percolation. The system also gets higher yields and better quality of fruits, lowers the cost of production and increases the farmers' income. This aspect is very significant with the adoption of fertigation (application of fertilizers with the drip irrigation in split dozes). The very essence of drip Irrigation is to apply water in smaller volumes and with shorter intervals in between. Even if farmers get a small window of sunshine, they will be able to irrigate. Moreover, whenever the water requirement is high, the sun will be available to operate the pumping system.

1.6 This off-grid Solar Photo Voltaic Pumping System is more viable in the minimum/negligible remote locations. Considering the savings through low power consumption, improvements in water use efficiency, yields, minimum maintenance costs, freedom from the burden of power cuts and load-shedding, certainty of higher efficiency during summer months, long operating life of 20-25 years will certainly go a long way in raising the standard of life in the area. The system is also non-polluting and eco-friendly with zero carbon footprint. The idea of Solar Parks in the far-flung areas of the state will give a boost to the agriculture sector and make it less dependent

on the grid-based electricity by providing assured irrigation through Cluster Approach. The farmers will have increase in farm productivity, higher water use efficiency/income and can bring more & more area under cultivation the country will be self-sufficient for food. This scheme will be a role model for other states to show their farmers the efficient water and irrigation management.

BRIEF DESCRIPTION OF THE PROJECT

2.1 The project Area lies on left bank of Kandi Canal. The entire region is hilly area. There is no irrigation facility available to the farmers in this area. The agriculture is rain fed only. The area is of rich, drainable cultivable soil. The climate is suitable for cultivation of agro-forestry, maize, wheat, vegetables and horticulture.

2.2 Ground water in this area is very deep and the agriculture of this area is dependent on rain water only. In this scheme it is proposed to lift Kandi canal water by using solar photo voltaic pumping systems. The total area under command is 1750 hectares, out of which 658 hectares shall be taken up under the project. Five lifts schemes have been proposed for irrigation of this area. The scheme is conceived by lifting canal water in two stages. In one stage the canal water is lifted through rising mains to the sump. In second stage, the water is pumped for irrigation from the sump. In both the stages the solar powered pumps will be used for handling the water.

2.3 **Three locations have been selected for taking water from canal.** Water from canal will be taken to the sump with the help of siphon. The sump will be equipped with the water level sensors, to help in maintaining the water level in both excess and lower water in the sump. In the case of excess water level motorized valves will stop the supply from the canal and in case of lower water level in the sump it will switch the solar photovoltaic pumping systems. A pump house will be constructed near the each sump to house the required pumping systems. There will be one siphon for the lift scheme number 1 and one for lift scheme no. 2 and common siphon, sump, pumping station has been proposed for lift scheme 3, 4 and 5. Though it has been mentioned that water from the canal will be brought by the siphon the document is silent about how the siphon action will be created. However the team was apprised about the working of the siphon and was satisfied by the explanation.

2.4 The main features of the lift schemes are as follows:

a) It is solar powered project;

b) Solar radiation decides the water requirement of the crops higher the radiation higher will be water requirement and higher will be the energy produced;

c) It is assumed that the water requirement will be 2 l/m^2/day; and

d) Project designed for continuous run of Kandi Canal.

FIELD VISIT

3.1 The NABCONS team comprising of Dr. Rakesh Sharda, Extension Specialist, Dept. of Soil & Water Engineering, Punjab Agricultural University, Dr. AK Jain, Dept. of Soil & Water Engineering, PAU, Er. Mohinder Kanmal, Mrs. Inderjit Sangwan, District Development Manager, NABARD, Hoshiarpur, alongwith officials from Department of Soil Conservation, Punjab, visited the site on 19-6-2014. The team did a comprehensive survey of the project site. After visiting the different sump sites the team met the farmers of the command area. The farmers of the area interacted with the team and were very enthusiastic about the project.

TECHNICAL FEASIBILITY AND ANALYSIS OF COST ESTIMATES

4.1 Solar Photo Voltaic Pumping system

4.1.1 There are five schemes designed which use 41 solar pumps to deliver net discharge 12832 m^3/day for irrigation to the farms, using 1012 kWp solar power panels and will irrigate 664 ha of land.

4.1.2 In the lift scheme number 1, six pumps of 31.92 kWp each, are being used to raise the water up to the sumps at the elevated points. From the main sump near the canal the two pumps of the rating 23.27 kWp and 32.58 kWp will supply water directly to the farmers' fields. Total water used for irrigation is 5718 m3/day and will cover 295.48 ha.

4.1.3 In lift scheme number 2 two pumps of 22.8 kWp each and 3 pumps of 24 kWp each are used for irrigating the fields directly from the canal in two distribution channels. Total water used for irrigation is 1758 m^3/day and will cover 94.47 ha.

4.1.4 In the lift scheme number 3 three pumps of 24.5 kW Solar powered each, are used to raise the water up to the sump. From the sump there are 3 pumps (18.24 kW to 24.5 kW Solar powered each) used to irrigate the field. In this scheme total 6 pumps are used and water is lifted in two stages. One stage is to lift up to sump and second is for irrigation. Total water used for irrigation is 1184 m3/day and will cover 59.70 ha.

4.1.5 In the lift scheme number 4 two pumps of 18.6 kW Solar powered each, are used to raise the water up to the sump/ pond. From the sump there is 1 pump (27.36 kW solar powered each) used to irrigate the field. There are 2 pumps (18.6 kW solar powered) for irrigating the fields directly from the canal water. In this scheme total 5 pumps are used and water is lifted in two stages. One stage is to lift up to sump and second is for irrigation. Total water used for irrigation is 1341 m3/day and will cover 70.25 ha.

4.1.6 In the lift scheme number 5 four pumps of 27.36 kW Solar powered each, are used to raise the water up to the sump/ pond. From the sump there are 2 pumps (23

kW & 27 kW Solar powered each) used to irrigate the field. There are 4 pumps (18.2 kW & 24 kW Solar powered each) for irrigating the fields directly from the canal water. In this scheme total 10 pumps are used and water is lifted in two stages. One stage is to lift up to sump and second is for irrigation. Total water used for irrigation is 2831 m3/day and will cover 144.10 ha.

4.1.7 The design of the solar pumps has been done meticulously and the costs of the solar pumping systems seems to be well within the limits.

4.2 Desiltation of the sumps

4.2.1 Silt load in the canal water varies throughout the year. It is highest during the rainy season and decreases during the non-rainy days. Calculations should have been made using an assumption of silt load as 1.5 gm per litre of water. And as such the cost of desiltation will be as per the following table.

Desilting of silt for total flow of 12832 cum of water per day in twelve number of sumps at three lift points and nine ponds within the command area of 664 Ha, for 7 years of operation.			
Sr. No.	**ITEM**	**Total Quantity**	**Units**
1	Total amount of water lift from all the twelve sumps, to irrigate all the command area of 664 Ha, in one day	12832	cum
2	Silt content in one litre of water	1.5	gm
3	Deposition of silt content in the sump well for in the retention time	75	percent
4	Total deposition of silt content at 75% of deposition in one litre of water	1.125	gm
5	Total weight of silt deposition in whole day, in eight hours of operation	14436000	gm
6	Specific density of silt	2.798	gm/cm3
7	Total volume of silt deposited per day in sumps	5159399.571	cm3
	or	5.159399571	cum
8	Volume of silt in one year, for 300 working days	1547.819871	cum
9	Cost of silt removal from sumps at depth more than 1.5 meters at Rs 89 per cum		
10	Cost of desilting per year from all the twelve sumps at canal lift points and ponds in command area		Rs. 137,755.97
11	Total cost of desilting from all the twelve sumps at canal and in command area of the project, for seven years of operation,		Rs. 964,291.78

	involves all other works including cost of labour, loading and unloading of silt, transportation of silt through tractor/trolley or other means, dumping of silt away from the site etc.	

1. Footing details

In the table bill of quantities for Footing Details the costs are being charged for clearance of forest/village land for construction of footing and errection of fencing around the solar panels. Since this cost is inclusive in the cost of construction, so it may be deducted.

4.3 The overall revised costs are summarised in the following table :

Sr. No	Item Description	Total Amount (Rs)	Payment Stage	Percentage	Breakup Amount (Rs)
A	**CIVIL WORK**				
1	Construction of Sump Rooms (9 no.s), Pump Room (9 no.s) at nine ponds	7,841,961.00	After approval of Design	5.00%	392,098.00
			Excavation and Bed concrete	32.00%	2,509,428.00
			Completion of RCC wall	22.00%	1,725,231.00
			Completion of Roof	20.00%	1,568,392.00
			completition of face work	16.00%	1,254,714.00
			Commissioning of System	5.00%	392,098.00
2	Desilting of silt and clearance of other unwanted material/impurities twelve sump wells for seven years of operation	964,291.00	After First year of operation	14.28%	137,755.86
			After Second year of operation	14.28%	137,755.86
			After Third year of operation	14.28%	137,755.86
			After Fourth year of operation	14.28%	137,755.86
			After Fifth year of operation	14.28%	137,755.86
			After Sixth year of operation	14.28%	137,755.86
			After seventh year of operation	14.28%	137,755.86

Sr. No	Item Description	Total Amount (Rs)	Payment Stage	Percentage	Breakup Amount (Rs)
A	**CIVIL WORK (contd.)**				
3	Construction of footings for installation of solar panels and clearance of forest/village/canal bank land around the sumps for construction of footings and erection of fencing	6,761,439.75	After approval of Design	5.00%	338,071.88
			Excavation and Bed concrete	80.00%	5,409,152.00
			Commissioning of System	15.00%	1,014,216.00
4	Fencing Around Solar Systems, Sump wells and Pump rooms	8,553,615.00	After Design Approval	5.00%	427,681.00
			Supply of Material	75.00%	6,415,211.00
			Erection of Fencing	20.00%	1,710,723.00
B	**Pumping System**				
1	Solar Pumps	27,879,062.79	After Design Approval	5.00%	1,393,952.79
			Supply of solar pumps	75.00%	20,909,297.00
			Commissioning of System	20.00%	5,575,813.00
2	Solar Panels	48,727,610.00	After Design Approval	5.00%	2,436,381.00
			Supply of solar panels	75.00%	36,545,708.00
			Commissioning of System	20.00%	9,745,521.00
3	Auto Tracker for Solar system	32,296,650.64	After Design Approval	5.00%	1,614,833.00
			Supply of auto trackers	75.00%	24,222,488.00
			Commissioning of System	20.00%	6,459,329.64
4	Piping, Cabling, Accessories & Others	6,680,876.57	After Design Approval	5.00%	334,044.00
			Supply of Material	75.00%	5,010,657.57
			Installation of System	15.00%	1,002,131.00
			Commissioning of System	5.00%	334,044.00

Sr. No	Item Description	Total Amount (Rs)	Payment Stage	Percentage	Breakup Amount (Rs)
B	**Pumping System (contd.)**				
5	Installation & Commissioning	7,739,800.00	After Design Approval	5.00%	386,990.00
			Installation of pumps complete	75.00%	5,804,850.00
			Commissioning of System	20.00%	1,547,960.00
	TOTAL	**147,445,307**			**147,445,307**

4.4 The Department of Soil and Water Conservation has estimated the revised project cost of Rs. 41.27 crore. After thorough analysis and examination of these cost estimates, the Study Team recommends the total project cost of Rs. 40.94 crore for implementation of the proposed project of Solar Powered Community Micro-irrigation project in Kandi belt of Talwara and Hajipur blocks of Hoshiarpur district, as detailed hereunder :

(Amount in Rs. Lakh)

Sr No	Item Description	Cost Proposed by the Department	Cost Recommended by the Study Team
A	**PART – I (DISTRIBUTION AND APPLICATION)**		
1	Civil Work : Construction of Siphon, Sump, Pump Room and Training Hall	85.14	85.14
2	Rising Main for lift schemes	337.27	337.27
3	Pipe Distribution Network	499.44	499.44
4	On Farm Drip/Sprinkler System	852.52	852.52
5	Automation	346.07	346.07
6	Fencing along forest border	218.46	218.46
7	O & M for 7 years	167.22	167.22
8	Farmers Training	22.85	22.86
9	Farmers Support Programme by Department	49.60	49.60
	Total for Part-I	**2578.57**	**2578.57**
B	**PART – II (SOLAR POWER PUMPING SYSTEM)**		
1	Construction of Sump Rooms (9 nos) Pump Room (9 Nos) at nine ponds	78.42	78.42
2	De-silting of silt and clearance of other unwanted material/impurities at 12 sump wells for 7 years of operation	28.28	9.64
3	Construction of footings for installation of solar panels and clearance of forest/village/canal bank land around the sumps for construction of footings and erection of fencing	81.88	67.61

Sr No	Item Description	Cost Proposed by the Department	Cost Recommended by the Study Team
B	**PART – II (SOLAR POWER PUMPING SYSTEM) contd.**		
4	Fencing around solar systems, sump wells and pump rooms	85.54	85.54
5	Solar Pumps	278.79	278.79
6	Solar Panels	487.28	487.28
7	Auto tracker for solar system	322.97	322.97
8	Piping, cabling, Accessories & Others	66.81	66.81
9	Installation & Commissioning	77.40	77.40
	Total for Part-II	**1507.37**	**1474.46**
	Total for (Part – I & II)	**4085.94**	**4053.03**
	Administrative Cost including planning, evaluation, monitoring and other misc. charges (1% of total cost)	**40.86**	**40.53**
	Total Cost of the Project	**4126.80**	**4093.56**

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(Amount in Rs. Lakh)

FINANCIAL AND ECONOMIC ANALYSIS OF SOLAR POWERED COMMUNITY MICRO-IRRIGATION PROJECT IN KANDI BELT OF TALWARA AND HAJIPUR BLOCKS OF HOSHIARPUR DISTRICT IN PUNJAB

Particulars	Electrical pumping	Solar Pumping
Life of system	**25 years**	**25 years**
Infrastructure Cost	180	232
Cost of Pumping System	100	1275
Total Capital Cost	**280**	**1507**
Maintenance Cost for 7 years	140	376.75
Maintenance Cost for 1 year	20	53.82
Power Required (kW)	380	664
Operating Hours per day	16	8
No of days of operation per year	300	300
Units consumed	18,24,000	15,93,600
Electrical Charges @ 3.57 per unit	65.12	0
Electrical Charges @ 8.00 per unit for non-conventional sources	0	127.49

A) FINANCIAL ANALYSIS (at 15% Discounting factor) **(Rs in Lakh)**

Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10-20)
Increase in Capital Cost	736.20	490.80								
Incremental Maintenance Cost	0.00	16.91	33.82	33.82	33.82	33.82	33.82	33.82	33.82	33.82
Cash Outflow	**-736.20**	**-16.91**	**-33.82**	**-33.82**	**-33.82**	**-33.82**	**-33.82**	**-33.82**	**-33.82**	**-33.82**
Savings in Electrical charges	0.00	32.56	65.12	65.12	65.12	65.12	65.12	65.12	65.12	65.12
Cash Inflow	**0.00**	**32.56**	**65.12**	**65.12**	**65.12**	**65.12**	**65.12**	**65.12**	**65.12**	**65.12**
Net Cashflow	**-736.20**	**15.65**	**31.30**	**31.30**	**31.30**	**31.30**	**31.30**	**31.30**	**31.30**	**31.30**
NPV_COST	**809.67**									
NPV_BENEFIT	**326.36**									
NPW	**-483.31**									
BCR	**0.40**									
IRR	**-2.25%**									

B) ECONOMIC ANALYSIS (at 15% Discounting factor) **(Rs in Lakh)**

Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10-20)
Increase in Capital Cost	**736.20**	**490.80**								
Incremental Maintenance Cost	0.00	16.91	33.82	33.82	33.82	33.82	33.82	33.82	33.82	33.82
Cash Outflow	**-736.20**	**507.71**	**-33.82**	**-33.82**	**-33.82**	**-33.82**	**-33.82**	**-33.82**	**-33.82**	**-33.82**
Savings in Electrical charges	0.00	63.75	127.49	127.49	127.49	127.49	127.49	127.49	127.49	127.49
Cash Inflow	**₹ 0.00**	63.745	127.49	127.49	127.49	127.49	127.49	127.49	127.49	127.49
Net Cashflow	**-736.20**	571.455	93.67	93.67	93.67	93.67	93.67	93.67	93.67	93.67
NPV_COST	**412.98**									
NPV_BENEFIT	**638.94**									
NPW	**225.96**									
BCR	**1.55**									
IRR	**25.93%**									

KEY OBSERVATIONS AND RECOMMENDATIONS

The project has been examined thoroughly for its technical feasibility, financial viability and economic viability. Based on the study, the key observations and recommendations are as follows :

1. The project falls in the Kandi belt of Talwara and Hajipur blocks of Hoshiarpur district in Punjab;

2. Comprising 10% of the geographical area of the state, kandi area has an undulating topography. The project area is mainly rainfed with small land holdings;

3. The Kandi Canal – a branch of Mukerian Hydel channel, passes through the project area and provides flow irrigation facilities to the area falling on its right side being at a lower elevation. However, the area falling on the left side of the Kandi Canal, being at a higher elevation, can only be irrigated through lift irrigation;

4. The proposed project aims to provide irrigation facilities to the area falling on the left side of the Kandi Canal in Talwara and Hajipur blocks of Hoshiarpur district by lifting water from Kandi Canal and using it for irrigation through solar powered Micro Irrigation (Drip and Sprinklers) in the fields of farmers;

5. The project will improve irrigation efficiency in the project area by efficient utilization of water;

6. Micro-irrigation system proposed under the project will also help in crop diversification with optimal utilization of land and water resources;

7. Most of the community lift irrigation schemes based using conventional electrical sources become non-functional, once the implementing agency moves out of project due to lack of maintenance personnel as also pumps becoming non-functional for higher recurring expenditure on fuel/electricity bills. Using pump with Solar Photo Voltaic system replacing the conventional electrical sources can be an effective solution to address these problem(s);

8. Conventional pumping system using diesel/electrical power have lower installation cost but higher and ever increasing operation and maintenance cost. As against this, solar powered pumping system will have higher installation cost but very low or negligible operation and maintenance costs;

9. The reliability of Solar pumping system is found to be much better than that of diesel/electrical pumping system;

10. The Solar Pumping System is highly effective with drip irrigation systems as it gives farmer(s) the ability to manage precision irrigation with certainty of power availability at the time of real need. Thus, the technology helps in increasing water use efficiency thereby conserving the precious natural resource i.e. water. Combining micro-irrigation system with solar power based pumping system is expected to save 40-60% of water;

11. The proposed off-grid Solar Photo Voltaic System is more viable in negligible/remote location such as the proposed project area in Kandi belt;

12. Considering the savings through lower power consumption, improvements in water usage efficiency, increase in yield, minimum maintenance costs, freedom from the burden of power cuts and load shedding, comparatively higher efficiency during summer months, long operating life of 20-25 years, the proposed project is expected to go a long way in raising the standard of living of the farmers in the Kandi Area;

13. The proposed micro-irrigation project using Solar Photo Voltaic Pumps sets in place of conventionally powered pump sets (Diesel/Electricity) has been found to be technically feasible by the study team;

14. The Department of Soil and Water Conservation has estimated the revised project cost of Rs. 41.27 crore . After thorough analysis and examination of these estimates, the Study Team recommends the total project cost of Rs. 40.94 crore for implementation of the proposed project of Solar Powered Community Micro-irrigation project in Kandi belt of Talwara and Hajipur blocks of Hoshiarpur district;

15. The proposed project has been subjected to financial and economic analysis with 15% discounting factor. It has been found that it is economically viable with ERR of 25.93% (BCR of 1.55) but financially unviable with FRR of -2.25% (BCR of 0.40);

16. Keeping in view the innovative nature of the project as also likely impact it will have on the livelihoods of the farmers of Kandi Area of Punjab, the Study Team recommends the implementation of the proposed project. Further, the Study Team also recommends that this innovative model may be replicated in other areas of the state.

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