



## Mid-Term Review (MTR) Report

of the UNDP-supported GEF-financed Climate Change Mitigation Project

## "Promoting the use of electric water pumps for irrigation in Sudan (PEWP)"

PIMS Number: 5324 - GEF ID 5673 - Project ID: 00094271 Implemented by: Ministry of Water Resources Irrigation and Electricity - Sudan



MTR Team Members: Ron Mukanya (International Consultant) Babiker Abdalla Ibrahim (National Consultant)

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#### Contents

LIST C	DF ACRONYMS	2
1.0 EX	ECUTIVE SUMMARY	3
2.0	INTRODUCTION	21
2.11	Background	21
2.2	DESCRIPTION OF THE PROJECT	22
2.3	PURPOSE OF THE MID-TERM EVALUATION	23
2.4	METHODOLOGY OF THE MID-TERM REVIEW (MTR)	24
2.5	STRUCTURE OF THE MID-TERM REVIEW (MTR) REPORT	24
2.6	RATING SCALES	25
3.0	THE PROJECT AND ITS SCOPE	26
3.1	ENERGY SHORTAGES, DIESEL PUMPS ISSUES AND OPPORTUNITIES IN SUDAN	26
3.2	PROBLEMS THE PROJECT SEEKS TO ADDRESS	26
3.3	PROJECT GOAL AND OBJECTIVES	27
3.4	PROJECT MANAGEMENT, IMPLEMENTATION AND COORDINATION ARRANGEMENTS	27
3.5	PROJECT TIMING AND MILESTONES	28
3.6	MAIN STAKEHOLDERS' ENGAGEMENT AND BASELINE ANALYSIS	28
3.7	Expected Results	30
3	8.7.1 Financing and dissemination mechanism established and operational to support a PV pump installation programme .	31
3	8.7.2 Financing and dissemination mechanism de-risked through technical standards and demand-side support	31
3.	8.7.3 Mitigation instrument design elaborated and implemented in support of the PV pump installation programme	32
3.		32
4.0	MID-TERM REVIEW (MTR) FINDINGS AND CONCLUSIONS	33
4.1	INTRODUCTION	33
4.2.	KEY OBSERVATIONS FROM STAKEHOLDER AND PROJECT STAFF INTERVIEWS.	33
4.3.	PROJECT DELIVERY, OUTPUTS, OUTCOMES AND RELATED TARGET(S)/SUB-TARGET(S), AS APPLICABLE	34
4.5.	EFFECTIVENESS, EFFICIENCY AND TIMELINESS OF PROJECT IMPLEMENTATION	41
4.6	REMAINING BARRIERS TO ACHIEVING THE PROJECT OBJECTIVE	41
4	e.6.1 Overburdened PMU and lack of a state level project implementation unit (PIU)/field office	42
4	4.6.2 Land under-utilisation and Sustainable Agricultural practices	42
4.	4.6.3 Low usage of counterfactual scenarios M&E system and capacity	42
4.	0.4 LOW levels of state level SWP technicians teskining (de-risking) in existing diesel pump Sivivies	44 11
4.7		44 57
4.0 1 Q	VVORK PLANNING	
4.9		50
4.10	1 SUGTAINADILITY	
4.11	1. UUSTAINADILITT	00 60
4		<b>r</b> 11 /
4.	1.11.2 Socio-economic risks to sustainability	60
4 4. 4.	I.11.2 Socio-economic risks to sustainability I.11.3 Institutional framework and governance risks to sustainability	61 61

List of Acro	nyms
СО	UNDP Country Office
CO <sub>2</sub>	Carbon dioxide
CSP	Concentrating Solar Power
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
На	Hectare, a unit of measure of land area equal to 10,000 square meters
HCENR	Higher Council for Environment and Natural Resources
IEA	International Energy Agency
M&E	Monitoring and Evaluation
MEFPD	Ministry of Environment, Forestry and Physical Development
MoP	Ministry of Petroleum
MoSC	Ministry of Science and Communications
MWRE	Ministry of Water Resources and Electricity
MFNE	Ministry of Finance and National Economy
MOAARI	Ministry of Agriculture Animal Resources & Irrigation - Northern State
MRV	Monitoring, Reporting and Verification
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NEC	National Electricity Corporation
NERC	National Energy Research Centre
NGO	Non-Governmental Organization
O&M	Operations & Maintenance
PEWP	Promoting the use of electric water pumps for irrigation in Sudan
PIR	Project Implementation Review
PMU	Project Management Unit
PPG	Project Preparation Grant
PPP	Public Private Partnership
PB	Project Board
PV	Photovoltaic
QPR	Quarterly Progress Report
RCU	UNDP Regional Coordination Unit
RE	Renewable Energy
RTA	UNDP Region-Based Technical Advisor
SMME	Small, Medium and Micro-Sized Enterprises
SWH	Solar water heater
TPR	Tripartite Review
TTR	Terminal Tripartite Review
TWh	Terawatt-hour
WB	World Bank
UNDAF	United Nations Development Assistance Framework
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate

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#### 1.0 Executive Summary

The agricultural sector contributed approximately 30% of Sudan's Gross Domestic Product (GDP) in 2013, and is reported to employ 80% of the workforce. Although a significant portion of Sudan's cultivated area depends on rainfall for water, the irrigated lands contribute approximately 75% of the added value from agriculture. There are three irrigation systems within the country; pumped, gravity-driven and flood irrigation. The focus of the proposed UNDP-GEF project is the replacement of small and medium diesel pumps with solar pumps. Historically rising costs of energy have been one of the main drivers of high inflation in Sudan. Given the importance of the agricultural sector to the overall economy, reducing the cost of energy, particularly for small farmers, is a major priority for continued growth of the sector.

Sudan has significant potential for development in the agricultural sector. The country has promising water and arable land resources; however, these resources are not fully exploited. Because of the size of employment in the agricultural sector, its development is one of the main contributors to poverty alleviation in Sudan. Agriculture represents 80% of non-petroleum export revenues of the country. The cultivated land area in Sudan ranges between 12.5 and 17 million hectares based on annual rainfall intensity and its distribution.

The agricultural sector has by far the largest share of CO<sub>2</sub>e emissions in Sudan, represented approximately 74% of the total emissions produced in the country. The GHG emissions as reported are mainly from enteric fermentation and manure management with no GHG emissions attributed to the use of diesel for pumping water.

Sudan currently has a generation capacity of 2,723 MW of power; it has practically no grid connected solar or wind generation capacity and very little off-grid solar capacity.

To meet the Government's target of 75-80% electrification by 2031, the Government plans to install 12,000 MW of additional generation capacity by 2031. This is to include 1,582 MW of renewable energy (other than large-scale hydro-power). This project aims to install 1,468 PV pumps in off-grid regions with a total installed capacity of 6.5 MW. This potential capacity represents 0.2% of the current generation capacity and 0.4% of the planned non-hydro generation capacity. It aims to help Sudan and Sudanese farmers reduce their reliance on fossil fuels, reduce their cost of production (via decreased diesel expenditures), increase the sustainability of water use, and increase their income. The cost of diesel fuel constitutes the major burden of irrigation to the small producers in the Northern State. The ranking of agricultural costs indicates that the highest cost of crop production goes to labour, followed by diesel, fertilizers, pesticides and land preparation. The project has been designed to play a catalytic role in the transformational scaling up of solar power for productive use in Sudan's agricultural sector.

The project has the following four (4) integrated outcomes:

- 1. **Outcome1**: Financing and dissemination mechanism established and operational to support a PV pump installation programme.
- 2. **Outcome 2**: Financing and dissemination mechanism de-risked through technical standards and demand-side support.
- 3. **Outcome 3**: Mitigation instrument (NAMA) design elaborated and implemented in support of the PV pump installation programme.
- 4. **Outcome 4**: Supportive enabling environment and scaled-up implementation.

The purpose of this Mid-Term Review (MTRs) is to provide an overall assessment of the project and an opportunity to critically assess administrative and technical strategies and issues. More specifically, the MTRs are implemented to meet the following objectives: i) to assess progress being made towards the attainment

amendments to project design and improvements to project implementation; iv) to assess the effectiveness of and promote accountability for resource use; v) assess early signs of project success or failure with the goal of identifying the necessary changes to be made in order to set the project on-track to achieve its intended results; and vi) to document and disseminate lessons learned.

The evaluation gives recommendations to improve the potential of the project to achieve expected outcomes and objectives within the project timeframe. The MTR of PEWP has identified a number of issues that are presented in the following section as recommendations for use in the way forward and implementation of similar projects in future as Sudan has adopted a programme for displacing diesel pumps into solar pumps in the Northern State.

#### Project performance and progress

#### Project performance

The mid-term performance of the project against the targets measured through the indicators is evaluated based on its feasibility, effectiveness, efficiency, relevance and sustainability. Most of the direct technical assistance activities for PV solar pump systems for irrigation performed thus so far are satisfactory and their integration to support in promoting the use of PV solar water pumps for irrigation in Sudan is high. The overall performance of the project is highlighted in Table 1below.

Intervention	Feasibility	Effectiveness	Efficiency	Relevance	Sustainability
Project Design	5	n/a	n/a	R	n/a
Implementation Approach	5	4	4	R	3
Stakeholder Involvement <sup>1</sup>	6	5	4	R	5
Technical Reporting	5	4	4	R	n/a
Financial Reporting	4	4	n/a	R	n/a
Integrated Nature	5	3	4	R	4
Office facilities and staffing	6	3	3	R	4
Capacity building support	6	3	3	R	4
Awareness raising and addressing perceptions towards the introduction of the solar pump within appropriate timeframe development <sup>2</sup>	6	5	4	R	4

#### Table 1: Overall Project Performance

4

<sup>&</sup>lt;sup>1</sup> Defined as the ability of stakeholders to interact with one another in order to facilitate the implementation of the projects intervention (WHO, 2007:18). Available online at <a href="http://www.who.int/dietphysicalactivity/griffiths-stakeholder-involvement.pdf">http://www.who.int/dietphysicalactivity/griffiths-stakeholder-involvement.pdf</a>

<sup>&</sup>lt;sup>2</sup> 55% need more guarantees on the new technology; 40% need flexible funding opportunities; 3% fear the risk of failure; 1.8% others (do not know)

Provide direct technical assistance for investment / banks providing finance for solar PV pumps	6	3	3	R	3
Support the adoption of solar PV technology for water pumping for irrigation in agriculture	5	3	3	R	3
Putting in place legislation and a framework to promote private sector involvement in renewable energy in Sudan	5	5	n.a	R	5
Develop standards and guidelines to promote quality and sustainability of water pumping	4	3	n.a	R	3
Development of a NAMA to support solar water pumping	6	n/a	n/a	R	2
Developing a supporting environment to encourage scaling up and further replication	6	5	5	R	4
Stakeholder engagement <sup>3</sup>	6	5	4	R	n/a
Documentation and communication	5	4	4	R	4
Professional Trainings	6	6	6	R	4
Task teams	6	6	6	R	4
Regular M&E	5	5	4	R	4

Score: Feasibility, Effectiveness, Efficiency: 6 = highest, 0 = lowest

n/a = not assessed or non-assessable.

Sustainability	Relevance	Impacts (where applicable)
(5 = negligible risks, 1 = severe risks)	2. Relevant (R)	3. Significant (S)
	1. Not relevant (NR)	2. Minimal (M)
		1. Negligible (N)

The project has identified numerous off-grid PV solar pumps' best practices to overcome barriers to financing, dissemination mechanisms and operational support for a PV solar pump installation programme in Sudan to be tested, up-scaled or replicated as standard interventions. While the feasibility of most interventions is good, some efficiency and effectivity aspects like state-based local capacity i.e. state level project implementation unit (PIU), detailed socio-economic data tracking and local artisan or skills development challenges appear in interview responses. Effort plus time needs to be put into trying to resolve these ineffective inefficiencies as this will strengthen the overall project impact in the medium to long term aiding its sustainability beyond the current successes. The progress towards the achievement of the Project' Development Objective (PDO) which is "financing and dissemination mechanism established and operational to support a PV pump installation programme" is highlighted and elaborated on or justified upon in the sections below.

<sup>&</sup>lt;sup>3</sup> Defined as the process by which the project involves people who may be affected by the decisions it makes or can influence the implementation of its decisions (International Finance Corporation, 2007). Available online

http://www.ifc.org/wps/wcm/connect/938f1a0048855805beacfe6a6515bb18/IFC\_StakeholderEngagement.pdf?MOD=AJPERES

## **Project Progress**

Table 2: MTR Ratings &	Achievement Summar	y Table for	(Promoting	the use of	electric water	pumps)
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Measure	MTR Rating	Achievement Description
Project Strategy	N/A	The project was designed to promote the use of electric water pumps irrigation in Sudan and it involved a large variety of stakeholders in its design phase. The project strategy is sound, with a series of mutually establishing and operationalising sequential financing and dissemination mechanism outcomes, starting with strengthening the regulatory framework, followed by de-risking a PV pump installation programme through technical standards and demand-side support. he logframe reflects a country-driven strategy that also recognises that the next step in the strategy was to be strengthening the capacities by creating a supportive enabling environment and scaled-up implementation alongside a Mitigation instrument (NAMA) design elaborated and implemented in support of the PV pump installation programme. The 5-year implementation timeframe was also designed to accommodate monitoring of the implementation of the PV pump installation programme.
Progress Towards Results	Objective Achievement Rating: ( <i>rate using 6 pt. scale</i> ) 6 pt. Highly Satisfactory (HS)	Based upon monitoring results, published in 2018, of progress towards the targets set in the project strategy, 29 pumps with power have now been installed and exceeded the 28 pumps target set for the pilot phase planned baseline project. The number of banks providing finance for solar PV pumps as members of PV Fund is 11 banks with the 29 pumps savings due to avoided diesel cost (207360) SDG/ 6 months.
		This is partly due to the more efficient appliances on the market, thus indicating that energy performance has increased to some degree without diesel use. The savings are directly contributable to the GEF project. There are still more potential gains to be made, particularly with respect to water security and food security and the solar pump programme has made satisfactory contributions in this regard. In the short-term, however, there are concerns regarding the readiness of the reduction of down-time and farmer's time lost to pump repair if local artesian skills aren't developed and uptake of more efficient solar pumps will likely be hindered due to the low level of awareness and lack of incentive programmes. Furthermore, the unsatisfactory liquidity situation being realised on the ground at present has potentially adversely impacted the effectiveness in achievement of the project objective, and has diminished the likelihood that the results achieved will be sustained.
	Outcome 1 Achievement Rating: ( <i>rate using 6 pt. scale</i> )	Financing and dissemination mechanism established and operational to support a PV pump installation programme
	4 pt. Moderately Satisfactory (MS)	The first phase is the pilot phase in which the UNDP/GEF has provided a fund to purchase solar pumps and distribute them to 28 selected small pump farmers in the Northern State which has been successfully completed. The second phase implementation is now following after the completion of the pilot phase. The first phase funded the initial investment capital covering the installation of the 28 demonstration small pumps irrigating from the River Nile, Mattara and ground water sources in the seven localities of the State which has seen 28 solar pumps ranging from 56.4 Kwp to 257.40 Kwp installed in a phased approach and under operation for between 10 months to over a year for some with repairs and maintenance needs, except for two pumps that had defects on inverters which were checked and repaired in about one working day for each. In comparison with the diesel pump systems, there is at least two repairs with 2-day intervals per year. At present the central government funds 25% and the beneficiary farmer(s) pay the remaining 25%.
	Outcome 2 Achievement Rating: ( <i>rate using 6 pt. scale</i> )	Financing and dissemination mechanism de-risked through technical standards and demand-side support.

6

	5 pt. Satisfactory (S)	The technical standards that will see a fully-fledged SWP system testing lab up and running in a few months' time enable a private sector driven PV SWP market that meets a certain benchmarked standard which was highly lauded by stakeholders and highlighted multiple times as something which wouldn't have been achieved if it wasn't for this project. Evidence on progress thus far shows that at this MTR stage it's safe to conclude that the financing and dissemination mechanism is de-risked through the SSMO developed technical standards with a few action points that are being finalised over the final duration of the project.
	Outcome 3 Achievement Rating: ( <i>rate using 6 pt. scale</i> )	Mitigation instrument (NAMA) design elaborated and implemented in support of the PV pump installation programme.
	4 pt. Moderately Satisfactory (MS)	It must be noted that this outcome has the greatest number of activities that still haven't been done which are not yet in progress at this MTR stage. However, there is evidence on the progress of the Nationally Appropriate Mitigation Action (NAMA) thus far that shows amongst others, the contract signing process of the National consultant to develop standardized baseline within a NAMA and his selection is still in progress. The National consultant to develop an MRV mechanism selection and contract signing process is ongoing. A baseline survey including socio-economic study for this outcome area has been conducted by NewTech Consultancy Company. A workshop was also conducted for the results and outcomes of the Baseline survey which this MTR confirms.
	Outcome 4 Achievement Rating: (rate using 6 pt. scale)	Supportive enabling environment and scaled-up implementation.
	Trainig. (rate using o pl. seale)	Evidence on progress thus far shows that a decision was issued by the Council of
	5 pt. Satisfactory (S)	Ministers to exempt the system of solar energy pumps from customs duties and taxes. The inclusion of solar pumps in fiscal concessions lists of the Investment Law and the Agricultural Implements Regulation such that they receive preferential financial treatment has been done. Also, 15,000 pumps have been included in the 5 Year plan and a feasibility study for this is in progress which is a sign of progress towards PV Pumping integration into a futuristic National Energy Roadmap and Rural Energy Access Strategy which has renewable energy playing a key catalytic role in it. The planning of the installation of 3,000 solar water pumps has already started under the MWRIE. As a result of this project, interest from other donors has been strong with the Korean Organization for International Cooperation (KOICA) having agreed to repeat the experiment using this project's methodology in the state of the River Nile. The contracting of a national consultant for conducting a feasibility study in different states for the project replication is in progress.
Project Implementation & Adaptive Management	(rate using 6 pt. scale) 6 pt. Highly Satisfactory (HS)	The project was approved, it commenced implementation in February 2016. However, it took a second recruitment process for the project manager (PM) position to be filled as the first PM resigned after being recruited. Significant implementation delays of seven (7) months due to reasons which were unforeseen risks yet out of the control of the project team i.e. the resignation of the first Project Manager with a replacement being recruited, selected and appointment thereafter. There were also some structural barriers which had to be resolved as elaborated upon under Outcome 4 that did get resolved after a while delaying implementation but resulted in a decision being issued by the Council of Ministers to exempt the

		systems of solar energy pumps from customs duties and taxes which is seen as key to barrier removal by all the stakeholders. As a result of this delay, the project has been put under immense pressure to implement the pilot PV solar water pump installations to catch up on lost time which has enormous demands for the pilot phase results of seeing the installations in place from all stakeholders. This is a highly satisfactory level of delivery, and the delays associated have been resolved through strong adaptive management. Due to this strong adaptive management efficiency, the incremental reasoning of the GEF support has been considerably strengthened and the added value of the GEF-funding has been so far significant. The project requires more intensive and more integrated working to build the capacity of Agricultural extension officers to maximise the water security resulting from this project.
Sustainability	(rate using 4 pt. scale)	Enhances sustainability:
	3 pt. Moderately Likely (ML)	<ul> <li>Strategic Government investment supporting upgrade of SSMO testing laboratories;</li> <li>Strong willingness of the industrial sector to comply with PV regulations;</li> <li>Promulgation of SSMO technical standards on minimum energy performance standards for SWP appliances and equipment – development of standards and guidelines to promote quality and sustainability of water pumping;</li> <li>Aligning technical standards and regulations to international best practice;</li> <li>Strengthened partnership between private and public sector.</li> <li>Uptake of more SWP expected to be very high over the short-term due to government subsidy incentive programmes and high awareness;</li> <li>Reducing Sudanese farmers reliance on fossil fuels, reduces their cost of production (via decreased diesel expenditures), increase the sustainability of water use, increase their income and this situation is likely to change in the foreseeable future.</li> </ul>
		<ul> <li>Diminishes sustainability:</li> <li>Uncertain financial liquidity sustainability of the market or liquidity crunch constrained environment that's currently in existence (<i>including but not limited to high level of inflation and exchange rate and money transfer</i>) posing a risk;</li> <li>Limited access to SSMO testing laboratories;</li> <li>Current Sudan's agriculture economy remains heavily reliant on fossil fuels for energy generation.</li> </ul>

The following recommendations compiled below have been formulated to support improving project effectiveness and enhance the likelihood that project results will be sustained after GEF funding ceases.

# Outcome 1: Financing and dissemination mechanism established and operational to support a PV pump installation programme

The project is positively progressing towards achieving its development objectives. This outcome has been identified as a precondition for the other outcomes whose implementation at the start of the project was delayed by about seven (7) months due to reasons which were unforeseen risks yet out of the control of the project team i.e. the resignation of the first Project Manager with a replacement being recruited, selected and appointment thereafter. There were also some structural barriers which had to be resolved as elaborated upon under Outcome 4 that did get resolved after a while delaying implementation but resulted in a decision being issued by the Council of Ministers to exempt the systems of solar energy pumps from customs duties and taxes which is seen as key to barrier removal by all the stakeholders. As a result of this delay, the project has been put under immense pressure to implement the pilot PV solar water pump installations to catch up on lost time which has enormous demands for the pilot phase results of seeing the installations in place from all stakeholders.

The Project is being implemented in two phases as planned. The first phase is the pilot phase in which the UNDP/GEF has provided a fund to purchase solar pumps and distribute them to 28 selected small pump farmers in the Northern State which has been successfully completed. The second phase implementation is now following after the completion of the pilot phase. The first phase funded the initial investment capital covering the installation of the 28 demonstration small pumps irrigating from the River Nile, Mattara and ground water sources in the seven localities of the State which has seen 28 solar pumps ranging from 56.4 Kwp to 257.40 Kwp installed in a phased approach and under operation for between 10 months to over a year for some with repairs and maintenance needs, except for two pumps that had defects on inverters which were checked and repaired in about one working day for each. In comparison with the diesel pump systems, there is at least two repairs with 2-day intervals per year.

The Fund is provided by UNDP-GEF jointly with the Ministry of Finance and other Ministries of Irrigation, State Ministry of Agriculture and others. The demonstration units are expected to prove and build trust amongst farmers that solar pumping is an attractive viable alternative option to diesel pumping. The Initial Fund will provide a financing mechanism associated with a subsidy that reduces the high capital cost of the pump, reduce risks and increase the capacity of the farmers to purchase the pumps. At present the central government has committed to fund 50% of the pump costs, whilst the state level government funds 25% and the beneficiary farmer(s) pay the remaining 25%. This demonstrates government commitment towards this project, country ownership. The PV Fund mechanism has approval from minister of Finance and national Economy and it has been established and consists of 11 commercial Banks with an initial capital of US\$ 4 million for the 2018 plan (portfolio of projects (Banks) which the Central Bank of Sudan developed). The Board of Directors was formed under the chairmanship of the Central Bank of Sudan. For this Outcome, the MTR can conclusively state that the financing and dissemination mechanism has been established but with some logistical operational issues plus monitoring and evaluation gaps to effectively and efficiently support the PV pump installation programme as explained in the recommendations and also additionally under Outcome 4. The second phase is planned to be funded by a consortium of local commercial Banks. The consortium has to provide a fund for lending an additional 1,440 solar water pumps to the small farmers in the 3 types of irrigation pump system in the seven localities within a liquidity constrained environment that's currently in existence (including but not limited to high level of inflation and exchange rate and money transfer) posing a risk.

**Recommendation 1a** (*Responsible Party: UNDP*): Under this component, some in-effectivity and inefficiency has been picked up during the MTR under the dissemination mechanism establishment and operationalisation which requires rectifying as if unaddressed, it creates an unsupportive enabling environment and scaled-up implementation which is what Outcome 4 sought to achieve. There were no state level project team members except one/ there was no project implementation unit to run the daily operations from within the Northern state, yet this is where the key project day to day activities are being implemented and the bulk of its activities are taking place. The project management unit (PMU) is overwhelmed with project requirements and practically loses two days travelling to and from the Northern State as google maps approximates the distance to be about +/-7 h 52 min (637.1 km) via A11 which isn't a sustainable operational modality to implement such a project with intense on the ground person to person engagements with farmers in the Northern State.



Figure 1: setting up and funding PIU in developing project management capacity in the Northern State

EA = executing agency, IA = implementing agency, O&M = operation and maintenance, PIU = project implementation unit.

Note: Arrows indicate effect relationships.

Source: https://www.oecd.org/dac/evaluation/dcdndep/34988492.pdf

The lack of a state level project implementation unit (PIU) has put an enormous administrative, travel and reporting burden on the PMU team in Khartoum. This can be alleviated by establishing a PIU with the characteristics listed on the right of Figure 1 above. It must also be noted that there is no technical procurement support that exists for the PMU as things which adds additional workload. State level "on an On-Call Basis" technical capacity can be put in place for an additional number of Engineers alongside a Monitoring and Evaluation Specialist with some communication and administration or project management skills (*they could be junior or middle level appointments rather than senior level*). Incurred travel costs and every set of two work days lost on travel could work out to cover the relevant Northern state-based Measuring, Reporting and Verification (MRV) activities on an "On-Call Basis" salary requirement.

Some of the data required for the programme refers to farmer level change on their respective feddans. Information on the situation at pilot project' beneficiary level still needs to be gathered, and often will require a degree of local knowledge to assess whether such change can be considered to have happened in the locality. There have been discussions on whether the single Khartoum based PMU M&E Specialist (M&ES) is best placed to gather farmer level data. It is currently considered that, in general, if recruited local state level PIU staff support working in the community concerned would be best placed to gather this farmer level data, which would then be submitted to the M&ES, who would aggregate the submissions from different farmers into a programme level figure. This is recommended because:

- When recruited local state level PIU support staff working in a community should anyway be aware of the state level data concerning their sector of intervention;
- When recruited local state level PIU support staff working in a community are best placed to be able to provide a 'reality check' or 'local knowledge' on the accuracy of Government figures and to be able to provide qualifying comments or alternative sources to the M&ES if required.
- Gathering some figures within required timeframes may require 'knocking on doors' which is easier done by a recruited local state level PIU support staff working in a community than by the M&ES trying to cover seven or more sparse localities whilst working or operating fulltime alone on M&E out of the Khartoum PMU.

However, in all cases the M&ES will be expected to provide technical advice and backstopping to the state level PIU staff that are gathering this data. The M&ES will also aggregate the data from different farmers across the programme in order to enable the Project to deliver programme level reports to GEF and all other stakeholders as required. This approach will be kept under review by the M&ES and may be adjusted if necessary.

#### Recommendation 1b (Responsible Party: UNDP): Under this component, the seven months long project delays experienced have left this project with no socio-economic Monitoring and Evaluation tools/system in place to effectively and efficiently compare the socio-economic of the farmers before receipt of the solar water pump (SWP) systems and after receipt and installation of the SWP. A retrospective collection of this socioeconomic information or data needs to be done on the 28 pilot farmers so that clear indicators for example on: average crop area; production and productivity, crop composition by area; cost saving/increase; crop or animal yield increase/decrease; agricultural input expenses reduction/increase and the number of pumping system using water efficient irrigation methods etc. can be traced/tracked and be attributable to the project as a positive or negative outcome as this project potentially has a very powerful "story of change" attributable to it. The performance of the SWP also requires monitoring and this must also be done alongside the socioeconomic data collection process recommended here. For those farmers who've put their names forward for consideration for the next phase that aims to rollout 1,440 SWPs, then the same exercise must be done as they register their names for consideration so that this information is already available and at hand before they even receive a SWP. This in-effectivity and inefficiency has also been picked up during the MTR under operationalisation which requires addressing and if unrectified it creates an unsupportive enabling environment and scaled-up implementation which is what Outcome 4 sought to achieve. The failure to paint a good or bad economic, financial and social picture of benefits emanating from this project would be selling this brilliant innovative intervention short and this requires rectification for the sake of impactful project impact and achievements communication purposes. Outcomes 4 and 2 also partly touch on this issue as it cross cutting and put forward a few suggestions worth considering to implement the retrospective data collection.

**Recommendation 1c** (*Responsible Party: UNDP, Ministry of Finance & PV Fund consortium*): Given the current liquidity risk inexistence, the PV Fund consortium needs to explore other mechanisms/ways to seek additional diversified funding support if needed through the government from other international organisations including the Clean Development Mechanism (CDM), the Climate Adaptation Fund, the Green Climate Fund (GCF) etc. Diversification is a form of risk management and the liquidity risk needs to be managed. To further leverage upon the 18 suppliers that have already being selected and qualified to provide 400 solar PV water pumps for the project's 2018 plan by national PV fund mechanism. The introduction of a new technology such as the solar water pumps in the production cycle is vital for competitiveness of agricultural production given the recent experiences with the fluctuations and shortages in the electricity power in the national grid and in the State. It became clear that introducing the solar pumps is a wise decision that needs to be explored and expanded. In such cases it is important to be able to measure the change that could result from the introduction of such technologies before their dissemination largely. The introduction of solar water pumps will support the production of both winter and summer crops and will increase the income opportunities of the small farmers thus improving their food security position and livelihoods.

## Outcome 2: Financing and dissemination mechanism de-risked through technical standards and demand-side support.

When it comes to imported counterfeit SWP systems, this is one outcome which has been highly appreciated and seen as a key barrier removal by the Sudanese Standards and Metrology Organization (SSMO). The project's role in enabling setting up of technical standards was greatly commended and appreciated as ground breaking for Sudan. The technical standards that will see a fully-fledged SWP system testing lab up and running in a few months' time enable a private sector driven PV SWP market that meets a certain benchmarked standard which was highly lauded by stakeholders and highlighted multiple times as something which wouldn't have been achieved if it wasn't for this project. Evidence on progress thus far shows that:

- A solar committee was formed under the Sudanese Standards and Metrology Organization (SSMO) to adopt technical quality standards.
- A global standard has been selected in the field of solar power pumps to be the basis for the Sudanese standard in this field and has been adopted by higher management of SSMO.
- A National Consultancy institution working in the field of testing laboratories and solar pumping systems has been selected to prepare the tender document for establishing the PV pumps laboratory.

- An institution working in the field of procurement and installation of laboratories of solar pumping systems has been selected. Contract signing on progress.
- One of (29) solar water pumps has been installed at the Agricultural Research Station (ARC)-Dongola.
- Training: 4 engineers from 3 efferent government entities have been trained on basic information and specifying and supplying solar pumps and how to use software sizing tool (one training course).
- PVsyst software licensing: 4 Licenses of PVsyst software, have been purchased, of which:
  - 2 Licenses of PVsyst software have been granted to The General Directorate of Renewable and Alternative Energy.
  - Another 2 Licenses of PVsyst software with Project Management Unit (PMU).

Overall, at this MTR stage it's safe to conclude that the financing and dissemination mechanism is de-risked through the SSMO developed technical standards with a few action points that are being finalised over the final duration of the project.

Recommendation 2a (Responsible Party: UNDP & MWRE): PEWP project should aim to resolve the demand-side support technicalities mentioned about the number of entities trained and capable of specifying and supplying solar pumps. It's good that government has trained its officials, however the local existing state based private sector can play a significant role with complementation of this through existing local state based small businesses that only specialise in diesel pumps at present. In practice there is need to enable a community-based approach from technologies that can be benefited from using already existing skill sets and diversifying those skills towards the new technology. PEWP project's responsibility would be restricted more to making sure local artesian skills for the local diesel pump technician are broadened to the repairs and maintenance of solar water pumps - as diesel is slowly but surely phasing out, we don't want these diesel pump technicians out of work but for them to transition their service from diesel specialism to solar as this change is taking place on the local farms. This triggers the technology support and delivery system strengthening from a very early stage of local graduates as the project can't simply rely on experts to come in from Khartoum for certain simple aspects which local well capacitated technicians can do. More of these localised diesel oriented small businesses need to start becoming active players in the SWP sector and be part of the learning of this process to build local capacity and capability within this sphere of expertise at a localised level. Hybrid-ing wind energy with solar on solar powered agricultural farms for water pumping to be financed by farm owners is another avenue which if explored with cooperation from institutions of higher education will add value to the notion of SWP technology support and strengthen the delivery system. This is an area that will be required on an ongoing basis beyond the current installations as it determines how the local pool of expertise is developed for a stronger Sudanese renewable energy sector with SWP well catered for. Otherwise, a negative reputation of the project might emerge when the technology is fully implemented and all of a sudden, when the diesel pump technicians realise they are out of work yet can't work on SWPs which will not fully provide the benefits to the local communities by also enabling these smaller diesel pump technicians to become active in the SWP sector for adaptation effectiveness in a development context further notes in Outcome 4 also complement this point.

**Recommendation 2b** (*Responsible Party: UNDP, Ministry of Finance & MWRE*): The PEWP project should also aim to demonstrate the national benefits and savings in implementation of PV SWP water pumping, including avoided infrastructure costs. The ultimate goal of adaptation is to ensure that human wellbeing can be maintained or improved in the face of stresses and shocks. For the demand-side support aspect, the project needs to consider developing a certified training module for operation and maintenance technicians with the likes of the Energy Research Center - University of Khartoum or its equivalent.

- Develop a monitoring network for underground water in the northern state.
- Develop a training module for PV water pump performance.
- Develop a training module for project management (including contract management).

## Outcome 3: Mitigation instrument (NAMA) design elaborated and implemented in support of the PV pump installation programme.

It must be noted that this outcome has the greatest number of activities that still haven't been done which are not yet in progress at this MTR stage. However, there is evidence on the progress of the Nationally Appropriate Mitigation Action (NAMA) thus far that shows amongst others, the contract signing process of the National consultant to develop standardized baseline within a NAMA and his selection is still in progress. The National consultant to develop an MRV mechanism selection and contract signing process is ongoing. A baseline survey including socio-economic study for this outcome area has been conducted by NewTech Consultancy Company. A workshop was also conducted for the results and outcomes of the Baseline survey which this MTR confirms.

**Recommendation 3a** (*Responsible Party: UNDP & MWRE*): As a medium-to-long term fund seeking technology support and delivery system strengthening, the NAMA as an instrument needs to be designed, elaborated upon and implemented in support of the PV pump installation programme. This should aim to build a localised business case to sought additional financial resources to upscale this programme using this mitigation instrument. Equally so multi-lateral institutions like the Green Climate Fund (GCF) can also be approached to fund a scaling up project of the proof of concept from this GEF supported project to make the most of the current gains made through the GEF support in order to pave the way for further market development and scaled solar energy uptake in the potential areas.

#### Outcome 4: Supportive enabling environment and scaled-up implementation.

Evidence on progress thus far shows that a decision was issued by the Council of Ministers to exempt the system of solar energy pumps from customs duties and taxes. The inclusion of solar pumps in fiscal concessions lists of the Investment Law and the Agricultural Implements Regulation such that they receive preferential financial treatment has been done. Also, 15,000 pumps have been included in the 5 Year plan and a feasibility study for this is in progress which is a sign of progress towards PV Pumping integration into a futuristic National Energy Roadmap and Rural Energy Access Strategy which has renewable energy playing a key catalytic role in it. The planning of the installation of 3,000 solar water pumps has already started under the MWRIE. As a result of this project, interest from other donors has been strong with the Korean Organization for International Cooperation (KOICA) having agreed to repeat the experiment using this project's methodology in the state of the River Nile. The contracting of a national consultant for conducting a feasibility study in different states for the project replication is in progress.

However, an enabling environment<sup>4</sup> is a rich and varied space where risks are minimised and well managed Such as Multi-level, multi-stakeholder work on enabling environments. Connecting interventions at different scales of action and government is essential (DFID, 2011a, p.10) The solar pumps technology support and delivery system has not been strengthened with a lot of local technical training/artesian skills development and learning being undertaken from installations on the project's implementation and contexts elsewhere which is very good.

**Recommendation 4a** (*Responsible Party: UNDP, Ministry of Agriculture & MWRE*): address the business as usual land under-utilisation by SWPs farmers in the summer season through the Ministry of Agriculture's (MOA) extension services role. From a Sustainable Agriculture point of view, the MOA must be represented on this project's advisory structure (Project Board). At state level the MOA through its existing extension officers must support the project for increased yield and animal husbandry activities. There is a great need for a multi stakeholder and inter-ministerial coordinated management approach to improve the affordability, reliability, and environmental sustainability of this food, energy, and water nexus initiative. As

<sup>&</sup>lt;sup>4</sup> in general, developing the enabling environment thus consists of developing:

<sup>1)</sup> Supportive legal and policy frameworks and their implementation and enforcement

<sup>2)</sup> Institutional strengthening including coordination, clear roles and responsibilities of key entities (government, non-state actors including civil society)

<sup>3)</sup> Capacity strengthening of all actors so they can play their roles

<sup>&</sup>lt;sup>4)</sup> Social dialogue including participation of stakeholders (including links to issues such as decentralisation). See for details on analysis <u>http://eese-toolkit.itcilo.org/</u> (Source: <u>https://europa.eu/capacity4dev/iesf/blog/enabling-environment-definition-and-reference-tools-0</u>)

#### **Illustration 1**

This project should be viewed as an inter-ministerial food, energy, and water (FEW) learning curve where the Ministry of Agriculture is also represented and it must support the project from a yield and animal husbandry to maximise the gains of having on farm water security from the SWP which this project is installing and sustainable energy which guarantees water supply.



**Source**<sup>5</sup>: Ximing Cai, Kevin Wallington, Majid Shafiee-Jood, Landon Marston, 2018



**Source**: Scanlon, B. R., Ruddell, B. L., Reed, P. M., Hook, R. I., Zheng, C., Tidwell, V. C., & Siebert, S. (2017). The food-energywater nexus: Transforming science for society. *Water Resources Research*, 53(5), 3550–3556. https://doi.org/10.1002/2017WR020889

Currently some land is still underutilised yet on the farm. Increased crop yield and animal production imply an increase in income/revenue the farmers generate when they sell off their produce. This is a critical success factor when it comes to the farmers' ability and capability for repayments of borrowed finances and loans. As such, this is also a critical success factor to immediately demonstrate the fundability of the SWP concept and the farmers' repayment capacity which proves the concept is viable, works and is sustainable as also recommended under Outcome 1. The absence of a visible Ministry of Agriculture in the implementation of this project to fully support post SWP installation on farm agriculture activities and practices is a missed opportunity to maximise the SWP investment. It's also a missed opportunity for better return of investment of the SWP systems which is counterproductive and doesn't give the project any value for money beyond the SWP installations.

The project learning also need to be adapted for each FEW system outcome areas so that an integrated systems approach at implementing this project is strengthened which is a win-win scenario for all interested parties. By so doing a wholly supportive enabling environment and scaled-up implementation is enhanced and strengthened even further. Emerging interdisciplinary science efforts are providing new understanding of the interdependence of food, energy, and water (FEW) systems. These science advances, in turn, provide critical information for coordinated management to improve the affordability, reliability, and environmental sustainability of FEW systems. A combination of Interdisciplinary research (IDR)<sup>6</sup> and Trans-disciplinary

<sup>&</sup>lt;sup>5</sup>Understanding and managing the food-energy-water nexus – opportunities for water resources research. Advances in Water Resources Volume 111, January 2018, Pages 259-273. https://www.sciencedirect.com/science/article/pii/S0309170817304475

<sup>&</sup>lt;sup>6</sup> is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice (Rosenfield 1992). <u>https://www.obesity-cancer.wustl.edu/en/about/what-is-transdisciplinary-research</u>

research<sup>7</sup> must be used for this water-food-energy (WEF) nexus project as water security, energy security and food security — are inextricably linked and that actions in one area more often than not have impacts in one or both of the others. WEF is central to sustainable development.

The inextricable linkages between these critical domains require a suitably integrated approach to ensuring water and food security, and sustainable agriculture and energy production. Internship or bursary<sup>8</sup> using Ethnographic<sup>9</sup> research methods are important to generate raw data packaged and published as PhD and Master degree thesis organising, compiling information that will feed into reports and communications pieces effectively, and showcasing socio-economic development benefits as well as environment results. The PhD and Masters research studies can be based on "different country typologies for Sudan, allowing a quick assessment of possible interventions against overarching development goals such as food security, and the sustainability of the use and management of energy and water supplies" (FAO, 2018).Studies on the food, energy, and water (FEW) nexus lay a shared foundation for researchers, policy makers, practitioners, and stakeholders to understand and manage linked production, utilisation, and security of FEW systems.

As already suggested above under recommendation 1b, it's worth having a retrospective socio-economic survey done for the 28 farmers who've received the SWPs and equally so the next lot of 1,440 be surveyed too (even if it's a simple primary field research exercise done in consultation with the institutions of higher learning and education who can use their PhD and Master's students) to assist with data collection from the targeted farmers as a priority. The project' socio-economic survey interventions going forward must be more targeted and part of the potential beneficiary farmers' recruitment process. Even if it's at their own costs through Master and Doctoral students as a start so that their students can graduate, this will assist the project immensely. Some typical indicators that can be used at the impact level of this project's socio-economic survey can be:

- (a) Number of farmers whose main livelihood(s) (crop land, livestock, other) is managed using PEWP initiated practices as a result of SWP support;
- (b) Productivity levels and volumes of crop yields before receiving a SWP and after receipt;
- (c) Levels of agricultural produce diversification e.g. crops only, animals only, crops and animals etc.;
- (d) 'Conventional' development or well-being indicators such levels of food security, nutrition, savings, assets, employment etc.;
- (e) Number of farmers covered by good enough sustainable agriculture extensions service activities which results in improved implementation practice as a result of support;
- (f) Reduction in SDG losses due to SWP;
- (g) Level of satisfaction with SWP; and
- (h) State of the farmers' environment.

A strong and vibrant SWP applied research programme can be developed with institutions of higher learning to use PEWP fully funded or part funded conditional SWP project focused internships of bursaries for PhD and Master's degree students to track and update socio-economic indicators suggested above as their thesis research work under specific disciplines or areas of study – an indicative illustration is given below of how this could look like for consideration in order to enable the demonstration of the value and savings in implementation of a PV pumping programme that can be presented to the relevant authorities for inclusion in the fiscal plan and concession lists.

<sup>&</sup>lt;sup>7</sup> is defined as research efforts conducted by investigators from different disciplines working jointly to create new conceptual, theoretical, methodological, and translational innovations that integrate and move beyond discipline-specific approaches to address a common problem. https://www.hsph.harvard.edu/trec/about-us/definitions/

<sup>&</sup>lt;sup>8</sup> A bursary is a monetary award made by an institution to individuals or groups of people who in return for the bursary the individual is usually obligated to be employed at the institution for the duration as the bursary. <u>https://www.gov.uk/1619-bursary-fund</u>

<sup>&</sup>lt;sup>9</sup> is a qualitative method where researchers observe and/or interact with a study's participants in their real-life environment? Also called fieldwork, involves observation of and interaction with the persons or groups being studied in the group's own environment, often for long periods of time. https://hbr.org/2009/03/ethnographic-research-a-key-to-strategy



**Recommendation 4b** (*Responsible Party: UNDP & MWRE*): The installation of remote online SWP performance (*e.g. via online linked PS communicators*) for all the 28 pilot project installations is required. Going forward, all new SWP installations must be done with this remote SWP performance on them so that the performance of the pumps (*current and historical*) can be tracked, recorded, monitored and evaluated to aid developing a set of lessons learned through the implementation of the project. At present only, a handful of installations have this functionality installed on them and not all of them – the remainder of the 28 pilot pumps needs to be done as soon as possible so that their remote SWP performance tracking, recording, monitoring and evaluating can be initiated without any further delays. Without this, it's difficult to tell if all these 28 SWP installations are achieving value for money by performing optimally, below par or beyond expectations because information to make this call for the 28 installed SWPs isn't available yet. Farmer satisfaction or happiness alone isn't enough as an indicator to show us the technical performance of the SWP and this needs to be addressed.

**Recommendation 4c (***Responsible Party: UNDP & MWRE***)**: the development and use of an integrated counterfactual scenarios M&E system as "ground-based monitoring and modelling at local-to-regional scales; incorporating human and institutional behaviour in models; partnerships among universities, industry and government to develop socio-economic relevant data and systems modelling to evaluate trade-offs associated with FEW decisions" is still a key challenge, yet its key to creating a supportive enabling environment and scaled-up implementation. A delayed context in kick starting project implementation which the PMU found itself in requires adaptive learning to be drawn out of it and that the replication plans other localities and state need to factor this risk very well and how it can be mitigated. This MTR does acknowledge the existence of a December 2017 "Baseline Survey Report: A Financial mechanism of the national fund" (*from Page 26 of 211*) which gives a regional specific current social and economic situation of small pump farmers in the northern State. However, adopting a targeted approach for the remaining Adaptive learning to retrospectively capture pre-intervention and post intervention socio-economic data for all the 28 SWP beneficiaries alongside the expected 1,440 that await benefiting would be more strategic and impactful. This integrated use of counterfactual scenarios M&E system needs to cover the following aspects of activities separately but in an integrated manner:

- Monitoring performance of all the 28 pilot pumps remotely.
- Track and monitor the socio-economic status of SWP farmers pre and post installations to track change in socio-economic indicators and build the case for further SWP roll out.

- Development of a tool, or look-up table, to provide appropriate sizing for flow rate, informed by monitored parameters under Outcome 1.
- Evaluation of underground water resource and determination of sustainable pumping rates.
- o Develop a set of lessons learned through the implementation of the project.
- Demonstration of the value and savings in implementation of a PV pumping programme.

As a result of increased water security from the SWP intervention as demonstrated in recommendations 4a - 4b, there are a number of ways of comparing increased yield, production, measured losses, damages and changes in wellbeing indicators with a 'no-intervention' counterfactual. These ways include:

- (a) Where formal comparisons based on randomised control studies cannot be made, the likely impact of shocks and stresses with and without an increased water security adaptation intervention like PEWP can still be estimated or modelled. This may involve comparing the effects of shocks/stresses on a target community with those in 'similar enough' communities outside the area in which the intervention takes place. Another way is to compare the impact of similar shocks before and after the intervention. If the intervention is being introduced in phases, the effects of shocks might be compared between communities representing different phases of the intervention (i.e. with more or less 'adaptation'). These approaches are sometimes referred to as 'quasi-experimental approaches' and statistical analysis may be possible in such cases which recommendations 4b can feasibly achieve. However, care should be taken in attributing differences between comparison cases to an intervention, and attention should be paid to other potential drivers of change that might be unrelated to the intervention.
- (b) Using an experimental design in which the effects of shocks/stress can be compared between communities that have been targeted by PEWP adaptation interventions and those that have not. Such comparisons, based on the methodology of randomised control trials originating in the health sector, are increasingly common in development contexts (Stern et al. 2012; Gilbert 2013; Hughes 2013). These approaches are statistically powerful, but may not be possible in practice for a number of reasons that include the availability of a suitable control community/population, resource limitations that make the gathering of control data impractical, and ethical objections to the use of a population as a control when they do not benefit from an intervention. Bamberger and White (2007) estimate that randomised control trials may be applicable to as little as 5% of development finance, a figure cited by Prowse and Snilstveit (2009) and by DFID in the context of programme impact evaluations (Stern et al. 2012).
- (c) Even where statistical analysis is not possible due to lack of data or lack of a 'similar enough' counterfactual, the concept of the counterfactual can be extremely useful in qualitative evaluation. The monitor or evaluator can ask 'what would have been the likely impact of this shock/stress without PEWP adaptation?' Participatory exercises can be undertaken with communities and key informants to ground such comparisons firmly in local knowledge and to ensure significant rigour. These exercises can be used to ask how and why the consequences of a shock/stress may have been different before the PEWP intervention. Such qualitative approaches can also take the discussion a stage further and ask how and why an intervention did (or did not) affect the consequences of a stress or shock.

Some interventions like PEWP are likely to use a combination of the approaches described in (a) and (c) above, combining qualitative and quantitative information. All the approaches described in (a) to (c) above require some specialist skills. If these are not available within the PEWP team for implementing the SWP intervention, then it is recommended that the PMU obtains some specialist advice to device operational socio-economic indicators in the context of a monitoring and evaluation system

**Recommendation 4d** (*Responsible Party: UNDP, Ministry of Finance & MWRE*): The liquidity crunch is identified as a risk to outcome 1 that needs to be carefully managed with other financing modalities/product options being explored which aren't liquidity dependent from loans. Ethiopia has some interesting financing options which include cash micro-financing schemes. The UNDP Sudan Country Office have been exposed to that experience and could be worth to look at and learn from with the local Banks. Another international

The Grameen Bank is a microfinance organisation and community development Bank founded in Bangladesh. The Bank grew significantly between 2003 and 2007. As of January 2011, the total borrowers of the Bank number 8.4 million. Grameen Bank is founded on the principle that loans are better than charity to interrupt poverty: they offer people the opportunity to take initiatives in business or agriculture, which provide earnings and enable them to pay off the debt. The Bank is founded on the belief that people have endless potential, and unleashing their creativity and initiative helps them end poverty. Grameen has offered credit to classes of people formerly underserved: the poor, women, illiterate, and unemployed people. Access to credit is based on reasonable terms, such as the group lending system and weekly-instalment payments, with reasonably long terms of loans, enabling the poor to build on their existing skills to earn better income in each cycle of loans. Grameen has diversified the types of loans it makes. It supports hand-powered wells and loans to support the enterprises of Grameen members' immediate relatives. It has found that seasonal agricultural loans and lease-to-own agreements for equipment and livestock help the poor establish better agriculture. The Bank has set a new goal: to make each of its branch locations free of poverty, as defined by benchmarks such as having adequate food and access to clean water and latrines. ... almost all Grameen borrowers have their school-age children enrolled in regular classes. This in turn helps bring about social change, and educate the next generation. Solidarity lending<sup>10</sup> is a cornerstone of microcredit, and the system is now used in more than 43 countries. Although each borrower must belong to a five-member group, the group is not required to give any guarantee for a loan to its members. Repayment responsibility rests solely on the individual borrower. The group and the centre oversee that everyone behaves responsibly and none gets into a repayment problem. No formal joint liability exists, i.e. group members are not obliged to pay on behalf of a defaulting member. But, in practice the group members often contribute the defaulted amount with an intention to collect the money from the defaulted member at a later time. Such behaviour is encouraged because Grameen does not extend further credit to a group in which a member is default.

#### Conclusion

The mid-term review team concludes that PEWP is on target to achieve most of the results that are intended by the project for both the medium to long-term. The Project is being implemented in two phases as planned with the 28-pilot phase solar pumps having been achieved already. The first phase of the pilot phase in which the UNDP/GEF has provided a fund to purchase solar pumps and distribute them to 28 selected small pump farmers in the Northern State which has been successfully completed which is the outcome subjected to an implementation delay high risk. This risk has also been exacerbated by the lack of a state level project implementation unit (PIU) which has put an enormous administrative, travel and reporting burden on the PMU team in Khartoum. However, this risk has been noted with measures to mitigate it being suggested through the option of establishing a state level PIU which can be undertaken as part of an adaptive management which will render the overall project implementation a success at its end. The second phase implementation is now following after the completion of the pilot phase. The first phase funded the initial investment capital covering the installation of the 28 demonstration small pumps irrigating from the River Nile, Mattara and ground water sources in the seven localities of the State which has seen 28 solar pumps ranging from 56.4 Kwp to 257.40 Kwp installed in a phased approach and under operation for between 10 months to over a

<sup>&</sup>lt;sup>10</sup>Hossain, Mahabub (February 1988) [1988]. <u>Credit for Alleviation of Rural Poverty: The Grameen Bank in Bangladesh</u>. Int Food Policy Res Inst IFPRI. p. 7. <u>ISBN 0-89629-067-0</u>.

year for some with repairs and maintenance needs, except for two pumps that had defects on inverters which were checked and repaired.

A Fund is provided by UNDP-GEF jointly with Ministry of Finance and other Ministries of Irrigation, State Ministry of Agriculture and others. The demonstration units are expected to prove and build trust amongst farmers that solar pumping is an attractive viable alternative option to diesel pumping. The Initial Fund will provide a financing mechanism associated with a subsidy that reduces the high capital cost of the pump, reduce risks and increase the capacity of the farmers to purchase the pumps. At present the central government has committed to fund 50% of the pump costs, whilst the state level government funds 25% and the beneficiary farmer(s) pay the remaining 25%.

In addition, the early signs suggest that in the short – medium term the project has seen improved progress with the process of establishing and capitalizing a National PV Fund and coordinated loan facility which has been formulated from 11 Local Commercial Banks to promote concessional lending to farmers for PV pump equipment. The development and implementation of technical quality standards for PV pump components by the National Energy Research Centre (NERC), augmented by enforcement support from SSMO, Customs and relevant market observers has been done with the technical standards for equipment for solar water pumping systems having been developed and adopted by the Sudan Standards and Metrology Organization. However, training is included in the contract with the contractor that's going to supply and implement the test facility which is expected to be completed in the next few months alongside a few other aspects that are still in progress awaiting their implementation upon the delivery of equipment which has been ordered.

In the short term at this MTR stage the failure to have a Mitigation instrument design elaborated and implemented in support of the PV pump installation programme isn't giving a very positive reflection on the mitigation intent of this project. However, the fact that a ToR for contracting a national consultant for the NAMA and an MRV protocol under this NAMA was prepared sends a positive signal about the broader intent of this SWP project going into the future for the medium to long term.

A very well established and vibrant supportive enabling environment and scaled-up implementation has been catalysed as a result of this project. This has seen the demand for the PV pumps increasing significantly in response to the pilot phase of the project. This was aided by a decision of exempting the components of solar water pumping system from customs and other duties that was issued from the council of ministers. Some farmers' have even opted not to wait for the project but simply go private and install their own SWPs having seen the results of this pilot phase which augers well for the project. Pumping hours per day have increased significantly for farmers, their cultivated areas have increased in response to the availability of irrigation water with anecdotal responses of savings by farmers using the PV pumps and which is the basis for initiating the PV fund. Some farmers responded that they used these savings in other income generating activities like diversifying from simply planting crops and also now rearing animals like cattle, goats and sheep whilst some have increased the numbers of the animals they keep because they are more water secure now than before.

Overall, a cross-sectoral collaboration and forward-looking approach that satisfactorily considers the integrated and inter-related impacts such as the need for a state level field office / PIU and Ministry of Agriculture's extension services support to the farmers' and assist with the dissemination of water saving measures to farmers to reduce their need for water and thus capacity and capital cost of a pump is evident. Without this cross-sectoral collaborative approach, value for money and return on investment optimisation, such as farmers making more income from increased and better-quality crop yields and animals would be missed.

#### Lessons learned

The implementation of the PEWP project has yielded a number of lessons that will be useful for the design of future GEF funded projects as well the implementation of similar projects in Sudan stemming from the project's main challenges around budget allocation and efforts to finance the overall project.

19

- 1. Even though the Government of Sudan is committed to support this project, its late conception has made it necessary to consistently pay special attention to the current liquidity limited climate which have made it very difficult to quickly obtain sustainable financing from the Banking sector.
- 2. Stakeholders are interested in seeing the technology working on Sudanese soil the results there of. This has avoided the risk of weaning demand for SWP after so much capacity, and awareness raising has been successfully done – the demand for the SWP is very high.
- 3. Some farmers have the pilot project as a demonstration project of how the SWP work and they've gone to purchase and install their own SWP without the need to wait for the project to reach them. Because it works and has been proven on my neighbour's farm and I like the results I'm seeing, so I'll go and get myself one as I'm capable of self-financing my own. This is some of the reflections of farmers in the Northern State
- 4. The benefits are there and they are clear but the pilot phase of this project didn't really capture them. The level or extent of change wasn't captured yet. This can be used as a leverage to obtain more financing for the expansion of the project.
- 5. Even with the best of intentions, local regulatory of the Central Bank of Sudan (CBS), affected the pre-signed hard currency contracts for date of execution after advance payment 30% of the contract amount. An exception for payment in hard currency for the two companies according to the new policy of the CBS offered some reprieve and the lesson learned is that future bidding for local contractors will be in local currency. The total time delay from these two challenges above is seven (7) months from total time of project (Five years).
- 6. No matter how well the project implementation was planned, the first selected PMU project manager resigned, therefore delaying the start of project implementation from February 2016 to June 2016 which is the main challenge that affected and delayed project activities.
- 7. A shared vision is important as with challenges along the way, every interested party still hangs onto what the vision is and works towards that as evidenced by commitment all round by these project's stakeholders to ensure that the project delivers on its objectives no matter what.

### 2.0 Introduction

#### 2.1 Background

In Sudan the agricultural sector contributed approximately 30% of its Gross Domestic Product (GDP) in 2013 and is reported to employ 80% of the workforce. Although a significant portion of Sudan's cultivated area depends on rainfall for water, the irrigated lands contribute approximately 75% of the added value from agriculture. There are three irrigation systems within the country; pumped, gravity-driven and flood irrigation. The focus of the proposed UNDP-GEF project is the replacement of small and medium diesel pumps with solar pumps. Historically rising costs of energy have been one of the main drivers of high inflation in Sudan. Given the importance of the agricultural sector to the overall economy, reducing the cost of energy, particularly for small farmers, is a major priority for continued growth of the sector.

Sudan has significant potential for development in the agricultural sector. The country has promising water and arable land resources; however, these resources are not fully exploited. Sudan utilizes around 20% of its total potential arable land. Sudan consumes 15.6 million m<sup>3</sup> of Nile water, which represents 84% of the country's share of Nile River water.

The Second Stage for Agricultural Strategic Plan (2012 – 2014) states that the government will dedicate at least 20% of its expenditure to the agricultural sector to increase the annual growth rate for agriculture by 10%. The plan also aims to encourage investors to invest in the agriculture sector in order to increase the investment share in agricultural sector from 4% to 20%. Because of the size of employment in the agricultural sector, its development is one of the main contributors to poverty alleviation in Sudan. Agriculture represents 80% of non-petroleum export revenues of the country. The cultivated land area in Sudan ranges between 12.5 and 17 million hectares based on annual rainfall intensity and its distribution.

The agricultural sector has by far the largest share of CO<sub>2</sub>e emissions in Sudan. In 2000, the emissions from agriculture sector represented approximately 74% of the total emissions produced in the country. The GHG emissions as reported are mainly from enteric fermentation and manure management with no GHG emissions attributed to the use of diesel for pumping water.

The most common crops grown in Sudan are Sorghum, millet, wheat, rice and maize. In FY 2010/2011, the northern states produced 5.7 million MT of cereals; broken down into 4.6 million MT of sorghum, 667 thousand MT of millet, 433 thousand MT of wheat, 25 thousand MT of rice and 42 thousand MT of maize.

Sudan is largely dependent on imported fossil fuels. Hence, there is an urgency to implement Sudan's Renewable Energy Master Plan (REMP) and reduce Sudan's dependence on fossil fuel. Sudan has abundant wind and solar resources, as shown in the resource maps below, but largely lacks the capacity to utilize these resources for power generation. Fossil fuels are subsidized in Sudan, with oil subsidies representing 15% of the total government expenditure in 2012. There has been a steady reduction in subsidies, which has resulted in a 45% increase in diesel price in 2011, and a further 114% increase in 2013. Further increases in fossil fuel price are expected as subsidies are lifted.

Sudan currently has a generation capacity of 2,723 MW of power; it has practically no grid connected solar or wind generation capacity and very little off-grid solar capacity.

The Promoting the use of electric water pumps for irrigation in Sudan was designed to support the adoption of solar PV technology for water pumping for irrigation in agriculture in Sudan, particularly in the Northern State. Adoption of renewable energies has been identified as a priority in Sudan, as is the reduction of dependence on fossil fuels which are imported. The application of solar PV to pumping has been on a relatively limited scale globally, but is seeing increased commercial interest in the past years. Solar PV technology in general is not widespread in Sudan. It's against this background, that promoting the use of electric water pumps for irrigation in Sudan project was designed and launched with a development objective that includes four components.

#### 2.2 Description of the project

The Promoting the use of electric water pumps for irrigation in Sudan includes four components: : (1.) the development of pilot projects as a demonstration of the viability of the technology and an accompanying financing mechanism for continued finance of projects; (2.) development of standards and guidelines to promote quality and sustainability of water pumping; (3.) development of a NAMA to support solar water pumping; and (4.) developing a supporting environment to encourage scaling up and further replication. The objective of the project is to replace diesel-based irrigation water pumping through the promotion of solar photovoltaic (PV) powered pumps over the lifetime of the UNDP-implemented, GEF-financed project.

The project is structured around four Components and Outcomes which together aim to achieve the project objective. The first outcome is concerned with installing 28 pilot pumps ( $20 \times 3.12$  kWp units,  $5 \times 5.12$  kWp units and  $3 \times 29.6$  kWp units) to act as demonstration units, the creation of a financing mechanism with subsidy from GEF funds, and the subsequent financing and installation of 1,440 pumps. The focus of these activities is the dissemination of PV pumps in the Northern State.

The second outcome aims to reduce the risks associated with (de-risking) solar PV pumping by providing quality standards, testing and certification, training and capacity building. The second outcome also includes activities to increase efficiency of water use, thereby increasing the overall sustainability of pumping practices and reducing the size (and therefore cost) of solar PV pumps.

The third outcome develops a UNFCCC standardized baseline for solar PV water pumping and implements it within a NAMA to support the development of an appropriate MRV protocol for solar pumping.

The fourth outcome supports the scaling-up and expansion of the project to other states in Sudan. It makes the case to the relevant authorities for regulations to encourage solar PV pumping and exempt equipment from taxes and customs. It also includes a structured replication programme to replicate success in the Northern State in other States.

The Project will coordinate between the Northern State Government and the commercial Banks to develop a customized lending mechanism for solar water pumping systems. The GEF project, together with the Northern State Government and other stakeholders will provide a series of initiatives to ensure the success of the project such as:

- Establishing a National PV Fund to help finance farmers;
- Establishing a set of criteria for PV pump loans;
- Developing and maintaining a monitoring system;

- Establishing a set of minimum hardware standards to qualify for loans; and
- Establishing technical standards to help assure quality of solar water pumping equipment;

#### 2.3 Purpose of the mid-term evaluation

The Mid-Term evaluation is intended to provide a comprehensive overall assessment of the project in order to provide opportunity to critically assess administrative and technical strategies, issues and constraints associated with implementation. The evaluation gives recommendations to improve the potential of the Project to achieve expected outcomes and meet objectives within the Project timeframe.

While according to UNDP-GEF, Monitoring and Evaluation (M&E) procedures is conducted continuously throughout the lifetime of long term projects by implementing agencies, mid-term reviews (MTRs) are implemented to meet the following objectives: i) to assess progress being made towards the attainment of project results and impacts as set out in the project document; ii) to provide a basis for decision making on necessary amendments to achieve the overall objectives of the project within the time frame; iii) to assess the effectiveness, efficiency and sustainability of the project and promote accountability for resource use; and iv) to document and disseminate initial lessons learned. It is in this context that the Promoting the use of electric water pumps for irrigation project in Sudan was subjected to a mid-term review (MTR).

The overall objective of the MTR is to assess progress towards the achievement of the project objectives and outcomes as specified in the Project Document, and assess early signs of project success or failure with the goal of identifying the necessary changes to be made in order to set the project on-track to achieve its intended results. This report documents the findings of the Mid-term review of the Promoting the use of electric water pumps for irrigation project in Sudan (PEWP) implemented through the Ministry of Water Resources, Irrigation and Electricity in Sudan with support from the United Nations Development Programme-Global Environment Facility (UNDP-GEF) since the 28<sup>th</sup> of February 2016. The PEWP project will be implemented over a period of five (5) years until 31 January 2021and as per UNDP-GEF project management requirements, a mid-term review was to be conducted. UNDP Sudan Country Office commissioned this review with the involvement of the Ministry of Water Resources, Irrigation and Electricity in Sudan as the executing agency under the National Execution Modality.

The progress towards the achievement of the Project Development Objective PDO which is "to replace dieselbased irrigation water pumping through the promotion of solar photovoltaic (PV) powered pumps" is being assessed. This Mid Term Review is a planned activity that has the following specific objectives:

- 1. Review progress, efficiency and effectiveness of the Project implementation in terms of achieving project objectives, outcomes and delivering outputs.
- 2. The extent to which the project implementation approaches/strategies are contributing to the sustainability of the interventions.
- 3. Examine the time frame for implementing the remaining activities (considering project ends at the end of January 2021).
- 4. Review the financial and fiduciary aspects of the project.
- 5. Provide recommendations for corrective actions for the Project/Organisations management, government of Sudan and GEF as donor.

The objective of the project is to support the adoption of solar PV technology for water pumping for irrigation in agriculture in Sudan, particularly in the Northern State. Adoption of renewable energies has been identified as a priority in Sudan, as is reduction of dependence on fossil fuels which are imported. The project aims to help Sudan and Sudanese farmers reduce their reliance on fossil fuels, reduce their cost of production (via decreased diesel expenditures), increase the sustainability of water use, and increase their income. Given that agriculture is a main component of the economy in Sudan, the project will help increase Sudan's energy security and decouple its GDP from fluctuations in fossil fuel prices and availability. The project has been designed to play a catalytic role in the transformational scaling up of solar power for productive use in Sudan's agricultural sector. An outcome of the UNDP-implemented, GEF-financed project is firstly a 28-pump pilot phase of this project.

#### 2.4 Methodology of the mid-term review (MTR)

The MTR was conducted in a consultative, participatory, and cross learning approach that recognizes targeted stakeholders as active agents of change in the field of solar PV technology for water pumping and who have the potential power to support the achievement of the project's universal and immediate goals. A team made up of an International Consultant and a National Consultant conducted the MTR of the PEWP and <u>Error! Reference source not found.</u> highlights the MTR Methodology Matrix. To that end the MTR was based on both office and field work in Khartoum and Northern State for collection of primary data of both qualitative and quantitative nature.

The team used a variety of techniques including:

- a) Literature reviews where the MTR team reviewed documents including national policy and legal documents that provide the enabling framework for project implementation, the PEWP project documents and the various reports that have been produced by the project implementing entities to date including documents prepared during the preparation phase (i.e. PIF, UNDP Initiation Plan, UNDP Environmental & Social Safeguard Policy, the Project Document, project reports including Annual Project Review/PIRs, quarterly reports, national project steering committee meeting minutes, project budget revisions, lesson learned reports, national strategic and legal documents, LPAC meeting minutes, field survey reports, and any other materials that the team considers useful for this evidence-based review).
- b) Stakeholder interviews, and
- c) Field visits to project implementation sites.

#### 2.5 Structure of the Mid-term Review (MTR) Report

This report is divided into chapters to meet the desired objectives as set in the ToR for this mid-term evaluation (see *Annex 2: MTR TOR (excluding ToR annexes)*. The first chapter is an Executive Summary while Chapter 2 is an Introduction that provides general background and a brief overview of the project, purpose of the evaluation, key issues addressed and the methodology used in conducting the MTR. The PEWP project is described in Chapter 3. This chapter also provides an analysis of the context within which the project was developed. This includes the problems that the project was designed to address during its immediate and development objectives, the main stakeholders involved in the implementation of the project as well as the outcomes and or results expected from the process.

Chapter 4 analyses the main findings of the evaluation focusing on issues of project design, its responsiveness to national and global environmental priorities and the extent to which national stakeholders were involved in the

implementation of the project. Chapter 5 provides an analysis of the results achieved in implementing the project at mid-term. This includes financial planning and management and assesses whether project resources were used in an effective manner. This chapter also discusses the extent to which the project has met its intended objectives and provides a rating of specific project elements against targets set at project inception. Chapter 6 discusses recommendations and conclusions from the mid-term review exercise. Finally, the lessons learnt from the implementation of the PEWP that could be useful in the design of similar projects in future are given in Chapters 7, and Chapter 8 is a record of the Annexes to the MTR report.

#### 2.6 Rating scales

Evaluated progress was rated using the 6-point rating scale outlined below

Highly Satisfactory (HS)	The objective/outcome is expected to achieve or exceed all its end-of-project targets,
	without major shortcomings. The progress towards the objective/outcome can be
	presented as "good practice".
Satisfactory (S)	The objective/outcome is expected to achieve most of its end-of-project targets, with only
	minor shortcomings.
Moderately Satisfactory (MS)	The objective/outcome is expected to achieve most of its end-of-project targets but with
	significant shortcomings.
Moderately Unsatisfactory	The objective/outcome is expected to achieve its end-of-project targets with major
(MU)	shortcomings.
Unsatisfactory (U)	The objective/outcome is expected not to achieve most of its end-of-project targets
Highly Unsatisfactory (HU)	The objective/outcome has failed to achieve its midterm targets, and is not expected to
	achieve any of its end-of-project targets.

#### Ratings for progress towards results:

#### Ratings for adaptive management and management arrangements:

Highly Satisfactory (HS)	The project has no shortcomings and can be presented as "good practice".		
Satisfactory (S)	The project has minor shortcomings.		
Moderately Satisfactory (MS)	The project has moderate shortcomings.		
Moderately Unsatisfactory	The project has significant shortcomings.		
(MU)			
Unsatisfactory (U)	The project has major shortcomings.		
Highly Unsatisfactory (HU)	The project has severe shortcomings.		

Sustainability was evaluated across four risk dimensions, including financial risks, socio-economic risks, institutional framework and governance risks, and environmental risks. According to UNDP-GEF evaluation guidelines, all risk dimensions of sustainability are critical: i.e., the overall rating for sustainability is not higher than the lowest-rated dimension. Sustainability was rated according to a 4-point scale, ranging from Likely (negligible risks to the likelihood of continued benefits after the project ends) to Unlikely (severe risks that project Outcomes will not be sustained):

# Likely (L)Negligible risks to sustainability, with key outcomes on track to be achieved by the<br/>project's closure and expected to continue into the foreseeable futureModerately Likely (ML)Moderate risks, but expectations that at least some outcomes will be sustained due<br/>to the progress towards results on outcomes at the Midterm ReviewModerately Unlikely (MU)Significant risk that key outcomes will not carry on after project closure, although<br/>some outputs and activities should carry onUnlikely (U)Severe risks that project outcomes as well as key outputs will not be sustained

#### Ratings for Sustainability Scale (one overall rating)

#### 3.0 The Project and its Scope

The Promoting the use of electric water pumps for irrigation in Sudan Project (PEWP) commenced implementation in February 2016. The project is to be implemented over a five-year period ending in Jan 2021. The project is being implemented by the Ministry of Water Resources, Irrigation and Electricity in partnership with UNDP.

The Ministry of Water Resources, Irrigation and Electricity (MWRE) has succeeded the Ministry of Electricity and Dams (MED) as the body responsible for the electricity sector in Sudan. MWRE is planning to replace diesel-based irrigation water pumping through the promotion of solar photovoltaic (PV) powered pumps in Sudan. To meet the Government's target of 75-80% electrification by 2031, the Government plans to install 12,000 MW of additional generation capacity by 2031. This is to include 1,582 MW of renewable energy (other than large-scale hydro-power). This project aims to install 1,468 PV pumps in off-grid regions with a total installed capacity of 6.5 MW. This potential capacity represents 0.2% of the current generation capacity and 0.4% of the planned non-hydro generation capacity. This time-frame coincides with the implementation of the UNDP-implemented, GEF-financed project.

#### 3.1 Energy shortages, diesel pumps issues and opportunities in Sudan

Like many developing countries, the agricultural sector contributed approximately 30% of Sudan's Gross Domestic Product (GDP) in 2013, and is reported to employ 80% of the workforce. Yet Sudan has a shortage of electricity. Approximately 35% of the population has access to electricity (MWRE-Renewable Energy Master Plan 2013). Even then, it is not reliable and experiences regular power outages. Hydro-power has the largest share of energy generation. The potential to expand hydro-power to meet future needs is limited. Sudan does not have significant oil or gas production and as a result will have to turn to importation of fossil fuels to meet future energy needs. Climate change threatens to affect rainfall patterns on which Sudan relies for the water that generates its hydro-power. Although a significant portion of Sudan's cultivated area depends on rainfall for water, the irrigated lands contribute approximately 75% of the added value from agriculture. This further emphasises the need for Sudan to diversify its energy sources. Historically rising costs of energy have been one of the main drivers of high inflation in Sudan. Given the importance of the agricultural sector to the overall economy, reducing the cost of energy, particularly for small farmers, is a major priority for continued growth of the sector. The PEWP project seeks to address these problems and focuses on promoting the replacement of small and medium diesel pumps with solar pumps.

#### 3.2 Problems the Project seeks to address

Sudan is largely dependent on imported fossil fuels. Hence, there is an urgency to implement Sudan's Renewable Energy Master Plan (REMP) and reduce Sudan's dependence on fossil fuel. Sudan has abundant wind and solar resources, as shown in the resource maps below, but largely lacks the capacity to utilize these resources for power generation. Fossil fuels are subsidized in Sudan, with oil subsidies representing 15% of the total government expenditure in 2012. There has been a steady reduction in subsidies, which has resulted in a 45% increase in diesel price in 2011, and a further 114% increase in 2013. Further increases in fossil fuel price are expected as subsidies are lifted. This project aims to install 1,468 PV pumps in off-grid regions with a total installed capacity of 6.5 MW. This potential capacity represents 0.2% of the current generation capacity and 0.4% of the planned non-hydro generation capacity. Against this background, the main objective

of the project is to support the adoption of solar PV technology for water pumping for irrigation in agriculture in Sudan, particularly in the North State.

#### 3.3 Project Goal and Objectives

The goal of the project is to replace diesel-based irrigation water pumping through the promotion of solar photovoltaic (PV) powered pumps in the agricultural sector of Sudan. The project is structured around four Components and Outcomes which together aim to achieve the project objective. The project consists of the following four outcomes:

- (i) The first outcome is concerned with installing 28 pilot pumps (20 × 3.12 kWp units, 5 × 5.12 kWp units and 3 × 29.6 kWp units) to act as demonstration units, the creation of a financing mechanism with subsidy from GEF funds, and the subsequent financing and installation of 1,440 pumps. The focus of these activities is the dissemination of PV pumps in the Northern State.
- (ii) The second outcome is aims to reduce the risks associated with (de-risking) solar PV pumping by providing quality standards, testing and certification, training and capacity building. The second outcome also includes activities to increase efficiency of water use, thereby increasing the overall sustainability of pumping practices and reducing the size (and therefore cost) of solar PV pumps.
- (iii) The third outcome develops a UNFCCC standardized baseline for solar PV water pumping and implements it within a NAMA to support the development of appropriate MRV protocol for solar pumping.
- (iv) The fourth outcome supports the scaling-up and expansion of the project to other states in Sudan. It makes the case to the relevant authorities for regulations to encourage solar PV pumping and exempt equipment from taxes and customs. It also includes a structured replication programme to replicate success in the Northern State in other states.

#### 3.4 Project Management, Implementation and Coordination Arrangements

The promoting the use of electric water pumps in irrigation in Sudan project is implemented according to UNDP's National Implementation Modality (NIM). The Implementing Partner (IP) for this project is the Ministry of water resources, irrigation and electricity who has project ownership and entitled to recruit a National Project Manager (NPM), and National Consultants. The (WRIE) is the leading agency responsible for the implementation of activities for the promoting the use of electric water pumps in irrigation in Sudan Update Report to the UNFCCC. The project organization structure is comprising a Project Board which consists of Senior Beneficiaries that include government institutions, Executive, Senior Supplier as follows:

- o National Project Manager.
- o Financial and Administrative Associate.
- o Technical committee.
- o UNDP Programme Officer.
- o Project Engineer.
- o M&E Specialist.
- o National Focal Point.

To ensure the achievement of the overall outcome of the project, the involvement of the relevant national institutions and stakeholders, and their support and commitment to the implementation of the proposed activities is very crucial to the implementation of the project. Many National institutions are involved in the implementation of the project either as a member in Project Board (PB) or part of the technical team. The following institutions are the main implementing partners: (1). Ministry of Finance and National Economy, (2).

Ministry of International Cooperation, (3). Ministry of Petroleum and Gas, (4) Ministry of Agriculture and Forestry, (5). National Energy Research Centre, (6). Energy Research Centre - University of Khartoum, (7). Ministry of Environment, Forestry and Physical Development, (8) Higher Council for Environment and Natural Resources, (9). Ministry of Science and Communications, (10). Ministry of Agriculture Animal Resources & Irrigation - Northern State, (11). Central Bank of Sudan, and (12). Center for alternative energies and sustainable development - Omdurman National University.





#### 3.5 Project timing and milestones

The project's timing is opportune and appropriate, as Sudan has to act now and start building its climate resilience by investing in green energy and improving access by needy communities to sustainable energy. The project was initiated at a time when strategically Sudan has a national Renewable Energy Master Plan, which includes plans for the development of solar energy but not specifically related to power for pumping water for irrigation. The baseline for the proposed UNDP-GEF project is the use of off-grid, diesel powered pumps for irrigation. The UNDP-GEF project only targets those where the grid is unlikely to be extended in the foreseeable future (next 10 years) or where cost of extension is prohibitive. The project provides farmers with solar power in place of diesel thus liberating them from the diesel supply chain and enabling them to freely access the sun's energy to grow crops and earn their livelihood. Access to the pumps will not be affected by race, gender, or religion. As part of the PPG process, public stakeholder consultations were held in Khartoum and the Northern State and attended by several women. Based on these facts the timing of the project was perfect and the milestones are realistic and being satisfactorily achieved as expected.

#### 3.6 Main stakeholders' engagement and baseline analysis

A comprehensive stakeholder identification process was embarked upon at the time of the design of the PEWP project. Stakeholder consultation has been a key feature in the design of this LDCF Proposal, and stakeholders have been involved in identifying and prioritizing the proposed intervention activities as per the following stakeholder involvement plan:

Project Stakeholder	Relationship with The Project
Ministry of Water Resources & Electricity (MWRE)	The principal role of MWRE is to formulate policies, strategies and action plans for the supply of electricity in Sudan, with a key focus on diversifying Sudan's electricity mix to include renewables. MWRE has been undertaking a pump switching programme in Northern State, assisting farmers to switch from diesel-powered irrigation pumps to grid-connected electric pumps. With the opportunities for further on-grid switching almost exhausted, MWRE is promoting the use of off-grid PV pumps instead. MWRE will be responsible for implementing the GEF project.
Ministry of Environment, Forestry & Physical Development (MEFPD)	MEFPD is the national focal point for the GEF and, under its subsidiary HCENR, the UNFCCC. MEFPD will be involved in technical assistance on the coordinated loan mechanism and on the climate finance elements of the project.
Higher Council for Environment and Natural Resources (HCENR)	As the national focal point for climate change under the UNFCCC, HCENR is responsible for coordinating National Communications, the development of Climate Change Action Plans, NAPAs, Technology Needs Assessments and NAMAs. The GEF project will build on a number of HCENR initiatives, including the development of standardized baselines, the elaboration of a national Low Emission Development Strategy, and the analysis of sectoral NAMA opportunities.
Ministry of Petroleum, Renewable Energy Directorate (MoP)	The Renewable Energy Directorate of MoP has a national mandate for renewable energy resource mapping and off-grid renewables applications. MoP has developed an expertise in rooftop PV systems and has begun to experiment with a limited number (7 to date) of PV irrigation pump units. MoP will assist the GEF project with advisory support, local capacity development and national policy formulation.
Ministry of Agriculture (MoA)	MoA is the implementing body for the Agricultural Strategic Plan (2007-2015), which has the central objective of increasing the amount of farming land in Sudan by 70% and – within that overall target – doubling the amount of irrigated land. MoA operates a number of support programmes for farmers on agricultural practices, including irrigation and water pumping. The GEF project will coordinate its PV pump installations, capacity development and replication programme with MoA's support activities. MoA is also expected to play a key role in the context of liaising with water user groups and coordinating the NAMA, in ensuring inclusion of PV pumps in the Agricultural Implements Regulation.
Ministry of Finance & National Economy (MoF)/Bank of Sudan	MoF will support the establishment of a National PV Fund with technical and financial assistance. MoF will assist with finance-related aspects of the project, notably the support to banks and oversight of banks' micro-finance lending and inclusion of PV pumps in the fiscal concessions list of the Investment Law and the Agricultural Implements Regulation. The Ministry also works closely with the Customs Administration, which will enforce the technical standards for PV hardware that will be developed by the Sudan Standards & Metrology Organization. MoF will also assist in establishing National Fund to support the deployment of solar pumps.
National Energy Research Centre (NERC)	NERC (formerly the Energy Research Institute, ERI), under the Ministry of Science and Communication, is the primary institute at the national level for conducting research on renewables in Sudan, as well as pilot project implementation. The Solar PV Encapsulation & Manufacturing Unit is the implementation arm of NERC: it has undertaken a number of PV pump installations in Nile State and Darfur, accompanied by system monitoring and

	technical performance assessments. NERC will support the GEF project in understanding farmers' technical and operational pumping needs, in designing a pump sizing software tool, in installing and monitoring demonstration PV pump units, and in capacity development.
Sudan Standards & Metrology Organization (SSMO)	SSMO is a Government body established to coordinate Sudan's engagement with the International Standards Organization (ISO), the African Regional Organization for Standardization (ARSO) and the Arab Standards and Metrology Organization (ASMO). SSMO operates 15 testing and certification laboratories across Sudan. The GEF project will build upon SSMO's mandate and expertise to support SSMO in developing technical standards for the PV pump hardware that will be deployed in Northern State (and subsequently nationally).
Northern State Government	Sudan has a federal governance structure, made up of 18 states with delegated functions and powers. The Northern State Government has been actively promoting grid-connected irrigation pumps as a means of improving farmers' livelihoods and reducing their (and the State's) reliance on diesel fuel, and is now extending this support to off-grid PV pumps in areas where grid extension is infeasible. The GEF project will build on the State Government's established support programme for electric pumps, and will harness the State Government's institutions (e.g. the State Ministry of Agriculture) and agricultural stakeholder networks.
Commercial Banks	The Agricultural Bank of Sudan, the Farmers Bank, the Savings Bank and the Islamic Bank have together financed – through ad hoc (uncoordinated) loans to farmers – the installation of approximately 2,000 grid-connected electric pumps in Northern and Nile States since 2011. Now, acting on an instruction from the Northern State Government that 12% of all commercial lending must be in the form of micro-finance to support electric and PV pumps, the banks are under pressure to systematize and scale-up their lending, with a particular emphasis on PV pumps. Ten banks have committed to providing US\$2 million each in loans to support the GEF project's initiatives. The GEF project will work with the State Government and the banks to coordinate their lending for this purpose, to develop the internal capacities of the banks to structure loan packages and assess loan risks, and to market innovative financial products to drive farmer take-up of PV pump technology.

Table 3: Stakeholder involvement plan

As a result of the extensive stakeholder consultations and comments received, which are reflected in the project design, the project has considerable ownership by the relevant entities and stakeholders in Sudan.

#### 3.7 Expected Results

PEWP is being implemented to overcome barriers to the current baseline of the prevailing practice that uses diesel engines to pump water in areas which are not connected to the grid. This outcome promotes the adoption of PV pumps in two ways:

- (i) Providing a pilot stage installation of 28 pumps to serve as a demonstration and to facilitate gathering of data on the operation of the pumps; and
- (ii) Creating a National PV fund that provides a finance mechanism which removes the barrier of the large capital required. The fund aims to finance 1,440 pumps over the five-year project lifetime.

The 28 demonstration pumps are expected to be installed within 6-9 months of project start. The financing mechanism is expected to be operational by the end of the first year of the project and to then finance 1,440 pumps over the remaining four years of the project.

During the first year, the data collected and the efforts to establish the National PV fund will establish the subsidy level to be offered, the loan term and cost of finance. The calculations presented here are preliminary based on the information available at the PPG phase.

# 3.7.1 Financing and dissemination mechanism established and operational to support a PV pump installation programme

#### A 28-pump pilot phase and creating a national PV fund and finance mechanism

The UNDP-implemented, GEF-financed project's first activities under this outcome are the identification of 28 farmers<sup>11</sup> to host 28 solar PV pumps on a "pay if satisfied" basis, and the appropriate specification of these pumps. The pumps will be installed at carefully selected farms at no initial cost to the farmers. After one year of operation, if the farmers are satisfied, they can enter into a loan re-payment scheme and benefit from the subsidy offered. If the farmers are not satisfied, the pumps will be removed at no cost to them. In effect, the farmers who receive the initial 28 pumps benefit from a free one-year trial, and if they continue, a one-year grace period on their loan. This method achieves several objectives. It allows the farmers to try the pumps with no risk to them and popularize the technologies and provide a proof-of-concept. At the same time, they realize that if they choose to keep the pump they will have to pay for it; thus, they have an incentive to honestly evaluate its performance and to ensure its safety. The indicators to verify the complete implementation of this outcome is:

- (i) Investment mobilized for purchase of solar pumps by EOP During the reporting period the project focused on installation of the pilot project (28) pumps and all action related to its execution with (AWP) budget US\$ 1,704,771.95 and expenditure of amount US\$ 457,115.58. Already (29) pumps have been installed.
- (ii) Dedicated mechanism for finance of PV pumps established The PV Fund (Mahfaza) has been approved from Minister of Finance and national Economy. It has been directed to the CBS to issue a configuration decision.

**Note**: At present it is not possible for Banks to lend for PV pumps because the Banks have no understanding of solar pumping and as such are apprehensive about financing it and lack an appropriate formulation for the structure of the finance. There are also practical difficulties, such as establishing collateral, establishing ownership of the PV system and pump, etc. as diesel pumps are relatively inexpensive as regards upfront cost. By contrast, comparable PV powered pumps are relatively expensive as regards upfront cost. However, in the long term, as part of this project's implementation outcome, the project will help put in place several elements to enable a sustainable finance mechanism for PV pumps. This mechanism will use the resources of the PV Fund and participating Banks to enable farmers to finance their purchase of PV pumps.

# 3.7.2 Financing and dissemination mechanism de-risked through technical standards and demand-side support

<sup>&</sup>lt;sup>11</sup> The objectives of the 28 pilot pumps are: a) to make farmers familiar with solar technology and enable them to visit operating pump installations, see them in operation, and obtain feedback from fellow farmers; b) to provide data on the operation of the pumps to the project team which will inform the design and selection of future pumps; and c) provide confidence to other stakeholders, such as lenders, on the effectiveness of solar pumps.

Establishing a set of measures to reduce the risk associated with solar water pumping and ensure the sustainability of the project. The project helps in raising the awareness and providing training and capacity building in order to encourage the private sector to install solar water pumps. Solar water pumping will be demonstrated to be attractive in the long term compared with both diesel water pumping and connection of the grid to remote or difficult to access areas. The indicators to verify the complete implementation of this outcome is:

- (i) Technical quality standards developed and enforced for PV pumps A global standard has been selected in the field of solar power pumps to be the basis for the Sudanese standard in this field and has been adopted by higher management of SSMO.
- (ii) Number of entities trained and capable of specifying and supplying solar pumps (4) engineers from
   (3) deferent government entities have been trained on basic information and specifying and supplying solar pumps and how use software sizing tool (one training course) in China.
- (iii) Bidders invited from the institutions working in the field of testing laboratories and solar pumping systems to prepare the tender document for establishing the laboratories and their components.

# 3.7.3 Mitigation instrument design elaborated and implemented in support of the PV pump installation programme

Through a combination of instruments, this outcome aims to implement the climate change mitigation tools to promote pump fuel switching in Sudan. In order to achieve this, the project will make use of a standardized baseline (already established with UNDP support) for pump fuel switching according to UNFCCC guidelines. A National Appropriate Mitigation Action (NAMA) will be developed for adoption of solar pumping. The main objective of the NAMA is to contribute to climate change mitigation by reducing greenhouse gas emissions whilst a Monitoring, Reporting and Verification (MRV) system will also be developed under this outcome. The indicators to verify the complete implementation of this outcome is:

- (i) Development of a standardized baseline for solar PV pumping in Sudan (in progress).
- (ii) Development of an MRV mechanism for solar water pumping (in progress).

#### 3.7.4 Supportive enabling environment and scaled-up implementation

This fourth outcome is centred on scaling up and replication of the programme. It provides for the inclusion of PV pumping in the fiscal concessions, investment laws, and agricultural regulations but developing and documenting the lessons and benefits of the PV programme. It will trigger the development of a structured replication programme, built around the institutional architecture provided by the National PV Fund established under Component 1, the NAMA developed under Component 3 and the GEF-supported hardware certification standards developed under Component 2 (which will have national force), to transfer the pump dissemination model developed for Northern State to the other 17 states in Sudan. Replication will be encouraged in other states and areas by demonstrating, documenting, and disseminating the avoided costs of infrastructure and fossil fuels, as well as the environmental benefits of avoiding diesel use, thereby incentivising governments in other states to adopt measures, to promote solar water pumping in place of diesel. The lessons will apply broadly to the use of solar PV in other applications, such as remote power for refrigeration or lightening. The indicators to verify the complete implementation of this outcome is:

(i) Inclusion of solar pumps in fiscal concessions lists of the Investment Law and the Agricultural Implements Regulation such that they receive preferential financial treatment - A decision was issued

by the Council of Ministers to exempt the system of solar energy pumps from customs duties and taxes.

(ii) PV Pumping integrated in National Energy Roadmap and Rural Energy Access Strategy – 15,000 pumps included in the 5 Year plan.

#### 4.0 Mid-term Review (MTR) Findings and Conclusions

#### 4.1 Introduction

This MTR analyses the baseline problems that the project seeks to address in line with its development objectives. The project's performance has been made by evaluating project performance against the targets for the mid-project period through the indicators. The report followed the ToR, and covers three main areas:

- (i) Project Delivery
- (ii) Project Implementation
- (iii) Project Finances

#### 4.2. Key Observations from Stakeholder and Project Staff Interviews.

- The project is proceeding according to expectations of interviewed stakeholders;
- There is good contact between UNDP/GEF project office and stakeholders;
- Timing of project (*delayed start due to 2<sup>nd</sup> project manger's recruitment*) has had an impact;
- The PMU in Khartoum is heavily burdened and consistently under pressure to deliver without any field office support capacity yet the project localities are vast and sparse;
- The project has had significant impact with local stakeholders by providing a viable and reliable technological option that cheaper than the diesel technology;
- The technology is highly valued and appreciated by those farmers' who have it and none of them don't want it nor would swap it for any other technology out there;
- There is good communication between project team and stakeholders at all levels except;
- There is some published material on the SWP website <a href="https://swp-sd.org/index.php">https://swp-sd.org/index.php</a> that can be of good information benefit about the project and learning of the concept;
- The project is viewed as having a very positive impact at local and farmer level;
- The Stakeholder engagement on this project has been highly satisfactory and it's evident by the manner of participation and commitment that all the relevant stakeholders are putting towards implementing the project except for the Ministry of Agriculture whose role needs to be strengthened to complement and maximise return on investment from the water security created by the SWP.

In a nutshell tables 3 – 7 summarise the mid-term stage progress that the project has made towards meeting the set targets.

#### 4.3. Project delivery, outputs, outcomes and related target(s)/sub-target(s), as applicable

#### Table 4: Project Results Framework

Strategy	Indicator	Baseline	Targets	Progress
Project Objective: Financing and dissemination mechanism established and operational to support a PV pump installation programme	<ul> <li>Amount of reduced CO<sub>2</sub> emissions reductions from water pumps for irrigation (compared to the project baseline) installed EOP, tons CO<sub>2eq</sub></li> </ul>	• 0	• 313,174 <sup>12</sup>	1,297.95 Tons /20 years' operation
	<ul> <li>Cumulative installed capacity of off-grid PV solar pumps (kWp)</li> <li>Fuel saved</li> </ul>	• 0	<ul> <li>6,531 kWp as 1,468 pumps</li> <li>5.9 million liters/year</li> </ul>	257.405 Wp 185,619.6 liters/year
	<ul> <li>Number of banks providing finance for solar PV pumps</li> </ul>	• 0	• 7	11
	<ul> <li>Reduction of down-time and farmer's time lost to pump repair</li> </ul>	• 0	• 80%	83%
	<ul> <li>Savings due to avoided diesel cost after pumps have been paid off (over 15 years remaining technical life)<sup>13</sup></li> </ul>	• 0	US\$56 million	(8,294,400.00) SDG / 20years.
	<ul> <li>Number of new suppliers (partnerships) providing equipment financed by National PV Fund mechanism</li> </ul>	• 0	<ul> <li>At least 7 (representing a business volume of approximately 200 pumps/supplier, or 50/year)</li> </ul>	19 Different local companies have pre-qualified for supply and installation of 400 solar water pumps
	<ul> <li>Extent of change in modern energy coverage by users and specific sectors</li> </ul>	• 0	<ul> <li>22.5% (representing 1,468 pumps out of an estimated 6,500 existing)</li> </ul>	0.45%
Outcome 1: Financing and dissemination mechanism established and operational to support	<ul> <li>Investment mobilized for purchase of solar pumps by EOP</li> </ul>	• 0	• US\$24,190,000	2,419,001 USD Cost of 29 pumps is: 401,000.00 USD Cost of subsidy for 1,440 pumps is: 1,800,000.00 USD

<sup>&</sup>lt;sup>12</sup> GHG emissions reductions are calculated per GEF methodology and reflect GHG reductions from equipment installed during the GEF project over its lifetime, which extends beyond the GEF project. Calculations are for equipment life of 20 years, per GEF guidelines.

<sup>&</sup>lt;sup>13</sup>Assumes technical lifetime of equipment of 25 years, per manufacturer warranty for solar modules are present diesel prices.
a PV pump installation programme	<ul> <li>Dedicated mechanism for finance of PV pumps established</li> </ul>	None	<ul> <li>At least one national PV pump fund</li> </ul>	PV Fund has been formulated.
Outcome 2: Financing and dissemination mechanism de-risked through technical	<ul> <li>Technical quality standards developed and enforced for PV pumps</li> </ul>	None	<ul> <li>Reasonable standards in place to assure quality</li> </ul>	National standards for the components of the solar water pumps have been issued and adopted by the SSMO
standards and demand- side support	<ul> <li>Number of entities trained and capable of specifying and supplying solar pumps</li> </ul>	• 0	• 3	0
	<ul> <li>Number of pumping system using water efficient irrigation methods</li> </ul>	• 0	• 1,468	<ul><li>-29 pumping systems have</li><li>been installed.</li><li>-400 pumping systems under</li><li>tendering phase</li></ul>
Outcome 3: Mitigation instrument (NAMA) design elaborated and	<ul> <li>Development of a standardized baseline for solar PV pumping in Sudan</li> </ul>	None	<ul> <li>Standardized baseline developed and submitted to UNFCCC</li> </ul>	0
implemented in support of the PV pump installation programme	<ul> <li>Development of an MRV mechanism for solar water pumping</li> </ul>	<ul> <li>No MRV mechanism</li> </ul>	<ul> <li>An MRV mechanism developed and implemented</li> </ul>	0
Outcome 4: Supportive enabling environment and scaled-up implementation	<ul> <li>Inclusion of solar pumps in fiscal concessions lists of the Investment Law and the Agricultural Implements Regulation such that they receive preferential financial treatment</li> </ul>	<ul> <li>PV pumps are not included and receive no preferential treatment</li> </ul>	• PV pumps exempt from customs and taxes, receive benefits afforded to other agricultural implements	Exemption from customs and other duties has been issued.
	<ul> <li>PV Pumping integrated in National Energy Roadmap and Rural Energy Access Strategy</li> </ul>	<ul> <li>PV pumping not a part of NER or REAS</li> </ul>	<ul> <li>PV pumping integrated into NER and REAS</li> </ul>	<ul> <li>15,000 PV pumps were planned to be included in the MWRIE 5-year strategic plan (2017- 2021)</li> <li>A 50,000 PV pumps is planned to be included in the long term strategic development plan for MWRIE.</li> </ul>
	<ul> <li>Awareness raising and capacity building carried out</li> </ul>		<ul> <li>At least one workshop and demonstration held with the Ministry of Agriculture in each State in Sudan</li> </ul>	0

Project Strategy	Indicator <sup>14</sup>	Baseline Level <sup>15</sup>	Level in 1 <sup>st</sup> PIR (self- reported)	Midterm Target <sup>16</sup>	End-of-project Target	Midterm Level & Assessment <sup>17</sup>	Achieveme nt Rating <sup>18</sup>	Justification for Rating
Objective:	Indicator (if applicable): replace diesel- based irrigation water pumping through the promotion of solar	0		<ul> <li>Amount of reduced CO<sub>2</sub> emissions reductions from water pumps for irrigation (<i>compared to the project baseline</i>) installed EOP, tons CO<sub>2eq</sub></li> <li>Cumulative installed capacity of off-grid PV solar pumps (kWp)</li> <li>Fuel saved</li> <li>Number of banks providing finance for solar PV pumps</li> </ul>	Refer to Table 4: Project Results Framework		MS	Partially achieved at MTR stage which is considered satisfactory progress towards the 5-year target and on track for full achievement at the end of the project
	photovoltaic (PV) powered pumps	0		<ul> <li>Reduction of down-time and farmer's time lost to pump repair</li> <li>Savings due to avoided diesel cost after pumps have been paid off (over 15 years remaining technical life)<sup>19</sup></li> <li>Number of new suppliers (partnerships) providing equipment financed by National PV Fund mechanism</li> <li>Extent of change in modern energy coverage by users and specific sectors</li> </ul>	Refer to Table 4: Project Results Framework		MS	Partially achieved at MTR stage which is considered satisfactory progress towards the 5-year target and on track for full achievement at the end of the project
Outcome 1:	Indicator 1:	0		(i) Investment mobilized for purchase of solar pumps by EOP - installation of 28 pilot pumps to act as demonstration units	Refer to Table 4: Project Results Framework		HS	Fully achieved at MTR stage already with 29 pilot pumps
	Indicator 2:	0		(ii) Dedicated mechanism for finance of PV pumps established i.e. a National PV Fund to help finance farmers (Mahfaza)	Refer to Table 4: Project Results Framework			demonstration units installed.
	Indicator 3:	0		(iii) subsequent financing and installation of 1,440 pumps				Being implemented as 2 <sup>nd</sup> phase after the installations of the pilot pumps.

#### Table 5: Progress Towards Results Matrix (Achievement of outcomes against End-of-project Targets)

<sup>&</sup>lt;sup>14</sup> Populate with data from the Logframe and scorecards

<sup>&</sup>lt;sup>15</sup> Populate with data from the Project Document

<sup>&</sup>lt;sup>16</sup> If available

<sup>&</sup>lt;sup>17</sup> Colour code this column only

<sup>&</sup>lt;sup>18</sup> Use the 6 point Progress Towards Results Rating Scale: HS, S, MS, MU, U, HU

<sup>&</sup>lt;sup>19</sup>Assumes technical lifetime of equipment of 25 years, per manufacturer warranty for solar modules are present diesel prices.

Outcome 2:	Indicator 1:	0	<ul> <li>(i) Reduce the risks associated with (de- risking) solar PV pumping by providing technical quality standards, testing and certification</li> </ul>	Refer to Table 4: Project Results Framework	HS	Fully achieved at MTR stage already.
	Indicator 2:	0	(ii) Training and capacity building - entities trained and capable of specifying and supplying solar pumps	Refer to Table 4: Project Results Framework		
	Indicator 3:	0	(iii) Bidders invited from the institutions working in the field of testing laboratories	Refer to Table 4: Project Results Framework		
	Indicator 4:	0	(iv) Activities to increase efficiency of water use, thereby increasing the overall sustainability of pumping practices and reducing the size (and therefore cost) of solar PV pumps.			Partially achieved at MTR stage which is considered satisfactory progress towards the 5-year target and on track for full achievement at the end of the project
	Indicator 5:	0	(v) Number of pumping system using water efficient irrigation methods	Refer to Table 4: Project Results Framework	MS	Partially achieved at MTR stage which is considered satisfactory progress towards the 5-year target and on track for full achievement at the end of the project
Outcome 3:	Indicator 1:	0	<ul> <li>(i) Development of a UNFCCC standardized baseline for solar PV water pumping in Sudan</li> </ul>	Refer to Table 3: Project Results Framework	MS	Fully achieved at MTR stage already.
	Indicator 2:	0	(ii) Implements the point above within a NAMA to support the development of appropriate MRV protocol for solar pumping	Refer to Table 4: Project Results Framework	MS	Partially achieved at MTR stage which is considered satisfactory progress towards the 5-year target and on track for full achievement at the end of the project
	Indicator 3:					
Outcome 4:	Indicator 1:	0	<ul> <li>(i) Inclusion of solar pumps in fiscal concessions lists plus regulations to encourage solar PV pumping and exempt equipment from taxes and customs</li> </ul>	Refer to Table 4: Project Results Framework	MS	Fully achieved at MTR stage already.
	Indicator 2:	0	(ii) PV Pumping integrated in National Energy Roadmap and Rural Energy Access Strategy	Refer to Table 4: Project Results Framework	MS	Fully achieved at MTR stage already.

Indicator 4:	0	Scaling-up and expansion of the project to other states in Sudan alongside a structured replication programme to replicate success in the Northern State in other states.			Partially achieved at MTR stage which is considered satisfactory progress towards the 5-year target and on track for full achievement at the end of the project
Indicator 4:	0	Awareness raising and capacity building carried out	Refer to Table 4: Project Results Framework	MS	Partially achieved at MTR stage which is considered satisfactory progress towards the 5-year target and on track for full achievement at the end of the project

#### Indicator Assessment Key

The main objective of outcome 1 is to have 28 pumps installed as part of a pilot phase. In this regard, the project was able to successfully install the planned baseline for the project. At present 10 pump with power (56.4 Kwp) installed. The PV Fund (Mahfaza) has been approved from Minister of Finance and national Economy. It has been directed to the central bank of Sudan to issue a configuration decision.

The project selected a global standard in the field of solar power pumps to be the basis for the Sudanese standard in this field and has been adopted by higher management of SSMO. The solar pumping systems testing laboratory Consultancy company bidding already has been sorted and consultancy company selected to prepare the tender document for establishing the laboratory and its components. The project has (4) engineers from (3) deferent government entities have been trained on basic information specifying and supplying solar pumps and how use software sizing tool (one training course).

Four (4) Licenses of PVsyst software have been purchased, of which:

- (2) Licenses of PVsyst software have been grant to The General Directorate of Renewable and Alternative Energy.
- (2) Licenses of PVsyst software with Project Management Unit (PMU).

The project has no results achieved under this outcome till this moment (it's still work in progress).

A decision was issued by the Council of Ministers to exempt the system of solar energy pumps from duties and taxes. 15,000 pumps are included in the 5 Year plan.

Based on a detailed analysis of the facts above, the project has made significant progress towards achieving its outcomes. Capacity development includes the process whereby individuals, groups, and organisations enhance their abilities to mobilise and use resources in order to achieve their objectives on a sustainable basis (DFID, 2013). There is, in addition to the three levels in the definition, the 'institutional' context in which capacity development takes place. This covers the incentives, the economic, political and regulatory context and the resource base on which the context is built. Based on this DFID definition, PEWP has made significant progress towards its outcomes.

## 4.4. Project ownership, stakeholders' participation and partnerships

From a development context perspective, PEWP goals, objectives and expected results were developed for promoting the use of electric water pumps in irrigation in Sudan which pursued to establish a permanent relationship towards sustainable and concrete framework through establishment of many partnerships for sustainability as mentioned below:

- Signed contracts with two local private companies (Switch company and solar Man company) to import and install the first stage solar pumps (28).
- Ministry of Finance and national Economy The PV Fund (Mahfaza) has been approved from Minister of Finance and national Economy and already has been directed to the central Bank of Sudan to issue a configuration decision for the second stage of solar pumps installation (1440).
- Signed personal contract with technical local consultant to help on all activity of installation (28) solar Pumps.
- Signed personal contract with Agricultural and economical local consultant to help on study of baseline Survey for project zone (Northern State).

- Signed contract with Agricultural and economical local consultant company to help on study of baseline Survey for project zone (Northern State).
- Signed contract with local consultant company (Energy research Center) to help on import and install of Solar energy laboratory.
- Relationship with IFM company in U.A.E. DUBAI (02) Engineers trained on solar pumps operation and maintenance.
- Relationship with Lorenzo company (4) engineers from (3) different government entities have been trained on basic information and specifying and supplying solar pumps and how to use software sizing tool (one training course).
- o Relationship with PVsyst SA company (4) Licenses of PVsyst software have been purchased

In addition to this, the project also focuses on supporting the development of private sector participation in renewable energy through the private Bank financing and dissemination mechanism de-risking model. A deliberate focus of the project is redressing energy access inequality and energy poverty alleviation through reducing the cost of energy, particularly for small farmers, which is a major priority for continued growth of the sector potential that can largely be preferred as a sustainable vehicle towards poverty alleviation and climate proofing poor and vulnerable small farmers in Sudan.

PEWP was also formulated by Sudan nationals who understood the realities on the ground especially from the institutional strength and weakness perspective as well as from the perspective of the development needs of small farmers in the country. This is clearly evidenced by the deep community grassroots engagements, analysis of the policy, socio-economic and institutional context of the project that is included in the Project Documents. Although the need for external assistance is highlighted in the PD, the project design proposed and implemented decentralised management of most of the critical elements of the project be placed in the hands of local, communal and national institutions as a way of further ensuring sustainability, ownership and commitment to build local skills, expertise and capability.

The assessment of the project formulation process and current project design for PEWP revealed that the project emanated from a very comprehensive and robust analysis of the contextual status in Sudan. This was premised the Government of Sudan making considerable steps towards facilitating major small farmers' financing and dissemination mechanism service sectors to invest, including a decision issued by the Council of Ministers to exempt the system of solar energy pumps from customs duties and taxes alongside the inclusion of solar pumps in fiscal concessions lists of the Investment Law and the Agricultural Implements Regulation such that they receive preferential financial treatment. It has already begun putting in place incentives to encourage the participation of financing in the PV pumps sector in off-grid regions for small farmers.

The feedback from all stakeholders interviewed about their involvement on the project and their awareness in the project was supportive and high. All persons interviewed stressed the benefit of rising public awareness. Stakeholders praised initiation of discussions on promoting SWP as an alternative energy source to pump water as part of guaranteeing water security at farmer level.

Stakeholder consultation has been a key feature in the design of this project, and stakeholders have been involved in identifying and prioritizing the proposed intervention activities. The stakeholder consultations during project implementation are supporting all the outcomes. Details of the stakeholder engagement

40

during the PPG Phase were provided and a Stakeholder Baseline Analysis and their relationship to the project mind map was developed that outlined some of the key consultation principles and processes at a strategic level. It has been translated into practical action during the project implementation and provides guidance based on the initial stakeholder analysis, conducted as part of the project preparation process, and the consultations so far. This can be used to define further exact activities in consultation with the Project Board and Project Management Unit during the further period of implementation in particular the role of the Ministry of Agriculture (MoA).

The project's intervention involves national agencies. To ensure the proposed project was grounded in local realities whilst aligned to national policy, the PPG phase involved considerable stakeholder engagement and was driven through a PPG Steering Committee established as an inter-agency and multi-stakeholder coordination mechanism. The Stakeholder engagement on this project has been relatively satisfactory and it's evident by the manner of participation and commitment that most of the relevant stakeholders are putting towards implementing the project.

#### 4.5. Effectiveness, efficiency and timeliness of project implementation

On the basis of the mid-term report, discussion with project staff and with stakeholders, the project is proceeding close to the original plan apart from the Mitigation instrument (NAMA) design elaborated and implemented in support of the PV pump installation programme which is still work in progress. The project implementation was delayed initially because of: (1). A second project manager recruitment process as the first selected PMU manager resigned, therefore the start of project implementation delayed from February 2016 to June 2016. This PMU staffing second recruitment process took little time, which saw the implementation of the project with a fully-fledged PMU starting in June 2016. With a fully-fledged PMU, the project implementation model is in line with other government programs, it is effective and delivered efficiently because all the programs are aimed at investment in green energy and access by needy communities to sustainable energy improved alongside the agricultural sector has by far the largest share of CO<sub>2</sub>e emissions in Sudan, represented approximately 74% of the total emissions produced in the country. (2). A regulatory of the CBS challenge where the contracts for procurement and installation of the (28) solar pumps had been signed on 1<sup>st</sup> of December 2016 based on hard currency and date of execution was after advance payment 30% of the contract's amount. Yet, the central Bank of Sudan developed a new policy that payment for local companies is only by local currency. An exception of the first stage was done on the 19<sup>th</sup> of March 2017 after approaches requesting exemption to the Central Bank of Sudan by other State departments involved in the project which was successful. However, a total time delay from the first and second challenges is seven (7) months from the total project implementation timeframe of five (5) years. This lesson has been well learnt Future bidding for local contractors will be made in local currency.

## 4.6 Remaining barriers to achieving the project objective

From the document analysis and project beneficiaries' field assessment visits, a number of strategic barriers that were initially identified that need to be overcome in order to achieve the long-term solutions don't exist anymore. The implementation of a Mitigation instrument design elaborated and implemented in support of the PV pump installation programme is the remaining critical strategic milestone in this project's implementation. A strategic decision around instituting a state level project field office/PIU has to be made

soon as support to the PMU is much needed. The opportunity to productively and efficiently use the current opportunities already provided by the achievement of the project's aim particularly for future expansion and to reduce greenhouse gas (GHG) could always be debatable. The project has been designed to play a catalytic role in this transformational scaling-up of SWPs and renewable energies for water security more broadly and without a tangible project field office/PIU on the ground in the Northern State, sustaining current gains during the second phase of the project implementation phase would be a challenge. All structural and systematic barriers have been removed as also highlighted above. Some operational critical success factors and logistical barriers are highlighted below for attention.

#### 4.6.1 Overburdened PMU and lack of a state level project implementation unit (PIU)/field office

The project lacks a state level project implementation unit (PIU). This has put an enormous administrative, travel and reporting burden on the PMU team in Khartoum. This can be alleviated by establishing a PIU with the characteristics listed on the right of Figure 1 above. It must also be noted that there is no technical procurement support that exists for the PMU as things which adds additional workload. State level "on an On-Call Basis" technical capacity can be put in place for an additional number of Engineers alongside a Monitoring and Evaluation Specialist with some communication and administration or project management skills (*they could be junior or middle level appointments rather than senior level*). Incurred travel costs and every set of two work days lost on travel could work out to cover the relevant Northern state-based Measuring, Reporting and Verification (MRV) activities on an "On-Call Basis" salary requirement.

#### 4.6.2 Land under-utilisation and Sustainable Agricultural practices

With respect to land underutilisation especially in the summer, the role of the Ministry of Agriculture needs to be clarified so that it aids improved farmers yield and production over the full available piece of land (feddans). With the current land underutilisation yet water is abundant due to the SWPs, the project's outcomes 2, 3 and 4 are partly being risked by the absence of this value maximisation critical success factor. The installation of a SWP which this project is mainly about isn't the be all and end all end goal. It's an enabler to grow or increase on farm production as the pump installations are there to guarantee sustainable water security. Post installation, on farm activities (both crop production and animal husbandry) requires extension officer support to boost increased yield production, maximum available land tillage and increased animal husbandry production in a sustainable manner as some farmers are still practicing their ancient agricultural techniques and practices despite water availability security which the pump installations has brought. This falsifies their ability to repay loans as maximum on farm production isn't being realised and the lack of optimising the full potential which the SWP brings to the farmer. This is an indication that the initial project's conceptualisation amongst the project outcomes did not realistically view this as an integrated Food, Energy and Water (FEW) nexus intervention and this is the right time for the project to integrate its implementation further more across sectors and across government ministries to avail breakdown the silos to strengthen the different sectoral specific activities that support the achievement of the project's development objectives in the long run.

#### 4.6.3 Low usage of counterfactual scenarios M&E system and capacity

The usage of counterfactual scenarios M&E system and institutional capacity across the feedback loop from monitoring and evaluation technical aspects requires strengthening. This integrated use of

counterfactual scenarios M&E system needs to at least cover the following aspects of activities separately but in an integrated manner:

- Monitoring performance of all the 28 pilot pumps remotely.
- Track and monitor the socio-economic status of SWP farmers pre and post installations to track change in socio-economic indicators and build the case for further SWP roll out.
- Monitoring the farmers' ability to repay the PV pump fund loans based on full farm utilisation all year round.
- Development of a tool, or look-up table, to provide appropriate sizing for flow rate, informed by monitored parameters under Outcome 1.
- Evaluation of underground water resource and determination of sustainable pumping rates.
- o Develop a set of lessons learned through the implementation of the project.
- Demonstration of the value and savings in implementation of a PV pumping programme.

For a demonstration project, it's of paramount importance to practically demonstrate what's being referred to in the value and savings in farmers implementing this SWP PV pumping programme even if it's at a small scale – farmers' want to see the financial benefits and the improvements in socio-economic indicators as the hype around this demonstration project suggests. Failure of which discredits the project idea even though it's a brilliant one.

Other stakeholders are also looking at it, awaiting to see the financial benefits and the improvements in socio-economic indicators which mainly depend on farm production levels of their neighbouring farmers to then believe in this SWP in the first place - the capacity to have this discussion with the Ministry of Agriculture to address increased on farm production levels for the 28 pilot farmers and have a resolution taken on it has seemed to be missing and requires urgent attention. Without targeted adaptive management efforts to decide on this issue, this will create a barrier to long-term SWP uptake once a negative perception starts making the rounds in the sector. This was also reflected upon in most of the interview engagements, which also corroborates this finding increased on farm production levels not being supported in any form or nature as farmers are still using their old business as usual farming techniques' and practices which aren't fully utilising the water security competitive advantage the SWP brings, evidencing a lack of capacity for adaptive management, planning and implementation that this MTR cites as capacity barriers.

Whilst different stakeholders have greater capacity in certain elements than others - and the project has built on these strengths where possible – a further continuous process of capacity building optimisation across the project cycle is still needed. Some specific technical trainings will be needed (e.g. on contracting, procurement, monitoring and evaluation, Budget Plan on the job training) whilst for the main implementation aspects it would be best to continue to take a learning by doing approach with ongoing mentoring support as required, that builds problem solving confidence and the ability to work out solutions in a systematic, decisive and consultative way on which risks to tolerate and which one not to e.g. the current project failures to collate socio-economic data and pre-SWP installation status information for the 28 pilot farmers is a risk not worth tolerating and it could easily create a very bad name for the entire project I it fails to attribute farmer improved loan repayment capability/ability (reduced loan repayment default risk), improving socio-economic status, agricultural yield / crop improvements, value and savings to its implementation. This is the core value proposition and this project's unique selling point or niche.

Similarly, institutional barriers have contributed in most countries to weak coordination of the usage of counterfactual scenarios M&E systems and capacity between those working on climate change mitigation, development and poverty reduction. Government departments responsible for poverty reduction and

energy access are in some cases aware of renewable energy counterfactual scenarios M&E systems options, but have no means of coordination, which leads to the development of parallel efforts or to the lack of their development at all. In this case with limited capacity and to some success, all the key areas within the Sudanese government alongside non-government partners/stakeholders are being well coordinated through multi-sectoral representatives in the PTC, PMU and PB structures.

# 4.6.4 Low levels of state level SWP technicians' reskilling (de-risking) in existing diesel pump SMMEs

Water security enabled by access to energy, especially reliable, affordable, clean and smart electricity is important in addressing food, energy and water (FEW) poverty whilst improving FEW accesses in Sudan. The extent to which the existing state level based private sector/SMMEs can play a significant role with providing SWP troubleshooting and maintenance services like they already provide for the diesel pump systems isn't existent to satisfactory levels in this project at this MTR stage. In practice this project needs to enable a community-based approach from technologies that can be benefited from using already existing skill sets and diversifying or rechannelling those already existing technical skills towards the new technology. PEWP's responsibility must be restricted more to making sure local artesian skills for the local diesel pump technicians are diversified and broadened to also cover the repairs and maintenance of solar water pumps as well which are a fairly new system from this SWP project. Diesel is slowly but surely phasing out so local farmers can't rely on Khartoum based technicians' and the project shouldn't want these local diesel pump technicians out of work but for them to transition their service from diesel specialism to solar as this change on the local farms. This triggers the technology support and delivery system strengthening modality from a very early stage of local graduates as the project can't simply rely on experts to come in from Khartoum for certain simple aspects which local well capacitated technicians can do - repairs and maintenance for diesel pumps are locally done and SWP needs to mimic a similar if they are to be sustainable and see their on-farm adoption rates and uptake increase. More of these localised diesel oriented small businesses need to start transitioning and becoming active players in the SWP sector and be part of the learning of this process to build local capacity and capability within this sphere of expertise at a localised level. This is an area that will be required on an ongoing basis beyond the current installations as it determines how the local vibrant pool of SWP expertise is developed for a stronger Sudanese renewable energy sector with SWP well catered for. Otherwise, a negative reputation of the project might emerge when the technology is fully implemented and all of a sudden, when the diesel pump technicians realise they are out of work yet can't work on SWPs which will not fully provide the benefits to the local communities by also enabling these smaller diesel pump technicians to become active in the SWP sector for adaptation effectiveness in a development context.

This has been very evident and important with respect to the project's approach to apply and promote interventions that offer value addition: differential approaches have been used by project interventions in aiding renewable energy stimulation mainly wind energy and supporting both men and women through most of the projects aspects that have been programmed to date. The project needs to continue with this intentional targeting of both male and female beneficiaries in all aspects of its outcome areas if gender inequality is to be abated.

## 4.7 Project Administration and Management Arrangements

PEWP is a Nationally Executed project that is scheduled for implementation over a period of five years beginning in February 2016 implemented through the Ministry of Water Resources and Electricity (MWRE) which has succeeded the Ministry of Electricity and Dams (MED) as the body responsible for the electricity sector in Sudan, which is the designated institution for the implementation of the project. It has overall management oversight and monitoring responsibility over the project. UNDP Sudan Country Office has

the facilitating role for project implementation, which includes assisting in the procurement of equipment, international and local consultants for the project as needed and requested by the implementing agencies.

A Project Management Unit (PMU) was established and is operational. The PMU is composed of 1) A Project Manager, 2) Project Engineer, 3) A financial officer, and 4) An M and E officer. The project established an operational Project Board and a Technical Committee representing different stakeholders in Sudan. These management instruments were very instrumental in guiding the process of project development to achieve its developmental objectives. Project implementation is guided through high-level policy guidance and orientation from a Project Board (PB) alongside a Project's Technical Committee (PTC). A Project Implementation Unit (PIU) which is headed by a Project Manager (PM) is attached to MWRE where it has specific responsibility for project implementation. The PTC works under the supervision of MWRE. The PM is also supervised by MWRE, who are the executing agency of the project. The PM is also responsible to UNDP, through the executing agency, for the application of all UNDP administrative and financial regulations and procedures for the use of UNDP/GEF funds.

When it comes to the execution of the two key partners UNDP and MWRE for the implementation of this project, the following details came to light during the MTR. With regards to UNDP's role in the project there has been more than an appropriate focus on results. UNDP has been central in engaging the government line ministries in Sudan to unblock any delays or looming challenges that could delay aspects of project implementation. UNDP has been instrumental in facilitating and influencing these high level strategic and operational engagements to smoothen project implementation. The quality and timeliness of their technical support has been spot on and in good stead. In all of this they have been frankness, openness, honesty, candidness, truthfulness, sincerity and plain dealing alongside realism in reporting. The quality of risk management has been very high and the level of responsiveness to significant implementation problems (*mainly process delays that could hamper implementation*) has been of a very high calibre.

With regards to MWRE's role in the project there has been a very high level and appropriate focus on results. Like UNDP, the MWRE had dedicated a high-level adequacy of management inputs and processes towards this project. Their quality of risk management has been very high as they influenced some of their sister line ministries to unblock potential issues that could derail project implementation. Just like UNDP, in all of this they have been frankness, openness, honesty, candidness, truthfulness, sincerity and plain dealing alongside realism in reporting as evidenced by how functional and progress garnered by the respective bodies reviewed below have been.

No	Description	Date/Place	Parties
1	Meeting with the project technical committee of the ministry of agriculture- Northern state	03 July, 2016 / Dongola - Northern State	Ministry of agriculture- Northern state /ARC/ Underground water corporation- Northern state
2	Meeting with the director general of the	04 July, 2016/ Dongola-	Ministry of agriculture- Northern
	ministry of agriculture- Northern state	Northern State	state/ Technical committee
3	Meeting with the minister of agriculture-	04 July, 2016/ Dongola-	Ministry of agriculture- Northern
	Northern state	Northern State	state/ Technical committee
4	Meeting with the minister of agriculture-	24 July, 2016/ Dongola-	Ministry of agriculture- Northern
	Northern state	Northern State	state/ Technical committee
5	Meeting with the director general of the ministry of agriculture- Northern state	24 July, 2016/ Dongola- Northern State	Ministry of agriculture- Northern state/ Technical committee

#### Table 6: Performance of the project management unit - Meetings with partners

6	Meeting with the director general of the	24 July, 2016/ Dongola-	Technical committee/ Central Bank
	CBS- Northern state branch	Northern State	of Sudan
7	Meeting with the minister of Physical	24 July, 2016/ Dongola-	Technical committee
	Planning and Public Utilities- Northern state	Northern State	
8	Meeting with the director general of the	24 July, 2017/ Dongola-	MWRIE/UNDP/Technical
	ministry of agriculture- Northern state	Northern State	committee/ARC
9	Meeting with NewTech company for the	13 August, 2017/ Dongola-	Ministry of Agriculture- Northern
	baseline survey	Northern State	State/ ARC
10	Meeting with the Banks and NewTech	22 August, 2017/ Dongola-	Banks
	company for the baseline survey and	Northern State	
	financial mechanism		
11	Meeting with the director general of the	24 July, 2017/ Dongola-	MWRIE/UNDP/Technical
	CBS- Northern state branch	Northern State	committee/ Bank of Sudan/ARC
12	Meeting with the Banks- Northern state	27 July, 2017/ Dongola-	MWRIE/UNDP/Technical
	branches	Northern State	committee/ Banks/ARC
13	Meeting with Sudan Standards and	24 August, 2018/ Khartoum	SSMO
	Metrology Organization (SSMO)		
14	Meeting with the director general of	30 January, 2018	MWRIE
	renewable energy- MWRIE		
15	Workshop of final report of the baseline	21 December, 2017/	MWRIE/ Technical committee/
	survey and financial mechanism	Khartoum	Banks/ Ministry of Finance
16	Meeting with the minister of agriculture-	20 February, 2018/	MWRIE/ ministry of agriculture-
	Northern state	Dongola- Northern State	Northern state/ ARC
17	Workshop for the companies working in the	16 August, 2018/ Khartoum	Technical committee/ banks/
	solar water pump field.		ministry of Finance/ MWRIE
18	Workshop for the solar water pumps	03 September, 2018/	Technical committee/ banks/
	laboratory.	Khartoum	ministry of Finance/ MWRIE/
			UNDP/ Energy

## Table 7: Performance of the Technical Committee

No.	Meeting date	Attendance %	Decisions taken		Not done	In progress
			Fourth quarter 2016 report approved	$\checkmark$		
			Budget discussion and approved for the first quarter of 2017	$\checkmark$		
1	23 February 2017	92%	A coordination with the Sudanese Standards and Metrology (SSMO) is recommended to maintain the required IEC document by the project in the Wind/Solar Technologies to the country	✓		
			First quarter 2017 report has been approved	$\checkmark$		
2	25 May 2017	90%	Budget discussion and approved for the second quarter of 2017	$\checkmark$		

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			The Committee attributed the delay in the implementation of the pumps of the pilot phase to the decision of the Central Bank of Sudan regarding the foreign currency exchange	~	
			The project was granted a special exception from the Central Bank of Sudan on 19/3/2017	✓	
			Accelerate the steps to establishment the banks fund	$\checkmark$	
			National consultant to supervise the study of the baseline survey in the northern state	$\checkmark$	
			Second quarter 2017 report approved	✓	
			Budget discussion and approved for the third quarter of 2017	✓	
			The Committee recommended that the issue of the Central Bank of Sudan decision on foreign exchange be expedited	✓	
3	25 July 2017 Dongola	90%	To ensure that groundwater assessment is considered, according to the document. A technical description of the equipment should be made to purchase measuring instruments to assess the groundwater level	✓	
			The Committee recommended that Purchase software to help on design processes for the solar water pumps	✓	
			New design for ARC solar pump should be made	✓	
			The committee recommended the importance of the training course for solar water pumps		$\checkmark$
			First quarter 2018 report has been approved	$\checkmark$	
4	3 May 2018	90%	Budget discussion and approved for the second quarter of 2018	$\checkmark$	
			The study of the baseline survey has been completed	$\checkmark$	

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	I ne measuring devices were not installed in		
	March due to delayed payments from the	V	
	Central Bank of Sudan		

Note:

- The meeting of the fourth quarter of 2017 has been held in joint with the second Project Board meeting.

## Table 8: Performance of the Project Board

No.	Meeting date	Attendance %	Decision taken	Done	Not done	In progress
			Project Board recommended the PMU to accelerate the project execution.	$\checkmark$		
			Project Board recommended the PMU to prepare a detailed plan and reporting cycle.	$\checkmark$		
			Project Board recommended the PMU to support the support unit within the UNDP.	$\checkmark$		
			Project Board recommended the PMU to highlight the problems and challenges immediately once they occur in order to speed up the solutions.			✓
1	January 17, 2017	100%	Project Board recommended the PMU to develop a training plan and clear plan for promotion (especially in northern state).			✓
I			Project Board recommended the PMU to apply Documentation (for all project phases).	$\checkmark$		
			Project Board recommended the PMU to review the existing legislations and exemptions and creating a list of all requirements.	✓		
			Project Board recommended the PMU to clarify all abbreviations.	$\checkmark$		
			Project Board recommended the PMU to accelerate entering of the banks into finance.	✓		
			Project Board recommended the PMU to speed up the issue of payment in foreign currency.	✓		
2	January 4, 2018	93%	Project Board recommended the PMU to increase the awareness about using solar pumps in irrigation in various media.			$\checkmark$

Outcome 1		Outputs	Activities		Not	In	Remarks
		ouipulo	7,0171,000	Dono	done	progress	
			1.1.1. Selection of 28 farmers to receive the pilot pumps	v			<ul> <li>Site visits have been conducted for 46 sites.</li> <li>28 sites have been selected based on specific criteria.</li> </ul>
			1.1.2. Installation of baseline monitoring equipment to establish baseline diesel consumption, water pumped, operating hours, and cost expenditure.	V			Site Visits and collection of data from the farmers have been performed
Financing and dissemination mechanism established and operational to support a PV pump installation programme	1.1	28 pumps installed as part of a pilot phase	1.1.3. Specification, procurement, and installation of 28 pilot pumps	V			<ul> <li>Contract with national technical consultant to prepare the tender documents</li> <li>The tender documents were launched.</li> <li>Receipt of 28 offers from 21 different local and international companies.</li> <li>Award of contract to two local companies to supply and install the 28 solar pumps.</li> <li>Installation has been completed with delay due to difficulties of payments to the contractors in foreign currency due to new policy of Central Bank of Sudan (CBOS). The</li> </ul>

					imposed sanctions by US also
					delayed the implementation.
		1.1.4. Monitoring performance of the pilot pumps			<ul> <li>Each pump has been equipped with data module to send the performance parameters.</li> <li>The measurement equipment has been purchased and is under installation with delay due to the US sanctions.</li> </ul>
	1.2 National PV Fund and coordinated loan facility established and	<ul> <li>1.2.</li> <li>1.2.1. Support to the National Ministry of Finance to create national PV fund with appropriate fiduciary and legal standards in place for operation and monitoring</li> </ul>			<ul> <li>PV fund has been formulated from 11 Local Commercial Banks led by Nile Bank under the supervision of Central Bank of Sudan.</li> <li>Ministry of Finance committed to pay 50% of the cost of the solar pumping system on behalf of the farmers.</li> <li>Ministry of Finance guarantees the farmers in front of banks.</li> </ul>
	capitalized to promote concessional lending to farmers for PV pump equipment.	1.2.2. Coordination with North State Government and commercial banks to enact a loan program for PV pumps linked to the PV fund			<ul> <li>Northern State government committed to pay 25% of the cost of the solar pumping system on behalf of the farmers.</li> </ul>
		equipment.	1.2.3. Establish a set of criteria for PV pump loans	V	

		1.2.4. Establish and maintain a monitoring system			The financial mechanism report included a section on monitoring and evaluation of the farmers' ability to repay the PV pump fund loans.
1	1.3 A minimum of	1.3.1 Implement a subsidy scheme to support installation of 1,468 initial units	V		<ul> <li>75% of the solar system will be paid by the Central government and local government.</li> <li>The cost of the pump itself will be paid from GEF/UNDP Grant as a subsidy.</li> </ul>
	1,468 off grid PV pumps ranging in size from 3.12-29.6 kW installed in farms in the Northern State of Sudan with support from the national PV fund	1.3.2 Provide support to the lenders and users on closing and implementing the initial projects	V		<ul> <li>The National ministry of Finance and Economic Planning committed to guarantee the project.</li> <li>A national consultancy firm has been appointed to prepare a tender document for 400 solar pumps to be installed in 2018.</li> <li>Site visits have been performed by the consultant.</li> <li>A tender document has been prepared and launched.</li> <li>The process of bidding is ongoing.</li> </ul>

Outcome 2	Outputs	Activities	Done	Not done	In progress	Remarks
Financing and dissemination mechanism de-risked through technical standards and demand-side support	2.1 Development and implementation of technical quality standards for PV pump components by the National Energy Research Centre (NERC), augmented by enforcement support from SSMO, Customs and relevant market observers	2.1.1 Development of technical standards for equipment for solar water pumping	V			<ul> <li>A committee from the project, National energy research center, Sudan Standards and Metrology Organization and other entities has been formulated.</li> <li>Technical standards for equipment for solar water pumping systems have been developed.</li> <li>The standards have been adopted by Sudan Standards and Metrology Organization.</li> </ul>
		2.1.2 Approval of initial equipment suppliers and providers	V			<ul> <li>19 companies out of 30 companies have been pre- qualified in the field of supply and installation of solar water pumping systems.</li> <li>Pre-qualifications will be performed every year in order to get as much companies as possible.</li> </ul>
		2.1.3 Training for NERC and SSMO on evaluation of equipment			V	<ul> <li>The training is included in the contract with the contractor going to supply and implement the test facility.</li> </ul>
	2.2 SSMO test and certification laboratories strengthened to test and label PV pump components	2.2.1 Evaluation of tests required to be carried out in-country	V			<ul> <li>The standards and specifications have been developed by the technical committee of standards in addition to ToR for consultant to prepare the tender documents.</li> </ul>

					-	A national consultant was appointed to prepare a list of the equipment needed for tests and their specifications, and then prepare the tender documents.
	2.2.2 Establishment of basic testing protocols					
	2.2.3 Training of personnel to perform and develop tests			V	-	The training is included in the contract with the contractor going to supply and implement the test facility.
	2.3.1 Development or integration of solar resource assessment software	V			-	Four (4) licenses of PVSyst software have been purchased to enable the user to know the resource and to get the appropriate size of solar pump.
2.3 Software tool for pump sizing according to farm and hydrological conditions developed and implemented	2.3.2 Development of a tool, or look-up table, to provide appropriate sizing for flow rate, informed by monitored parameters under Outcome 1.			V		A training course on PVSyst software has been ordered from the manufacturer. Two engineers have been trained for one week in Dubai- UAE in solar pumping systems for agriculture. Four engineers have been trained for one week in China on Installation and maintenance of solar water pumps.
2.4 Training and certification scheme for PV pump installers (including local retailers,	2.4.1 Establishment of a training program for installers		$\checkmark$		-	It is included in the annual work plan for 2018. A call for training participants was already advertised.

technicians and pump rental companies) developed and implemented.	2.4.2	Establishment of a testing and certification scheme for installers.	V		<ul> <li>It is included in the annual work plan for 2018.</li> </ul>
2.5 Research on development of the most relevant, water efficient irrigation	2.5.1	Development of water saving measures at the Agricultural Research Centre in the North State.		$\checkmark$	<ul> <li>Equipment have been ordered.</li> </ul>
techniques directly applicable in the North State at minimal cost and dissemination of techniques to farmers.	2.5.2	Dissemination of such measures to farmers to reduce their need for water and thus capacity and capital cost of a pump.		V	<ul> <li>A solar water pump has been installed at the Agriculture Research Corporation (ARC) in Dongola- Northern State in order to reduce the farmers' water needs.</li> </ul>
2.6 Promotion of sustainable pumping practices based on outputs of the Nubian Sandstone Aquifer System from a separate GEF project (ID 4736).	2.6.1	Evaluation of underground water resource and determination of sustainable pumping rates relying on outputs from the Nubian Sandstone Aquifer System.		V	<ul> <li>Due to the termination of the GEF project (ID 4736) and lack of its outputs and results, equipment for evaluation of underground water resource and determination of sustainable pumping rates have been ordered.</li> </ul>

Outcome 3	Outputs	Activities	Done	Not done	In progress	Remarks
Mitigation instrument design elaborated and implemented in support of the PV pump installation programme	3.1 Development of a standardized baseline for pump fuel-switching,	3.1.1 Development of emissions standardized baseline according to UNFCCC guidelines			V	<ul> <li>A ToR for contracting a national consultant was prepared.</li> </ul>
		3.1.2 Establishment of additionality criteria according to UNFCCC guidelines		1		
	and the wider region	3.1.3 Submission of Standardized Baseline to the Sudan Designated National Authority for submission to UNFCCC		V		
	3.2 Implementation of the standardized baseline within a NAMA	3.2.1 Implementation of a NAMA utilizing the Standardized Baseline		√		
		3.2.2 Development of an MRV protocol under the NAMA		1		

Outcome 4	Outputs	Activities	Done	Not done	In progress	Remarks
Supportive enabling environment and scaled-up implementatio n	4.1 Inclusion of PV pumps in the fiscal concessions lists of the Investment Law and the Agricultural Implements Regulation	4.1.1 Develop a set of lessons learned through the implementation of the project			γ⁄	<ul> <li>The demand for the PV pumps is increasing significantly in response to the pilot phase of the project</li> <li>The number of pumping hours per day has increasing significantly at no extra cost</li> <li>The cultivated area has increasing in response to the availability of irrigation water</li> <li>A baseline survey study has been performed at the northern State including financial mechanism which came up with three different scenarios of funding mechanism.</li> <li>A proposal of similar project in Nile River State has been prepared according to this project and has been submitted to the Korean organization for International cooperation for funding and site visits have been performed.</li> <li>A committee has been formulated to develop a ToR of a national consultant to carry out all these activities.</li> <li>The committee performed a meeting and started preparation of the ToR.</li> </ul>
		4.1.2 Demonstration of the value and savings in implementation of a PV pumping programme			V	- The baseline survey indicated high savings by farmers using the PV pumps and this was the basis for initiating the PV fund.

				-PV pump farmers used these savings in other income generating activities.
	4.1.3	Presentation to the relevant authorities for inclusion in the fiscal plan and concession lists	v	<ul> <li>This is planned to be presented to the high investment council to be included in the fiscal plan and concession list.</li> <li>15,000 PV pumps were planned to be included in the MWRIE 5- year strategic plan (2017- 2021)</li> </ul>
4.2 Structured replication programme for other states designed and implemented, including strengthened integration of PV pumping in the Government's national energy roadmap and rural energy access strategy	4.2.1	Demonstration of national benefits and savings in implementation of PV pumping, included avoided infrastructure costs	V	<ul> <li>The evaluation of the national benefits and savings would be done at the end of the project.</li> <li>So far, from the 29 installed pumps, the saving is: 414,720.00SDG per year.</li> </ul>
	4.2.2 Presentat authorities national e energy ac	Presentation to the relevant authorities to support inclusion in national energy roadmap and rural energy access strategy	v	<ul> <li>A 50,000 PV pumps is planned to be included in the long term strategic development plan for MWRIE.</li> <li>A decision of exempting the components of solar water pumping system from customs and other duties has been issued from the council of ministers.</li> </ul>

Table 9: Project Progress Outputs and Related Target(s) as of September 2018

Source of data: ProDoc, Project Technical Reports, Interviews in the Field

## **Monitoring and Evaluation Performance**

#### • Inception workshop:

An inception workshop was already held within the first 2 months of project signature with those with assigned roles in the project organization structure, UNDP Country Office and, where appropriate/feasible, regional technical policy and programme advisors as well as other stakeholders.

#### • Quarterly Progress Reports:

Four (4) progress reports outlining main updates in project implementation are provided quarterly to the Project technical committee to enable the members witnessing any progress achieved in the project implementation and their advising has been included.

#### o Board meeting:

One (1) board meeting has been held to enable the members witnessing any progress achieved in the project implementation their advising has been included.

#### • Bi-annual Reports:

One (1) bi-annual progress reports already provided, outlining main updates and achievement in project progress to the UNDP Country Office in Khartoum.

#### • Technical Reports:

Six (6) technical reports have been provided about solar pumps installation and their achievement included on the periodic reports.

#### • Visits to the sites:

More than (10) visit to the Northern State from different entities (PMU, MWRIE and UNDP) provided for meetings, collecting data, monitoring and evaluation the situation of solar pumps installations.

#### 4.8 Work planning

The logic of the project's work plan makes it relevant to the Sudan situation where the quest has been to support the adoption of solar PV technology for water pumping for irrigation in agriculture in Sudan, particularly in the North State. Adoption of renewable energies has been identified as a priority in Sudan, as is reduction of dependence on fossil fuels which are imported. The application of solar PV to pumping has been on a relatively limited scale globally, but is seeing increased commercial interest in the past years. Yet solar PV technology in general is not widespread in Sudan. A systems approach has been adopted to help Sudanese farmers reduce their reliance on fossil fuels, reduce their cost of production (via decreased diesel expenditures), increase the sustainability of water use, and increase their income. Given that agriculture is a main component of the economy in Sudan, the project will help increase Sudan's energy security and decouple its GDP from fluctuations in fossil fuel prices and availability. The project has been designed to play a catalytic role in the transformational scaling up of solar power for productive use in Sudan's agricultural sector.

As shown in the results evaluation table, progress has been made towards the realisation of the project objective to replace diesel-based irrigation water pumping through the promotion of solar photovoltaic (PV) Powered Pumps. Progress of the project to realize its outcomes at the mid-term stage is quite evident except for outcome 3 which is to develop a UNFCCC standardized baseline for solar PV water pumping and implements it within a NAMA to support the development of appropriate MRV protocol for solar pumping which hasn't materialised yet. The removal of key high-level barriers like customs duty tax on solar system imports particularly to encourage private sector participation; strengthening the support for the adoption of solar photovoltaic (PV) technology to pump water for the irrigation of agriculture in the country and support an adaptive learning and replication intent from the project has been conducted and the results of these are now being used for further project implementation expansion efforts.

PMU support to the implementation of this project via a state level project office/PIU has been flagged as an operational risk at this mid-term point even from a work planning point of view. Its resolution has been flagged in the recommendations as it will also create a case study for replication in later similar SWP projects which will be good for Sudan's SWP sector and renewable energy sector much more broadly once this project is a success.

On the ground, the activities in the work plan are set up in a very practical and implementable way having assumed all the staffing requirements and customs duty tax exemption would be available or already in effect to support the project mainly for outcome 1: concerned with installing 28 which faced the customs duty tax barriers and a project manager resignation which had not been taken into consideration in the project design. The work plans deliverables are well organised and listed in an interrelated way which is progressive from one activity to the other. Overall, the work plan shows that the activities and targets set for this stage of the PEWP project have been mostly met apart from one major one which is outcome 3: NAMA development, indicating successful implementation of the project thus far.

#### 4.9 Financial Management

The financial management of this project is controlled at a local level through the PMU as below.

	GEF/UNDP Budget Amounts	GEF Received & Disbursement	GOS Received & Disbursement	GEF % Disbursement – Total	GEF/UNDP Budget Amounts Mid term	GEF % Disbursement – mid term	TOTAL
Funds Allocated: -	4,915,753						
Opening Balance							
Funds Received	1,970,611.06						
Foreign Exchange Gain							
Total Cash Available	1,970,611.06						
Less payments by Component:							
Component 1	2,523,161.83	768,842.40		30%	1,119,105.52	69%	
Component 2	846,005.04	141,041.36		17%	607,486.72	23%	
Component 3	486,220.77	123,597.91		25%	267,560.00	46%	
Component 4	276,447.00	12,301.84		4%	88,153.00	14%	
Project management	233,918.36	66,030.33		28%	158,319.50	42%	
Loans or advances		77,153.26					
Foreign Exchange (Loss)							
VAT paid on invoices							
Total Payments	4,915,753	1,188,967.10		24%	2,240,624.75	53%	
Closing Cash & Bank Balance							
Total payment + Committed payment		2,499,923.18		51%		133.9%	

Table 10: Financial progress of project budget utilisation against the plan in (\$) (Feb, 2016 - Feb, 2021)

## **Committed Payments:**

- Laboratory contract: \$578,000 USD
- Local consultant contract: \$6,000 USD
- Energy research center U of K contract: \$7,550 USD
- Local consultant contract: \$15,450 USD
- Switch company: \$88,350.00 USD
- Solar Man company: \$14,606.08 USD

#### Total: \$709,956.08 USD

- Subsidy for 400 PV pumps contract: 601,000 USD

## Grand total committed: \$1,310,956.08 USD.

#### Total payments plus committed payments: (\$1,188,967.10 + \$1,310,956.08) = \$2,499,923.18 USD.

#### Source: Project's 2018 fiscal budget

All necessary procedures appear to be in place. Technical administration of the components is undertaken by the experts responsible in collaboration with the appropriate Project Manager. As of 20 September, the project has disbursed \$2,240,624.75 which is equivalent to 53% of its approved grant fund of US\$ 4,409,103.83 with budget utilisation rate of 53.06% of the mid-term budget allocation which is \$ 2,240,624.75.

- a) The project's financial management system is well established with an Admin & Finance Assistant in place within the PMU.
- b) The project's outcome budget is progressively being spent at a good rate and as expected highest due to the nature of its high upfront costs of purchasing the SWP systems under the Component 1 budget line. It is clear that this component is heavily loaded with upfront costs that a solar photovoltaic (PV) technology cost which is normal.

In this particular MTR review period, no evidence of direct co-financing or collaborative financing of the same project by two or more donors, funders, banks or other lending could be determined. As such the MTR concludes that at this stage the project hasn't leveraged additional co-financing since its inception. However, they is interest to fund this project in other states by other donors and agencies as a result of the on the ground results emanating from this project's pilot phase. As a result, one could argue that a potential indirect upscaling co-financing or collaborative financing is likely before the end of this project which will contribute towards the achievement of project objectives, albeit in other states as discussed under Outcome 4 above where the Korean Organization for International Cooperation (KOICA) is highlighted as having agreed to repeat the experiment using this project's methodology in the state of the River Nile.

## 4.10 **Project level reporting, monitoring and evaluation systems**

Reporting has generally been working satisfactorily well for project level reporting, apart from the lack of undertaking a farmer pre SWP installation socio economic analysis. Important lessons are being generated through the monitoring and evaluation products of project implementation which provides huge scope for the replication and scaling up of the project both to other parts of the country as well as to other regions of

When it comes to broader monitoring and evaluation systems, under outcome 1 the development and use of an integrated counterfactual scenarios M&E system has been recommended with the assessment of this aspect and the motivations well captured there – those facts won't be repeated again here under this chapter, so please read outcome 4 RE: Monitoring and Evaluation systems that are very detailed there. Having said the above, at this MTR stage its safe conclude that the M&E plan was sufficiently budgeted for during project preparation and implementation thus far buts simply not followed through in time to yield valid MTR review results due to the pressures mentioned under Outcome 1 above. Insufficient human resources i.e. human capacity had been allocated towards M&E, which resulted in the PIR recommendation already mentioned and explained under the recommendations. Some follow-up actions have taken place in response to annual PIRs and putting in place adequate human resources towards M&E as recommended at this MTR stage should fully exhaust implementing all the PIR follow up actions.

## 4.11. Sustainability

## 4.11.1 Financial risks to sustainability

Based on the current budget of this project, the major financial risk to sustaining what has been set up is medium with a very high impact should it happen. With the current liquidity challenged local context, the project PV Fund might not be able to generate as much liquidity to generate as much loan capital to fund many SWPs to farmers through loans. The aim of attracting further private investment into the sector might negatively suffer from a bad perception if this liquidity crunch risk isn't managed properly. As a result, financial and economic resources will likely not be available from the private sector at the expected current scale and level once the GEF assistance ends, unless forms of liquidity and capital raising options like micro-financing are explored which is a precondition for the market to respond positively. Assuming the government picks up the entire financial tab of this project going forward, it won't be to such a very rapid pace at the scale of GEF. However, there are a lot of opportunities to access small chunks of financial and economic resources which when lumped together become significant like the local farmers micro-financing schemes, Adaptation Fund and the Green Climate Fund (GCF) etc. If connected well with other on-going projects being funded by other donors in the same project sites or similar sector of renewable energy, then the financial muscle might relatively stay the same if not increase.

Also, the huge financial burden of this project has been the high upfront start-up costs related to the SWP purchase and installations, which when the project ends will be very low as the private farmers will pick up all these costs if it's coming to SWP installation through Bank loans. As no high upfront start-up costs will be required from the farmers' as the state has put in place a 75% subsidy scheme, but actually maintenance costs which are relatively cheaper and lower when compared to start-up costs will all be privately borne by the farmers. The beneficiary farmers will transition from being water insecure, energy

poor and energy access deprived to well-being because they will see the benefits of this project on their livelihoods by having water security and clean energy/electricity to pump their water for irrigation. The capacity that's being developed will stay there and utilised beyond the projects life's span and this needs to be thought about very clearly to retain the skills in the sector by growing it so that it creates employment opportunities to absorb the skilled personnel and further develop them. So, the likelihood of financial and economic resources not being available at all once the GEF assistance ends (*considering potential resources can be from multiple sources, such as the public and private sectors, income generating activities, and other funding that will be adequate financial resources for sustaining project's outcomes)* is medium with a very high impact should it happen. Resources will be there and it is merely a question of their scale.

#### 4.11.2 Socio-economic risks to sustainability

The project has very minimal social or political risks that may jeopardize sustainability of project outcomes that can be justified at present. The political risk was very high before the changes in customs duty and taxes requirements being exempted on SWP which reduced the profitability of local SWP business and affected the price of SWPs and now that it's been lifted, this is now a relatively low risk. At present evidence is suggesting very high levels of stakeholder ownership (including ownership by government including all affected departments' and other key stakeholders). Based on present evidence, this will be sufficient to allow for the project outcomes/benefits to be sustained. At present all the various key stakeholders see that it is in their own interests that the project benefits continue to flow and that all the outcomes are achieved even if it means at a varied scale so that demonstration is done. There is sufficient public / stakeholder awareness in support of the long-term objectives of the project. However, this awareness needs to be continually raised so that it translates into tangible outcomes and project outcomes delivery until the project ends, so that the levels of outcomes delivered is increased. The lessons learned are being well documented by the Project Team on a continual basis and shared/transferred to appropriate parties who could learn from the project and potentially replicate and/or scale it in the future. They have also fully utilised the existing scope to strengthen this by using communications and knowledge management through the use of innovative streams like video footages and DVDs in local languages around the benefits of SWP in Sudan. People who intend to scale up the projects activities long after it's finished can already easily pick up the available video footages and DVD to recap and bring themselves up to speed with the vision and lessons learnt from the project even after its end. The NAMA development processes are still to be well documented on video and showcasing this project as one aspect of a broader renewable energy package will add weight and diversification plus credibility internationally if international financing is to be solicited.

#### 4.11.3 Institutional framework and governance risks to sustainability

At present the current legal frameworks, policies, governance structures and processes pose very minimal risks that may jeopardize sustenance of the project benefits. The required systems that have been set up like the mechanisms for accountability, transparency and technical knowledge transfer are well in place and functioning well. The barriers to the role of the Banks via a PV Fund issuing SWP loans to farmers have been well identified and addressed at a policy level through the PV Fund mechanism. Also, the

barriers in customs duty and taxes requirements that would have made SWP expensive and unattractive have also been well identified and addressed at a policy level through the exemption granted. SWP uptake is probably the strongest because of this project and the other energy sub-sectors like electricity driven pumps can adjust to appropriately to suit their needs – so the basis is there and now well set/established. However, that said, the aspects of accountability, transparency and technical knowledge transfer are all maintained. To ensure sustainability, however, there is a need to continue engaging with institutions of higher education and learning (*e.g. Universities' and technical colleges*) plus government structures like the Ministry of Agriculture, Agriculture Research Centre and local diesel pump technicians to ensure the already generated political will doesn't yearn.

#### 4.11.4 Environmental risks to sustainability

The environmental risks that may jeopardize sustenance of project outcomes are very minimal. The project is in predominantly water and energy scarce/strained regions i.e. water insecurity, food insecurity and energy poverty regions and in part is securing technologies for SWP which guarantees them Agricultural yields. The design of the SWP systems already factors in low environmental conditions of Sudan which mitigates any technological environmental risks to sustainability as custom made technology is being used.

#### 5 Recommendations and conclusion

#### 5.1 Conclusion

The mid-term review team concludes that PEWP is on target to achieve most of the results that are intended by the project for both the medium to long-term. The Project is being implemented in two phases as planned with the installation of 28-pilot phase solar pumps having been achieved already. The first phase of the pilot phase in which the UNDP/GEF has provided a fund to purchase solar pumps and distribute them to 28 selected small pump farmers in the Northern State which has been successfully completed which is the outcome subjected to an implementation delay high risk. This risk has also been exacerbated by the lack of a state level project implementation unit (PIU) which has put an enormous administrative, travel and reporting burden on the PMU team in Khartoum. However, this risk has been noted with measures to mitigate it being suggested through the option of establishing a state level PIU which can be undertaken as part of adaptive management which will render the overall project implementation a success at its end. The second phase implementation is now following after the completion of the pilot phase. The first phase funded the initial investment capital covering the installation of the 28 demonstration small pumps irrigating from the River Nile, Mattara and ground water sources in the seven localities of the State which has seen 28 solar pumps ranging from 56.4 Kwp to 257.40 Kwp installed in a phased approach and under operation for between 10 months to over a year for some with repairs and maintenance needs, except for two pumps that had defects on inverters which were checked and repaired.

The demonstration units are expected to prove and build trust amongst farmers that solar pumping is an attractive viable alternative option to diesel pumping. The Initial Fund will provide a financing mechanism associated with a subsidy that reduces the high capital cost of the pump, reduce risks and increase the capacity of the farmers to purchase the pumps. At present the central government has committed to fund 50% of the pump costs, whilst the state level government funds 25% and the beneficiary farmer(s) pay the remaining 25%.

In addition, the early signs suggest that in the short – medium term the project has seen improved progress with the process of establishing and capitalizing a National PV Fund and coordinated loan facility which has been formulated from 11 Local Commercial Banks to promote concessional lending to farmers for PV pump equipment. The development and implementation of technical quality standards for PV pump components by the National Energy Research Centre (NERC), augmented by enforcement support from SSMO, Customs and relevant market observers has been done with the technical standards for equipment for solar water pumping systems having been developed and adopted by the Sudan Standards and Metrology Organization. However, training is included in the contract with the contractor that's going to supply and implement the test facility which is expected to be completed in the next few months alongside a few other aspects that are still in progress awaiting their implementation upon the delivery of equipment which has been ordered.

In the short term at this MTR stage the failure to have a Mitigation instrument design elaborated and implemented in support of the PV pump installation programme isn't giving a very positive reflection on the mitigation intent of this project. However, the fact that a ToR for contracting a national consultant for the NAMA and an MRV protocol under this NAMA was prepared sends a positive signal about the broader intent of this SWP project going into the future for the medium to long term.

A very well established and vibrant supportive enabling environment and scaled-up implementation has been catalysed as a result of this project. This has seen the demand for the PV pumps increasing significantly in response to the pilot phase of the project. This was amplified by a decision of exempting the components of solar water pumping system from customs and other duties that was issued from the council of ministers. Some farmers' have even opted not to wait for the project but simply go private and install their own SWPs having seen the results of this pilot phase which augers well for the project. Pumping hours per day have increased significantly for farmers, their cultivated areas have increased in response to the availability of irrigation water with anecdotal responses of savings by farmers using the PV pumps and which is the basis for initiating the PV fund. Some farmers responded that they used these savings in other income generating activities like diversifying from simply planting crops and also now rearing animals like cattle, goats and sheep whilst some have increased the numbers of the animals they keep because they are more water secure now than before.

Overall, a cross-sectoral collaboration and forward-looking approach that satisfactorily considers the integrated and inter-related impacts such as the need for a state level field office / PIU and Ministry of Agriculture's extension services support to the farmers' and assist with the dissemination of water saving measures to farmers to reduce their need for water and thus capacity and capital cost of a SWP is evident. Without this cross-sectoral collaborative approach, value for money and return on investment optimisation, such as farmers making more income from increased and better-quality crop yields and animals would be missed.

## 5.2 Recommendations

The MTR of PEWP has identified a number of issues that are presented below as recommendations per outcome for use in the project design going forward and implementation of similar projects in future.

## Outcome 1: Financing and dissemination mechanism established and operational to support a PV pump installation programme

The project is positively progressing towards achieving its development objectives. This is one outcome which has been a precondition for the other outcomes whose implementation at the start of the project was delayed by about 7 months due to reasons which were unforeseen risks yet out of the control of the project team i.e. the resignation of the first Project Manager with a replacement being recruited, selected and appointment thereafter. They were also some structural barriers which had to be resolved as

elaborated upon under Outcome 4 that did get resolved after a while delaying implementation but resulted in a decision being issued by the Council of Ministers to exempt the systems of solar energy pumps from customs duties and taxes which is seen as key to barrier removal by all the stakeholders. As a result of this delay, the project has been put under immense pressure to implement the pilot PV solar water pump installations to catch up on lost time which has enormous demands for the pilot phase results of seeing the installations in place from all stakeholders.

The Project is being implemented in two phases as planned. The first phase of the pilot phase in which the UNDP/GEF has provided a fund to purchase solar pumps and distribute them to 28 selected small pump farmers in the Northern State which has been successfully completed. The second phase implementation is now following after the completion of the pilot phase. The first phase funded the initial investment capital covering the installation of the 28 demonstration small pumps irrigating from the River Nile, Mattara and ground water sources in the seven localities of the State which has seen 28 solar pumps ranging from 56.4 Kwp to 257.40 Kwp installed in a phased approach and under operation for between 10 months to over a year for some with repairs and maintenance needs, except for two pumps that had defects on inverters which were checked and repaired in about one working day for each. In comparison with the diesel pump systems, there is at least two repairs with 2-day intervals.

The Fund is provided by UNDP-GEF jointly with Ministry of Finance and other Ministries of Irrigation, State Ministry of Agriculture and others. The demonstration units are expected to prove and build trust amongst farmers that solar pumping is an attractive viable alternative option to diesel pumping. The Initial Fund will provide a financing mechanism associated with a subsidy that reduces the high capital cost of the pump, reduce risks and increase the capacity of the farmers to purchase the pumps. At present the central government has committed to fund 50% of the pump costs, whilst the state level government funds 25% and the beneficiary farmer(s) pay the remaining 25%. This demonstrates government commitment towards this project, country ownership. The PV Fund mechanism has approval from minister of Finance and national Economy and it has been established and consists of 11 commercial banks with an initial capital of US\$ 4 million for the 2018 plan (portfolio of projects which the Central Bank of Sudan developed). The Board of Directors was formed under the chairmanship of the Central Bank of Sudan. For this Outcome, the MTR can conclusively state that the financing and dissemination mechanism has been established but with some logistical operational issues plus monitoring and evaluation gaps to effectively and efficiently support the PV pump installation programme as explained in the recommendations and also additionally under Outcome 4. The second phase is planned to be funded by a consortium of Banks. The consortium has to provide a fund for lending an additional 1,440 solar water pumps to the small farmers in the 3 types of irrigation pump system in the seven localities within a liquidity constrained environment that's currently in existence posing a risk.

**Recommendation 1a** (*Responsible Party: UNDP*): Under this component, some in-effectivity and inefficiency has been picked up during the MTR under the dissemination mechanism establishment and operationalisation which requires rectifying as if unaddressed, it creates an unsupportive enabling environment and scaled-up implementation which is what Outcome 4 sought to achieve. They are no state level skeleton project team members / satellite field office / project implementation unit to run the daily operations from within the Northern state yet this is where the key project day to day activities are being implemented and the bulk of its activities are taking place.

Funding agency characteristics
EA/IA characteristics
Project characteristics
Project characteristics
PIU characteristics
Country context characteristics
Country context characteristics
Capacity in policy/institutional development

Figure 3: setting up and funding PIU in developing project management capacity in the Northern State

EA = executing agency, IA = implementing agency, O&M = operation and maintenance, PIU = project implementation unit.

Note: Arrows indicate effect relationships.

#### Source: https://www.oecd.org/dac/evaluation/dcdndep/34988492.pdf

The project management unit (PMU) is overwhelmed with project requirements and practically loses two days travelling to and from the Northern State as google maps approximates the distance to be about +/-7 h 52 min (637.1 km) via A11 which isn't a sustainable operational modality to implement such a project with intense on the ground person to person engagements with farmers in the Northern State. The lack of a state level project implementation unit (PIU) has put an enormous administrative, travel and reporting burden on the PMU team in Khartoum. This can be alleviated by establishing a PIU with the characteristics listed on the right of Figure 1 above. It must also be noted that they are no technical procurement support that exists for the PMU as things which adds additional workload. State level "on an On-Call Basis" technical capacity can be put in place for an additional number of Engineers alongside a Monitoring and Evaluation Specialist with some communication and administration or project management skills (*they could be junior or middle level appointments rather than senior level*). Incurred travel costs and every set of two work days lost on travel could work out to cover the relevant Northern state-based Measuring, Reporting and Verification (MRV) activities on an "On-Call Basis" salary requirement.

Some of the data required for the programme refers to farmer level change on their respective feddans. Information on the situation at pilot project beneficiary level still needs to be gathered, and often will require a degree of local knowledge to assess whether such change can be considered to have happened in the locality. There have been discussions on whether the single Khartoum based PMU M&E Specialist (M&ES) is best placed to gather farmer level data. It is currently considered that, in general, if recruited local state level PIU staff support working in the community concerned would be best placed to gather this farmer level data, which would then be submitted to the M&ES, who would aggregate the submissions from different farmers into a programme level figure. This is recommended because:

- When recruited local state level PIU support staff working in a community should anyway be aware of the state level data concerning their sector of intervention;
- When recruited local state level PIU support staff working in a community are best placed to be able to provide a 'reality check' or 'local knowledge' on the accuracy of Government figures and to be able to provide qualifying comments or alternative sources to the M&ES if required.
- Gathering some figures within required timeframes may require 'knocking on doors' which is easier done by a recruited local state level PIU support staff working in a community than by the M&ES trying to cover 7 or more sparse localities whilst working or operating fulltime alone on M&E out of the Khartoum PMU.

However, in all cases the M&ES will be expected to provide technical advice and backstopping to the state level PIU staff that are gathering this data. The M&ES will also aggregate the data from different farmers across the programme in order to enable the Project to deliver programme level reports to GEF and all

other stakeholders as required. This approach will be kept under review by the M&ES and may be adjusted if necessary.

Recommendation 1b (Responsible Party: UNDP): Under this component, the seven months long project delays experienced have left this project with no socio-economic Monitoring and Evaluation tools/system in place to effectively and efficiently compare the socio-economic of the farmers before receipt of the solar water pump (SWP)systems and after receipt and installation of the SWP. A retrospective collection of this socio-economic information or data needs to be done on the 28 pilot farmers so that clear indicators for example on: average crop area; production and productivity crop composition by area; cost saving/increase; crop or animal yield increase/decrease; agricultural input expenses reduction/increase and the number of pumping system using water efficient irrigation methods etc. can be traced/tracked and be attributable to the project as a positive or negative outcome as this project potentially has a very powerful "story of change" attributable to it. The performance of the SWP also requires monitoring and this must also be done alongside the socio-economic data collection process recommended here. For those farmers who've put their names forward for consideration for the next phase that aims to rollout 1,440 SWPs, then the same exercise must be done as they register their names for consideration so that this information is already available and at hand before they even receive a SWP. This in-effectivity and inefficiency has also been picked up during the MTR under operationalisation which requires addressing as if let unrectified it creates an unsupportive enabling environment and scaled-up implementation which is what Outcome 4 sought to achieve. The failure to paint a good or bad economic, financial and social picture of benefits emanating from this project would be selling this brilliant innovative intervention short and this requires rectification for the sake of impactful project impact and achievements communication purposes. Outcomes 4 and 2 also partly touch on this issue as it cross cutting and put forward a few suggestions worth considering to implement the retrospective data collection.

**Recommendation 1c** (*Responsible Party: UNDP, Ministry of Finance & PV Fund consortium*): Given the current liquidity risk in existence, the PV Fund consortium needs to explore other mechanisms/ways to seek additional diversified funding support if needed through the government from other international organisations including the Clean Development Mechanism (CDM), the Climate Adaptation Fund, the Green Climate Fund (GCF) etc. Diversification is a form of risk management and the liquidity risk needs to be managed. To further leverage upon the 18 suppliers that have already selected and qualified to provide 400 solar PV water pumps for the project's 2018 plan by national PV fund mechanism. The introduction of a new technology such as the solar water pumps in the production cycle is vital for competitiveness of agricultural production given the recent experiences with the fluctuations and shortages in the electricity power in the national grid and in the State, it became clear that introducing the solar pumps is a wise decision that needs to be explored and expanded. In such cases it is important to be able to measure the change that could result from the introduction of such technologies before their dissemination largely. The introduction of solar pumps will support the production of both winter and summer crops and will increase the income opportunities of the small farmers thus improving their food security position and livelihoods.

## Outcome 2: Financing and dissemination mechanism de-risked through technical standards and demand-side support.

When it comes to imported counterfeit SWP systems, this is one outcome which has been highly appreciated and seen as a key barrier removal by the Sudanese Standards and Metrology Organization (SSMO). The project's role in enabling setting up of technical standards was greatly commended and appreciated as ground breaking for Sudan. The technical standards that will see a fully-fledged SWP system testing lab up and running in a few months' time enable a private sector driven PV SWP market that meets a certain benchmarked standard which was highly lauded by stakeholders and highlighted multiple times as something which wouldn't have been achieved if it wasn't for this project. Evidence on progress thus far shows that:

- A solar committee was formed under the Sudanese Standards and Metrology Organization (SSMO) to adopt technical quality standards.
- A global standard has been selected in the field of solar power pumps to be the basis for the Sudanese standard in this field and has been adopted by higher management of SSMO.
- A National Consultancy institution working in the field of testing laboratories and solar pumping systems has been selected to prepare the tender document for establishing the PV pumps laboratory.
- An institution working in the field of procurement and installation of laboratories of solar pumping systems has been selected. Contract signing on progress.
- One of (29) solar water pumps has been installed at the agricultural researches' authority- Dongola.
- Training: 4 engineers from 3 efferent government entities have been trained on basic information and specifying and supplying solar pumps and how use software sizing tool (one training course).
- PVsyst software licensing: 4 Licenses of PVsyst software, have been purchased, of which:
  - 2 Licenses of PVsyst software have been grant to The General Directorate of Renewable and Alternative Energy.
  - Another 2 Licenses of PVsyst software with Project Management Unit (PMU).

Overall, at this MTR stage it's safe to conclude that the financing and dissemination mechanism is derisked through the SSMO developed technical standards with a few action points that are being finalised over the final duration of the project.

Recommendation 2a (Responsible Party: UNDP & MWRE): PEWP should aim to resolve the demandside support technicalities mentioned about the number of entities trained and capable of specifying and supplying solar pumps. It's good that government has trained its officials, however the local existing state private sector can play a significant role with complementation of this through existing local state based small businesses that only specialise in diesel pumps at present. In practice that is need to enable a community-based approach from technologies that can be benefited from using already existing skill sets and diversifying those skills towards the new technology. PEWP's responsibility would be restricted more to making sure local artesian skills for the local diesel pump technician are broadened to the repairs and maintenance of solar water pumps - as diesel is slowly but surely phasing out, we don't want these diesel pump technicians out of work but for them to transition their service from diesel specialism to solar as this change on the local farms. This triggers the technology support and delivery system strengthening from a very early stage of local graduates as the project can't simply rely on experts to come in from Khartoum for certain simple aspects which local well capacitated technicians can do. More of these localised diesel oriented small businesses need to start becoming active players in the SWP sector and be part of the learning of this process to build local capacity and capability within this sphere of expertise at a localised level. Hybrid-ing wind energy with solar on solar powered agricultural farms for water pumping to be financed by farm owners is another avenue which if explored with cooperation from institutions of higher education will add value to the notion of SWP technology support and strengthen the delivery system. This is an area that will be required on an ongoing basis beyond the current installations as it determines how the local pool of expertise is developed for a stronger Sudanese renewable energy sector with SWP well catered for. Otherwise, a negative reputation of the project might emerge when the technology is fully implemented and all of a sudden, when the diesel pump technicians realise they are out of work yet can't work on SWPs which will not fully provide the benefits to the local communities by also enabling these smaller diesel pump technicians to become active in the SWP sector for adaptation effectiveness in a development context – further notes in Outcome 4 also complement this point.

**Recommendation 2b** (*Responsible Party: UNDP, Ministry of Finance & MWRE*): PEWP should aim to demonstrate the national benefits and savings in implementation of PV pumping, including avoided infrastructure costs. The ultimate goal of adaptation is to ensure that human well-being can be maintained or improved in the face of stresses and shocks. For the demand-side support aspect, the project needs to consider developing a training module for operation and maintenance technicians with the likes of the Energy Research Center - University of Khartoum or its equivalent.

- Develop a monitoring network for underground water in the northern state.
- Develop a training module for PV water pump performance with a focus on monitoring, evaluation, troubleshooting and adaptive management.
- Develop a training module for project management (including contract management).

## Outcome 3: Mitigation instrument (NAMA) design elaborated and implemented in support of the PV pump installation programme.

It must be noted that this outcome has the greatest number of activities that still haven't been done which are not yet in progress at this MTR stage. However, evidence on progress the Nationally Appropriate Mitigation Action (NAMA) thus far shows that amongst others, the contract signing process of the National consultant to develop standardized baseline within a NAMA who has been selected is still in progress. The National consultant to develop an MRV mechanism has also been selected and contract signing process is in progress. A baseline survey including socio-economic study for this outcome area has been conducted by NewTech Consultancy Company. A workshop was also conducted for the results and outcomes of the Baseline survey which this MTR confirms.

**Recommendation 3a** (*Responsible Party: UNDP & MWRE*): As a medium-to-long term fund seeking technology support and delivery system strengthening, the NAMA as an instrument needs to be designed, elaborated upon and implemented in support of the PV pump installation programme. This should aim to build a localised business case to sought additional financial resources to upscale this programme using this mitigation instrument. Equally so multi-lateral institutions like the Green Climate Fund (GCF) can also be approached to fund a scaling up project of the proof of concept from this GEF supported project to make the most of the current gains made through the GEF support in order to pave the way for further market development and scaled wind energy uptake in the potential areas.

#### Outcome 4: Supportive enabling environment and scaled-up implementation.

Evidence on progress thus far shows that a decision was issued by the Council of Ministers to exempt the system of solar energy pumps from customs duties and taxes. The inclusion of solar pumps in fiscal concessions lists of the Investment Law and the Agricultural Implements Regulation such that they receive preferential financial treatment has been done. 15,000 pumps have been included in the 5 Year plan and a feasibility study for this is in progress which is a sign of progress towards PV Pumping integration into a futuristic National Energy Roadmap and Rural Energy Access Strategy which has renewable energy playing a key catalytic role in it. The planning of the installation of 3,000 solar water pumps has already started under MWRIE. As a result of this project, interest from other donors has been strong with the Korean Organization for International Cooperation (KOICA) having agreed to repeat the experiment using this project's methodology in the state of the Nile River. The contracting of a national consultant for conducting a feasibility study in different states for the project replication is in progress.

However, an enabling environment<sup>20</sup> is a rich and varied space where risks are minimised and well managed. Multi-level, multi-stakeholder work on enabling environments. Connecting interventions at different scales of action and government is essential (DFID, 2011a, p.10) The solar pumps technology support and delivery system has not been strengthened with a lot of local technical training/artesian skills development and learning being undertaken from installations on the project's implementation and contexts elsewhere which is very good.

<sup>&</sup>lt;sup>20</sup> in general, developing the enabling environment thus consists of developing:

<sup>1)</sup> Supportive legal and policy frameworks and their implementation and enforcement

<sup>2)</sup> Institutional strengthening including coordination, clear roles and responsibilities of key entities (government, non-state actors including civil society)

<sup>3)</sup> Capacity strengthening of all actors so they can play their roles

<sup>&</sup>lt;sup>4)</sup> Social dialogue including participation of stakeholders (including links to issues such as decentralisation). See for details on analysis <u>http://eese-toolkit.itcilo.org/</u> (Source: <u>https://europa.eu/capacity4dev/iesf/blog/enabling-environment-definition-and-reference-tools-0</u>)

**Recommendation 4a** (*Responsible Party: UNDP, Ministry of Agriculture & MWRE*): address the business as usual land under-utilisation by SWPs farmers in the summer season through the Ministry of Agriculture's (MOA) extension services role. From a Sustainable Agriculture point of view, the MOA must be represented on this project's advisory structure. At state level the MOA through its existing extension officers must support the project for increased yield and animal husbandry activities.

They are great needs for a multi stakeholder and inter-ministerial coordinated management approach to improve the affordability, reliability, and environmental sustainability of this food, energy, and water nexus initiative. As part of Adaptive learning given the interdependence of food, energy, and water (FEW) systems, integration and a holistic systematic approach of implementing this SWP programme is required. This project should be viewed as an inter-ministerial food, energy, and water (FEW) learning curve where the Ministry of Agriculture is also represented and it must support the project from a yield and animal husbandry to maximise the gains of having on farm water security from the SWP which this project is installing and sustainable energy which guarantees water supply. The project learning also need to be adapted for each FEW system outcome areas so that an integrated systems approach at implementing this project is strengthened which is a win-win-win scenario for all interested parties. By so doing a wholly supportive enabling environment and scaled-up implementation is enhanced and strengthened even further. Emerging interdisciplinary science efforts are providing new understanding of the interdependence of food, energy, and water (FEW) systems.

These science advances, in turn, provide critical information for coordinated management to improve the affordability, reliability, and environmental sustainability of FEW systems. A combination of Interdisciplinary research (IDR)<sup>21</sup> and Transdisciplinary Research<sup>22</sup> must be used for this water-food-energy (WEF) nexus project as water security, energy security and food security — are inextricably linked and that actions in one area more often than not have impacts in one or both of the others. WEF is central to sustainable development.







**Source**: Scanlon, B. R., Ruddell, B. L., Reed, P. M., Hook, R. I., Zheng, C., Tidwell, V. C., & Siebert, S. (2017). The food-energywater nexus: Transforming science for society. *Water Resources* 

69

<sup>&</sup>lt;sup>21</sup> is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice (Rosenfield 1992). <u>https://www.obesity-cancer.wustl.edu/en/about/what-is-transdisciplinary-research</u> <sup>22</sup> is defined as research efforts conducted by investigators from different disciplines working jointly to create new conceptual, theoretical, methodological, and translational innovations that integrate and move beyond discipline-specific approaches to address a common problem. <u>https://www.hsph.harvard.edu/trec/about-us/definitions/</u>

<sup>&</sup>lt;sup>23</sup>Understanding and managing the food-energy-water nexus – opportunities for water resources research. Advances in Water Resources Volume 111, January 2018, Pages 259-273. https://www.sciencedirect.com/science/article/pii/S0309170817304475

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The inextricable linkages between these critical domains require a suitably integrated approach to ensuring water and food security, and sustainable agriculture and energy production. Internship or bursary<sup>26</sup> using Ethnographic<sup>27</sup> research methods to generate raw data packaged and published PhD and Master's degree thesis organising and compiling information that will feed into reports and communications pieces effectively showcasing socio-economic development benefits as well as environment results. The PhD and Masters research studies can be based on "different country typologies for Sudan, allowing a quick assessment of possible interventions against overarching development goals such as food security, and the sustainability of the use and management of energy and water supplies" (FAO, 2018).Studies on the food, energy, and water (FEW) nexus lay a shared foundation for researchers, policy makers, practitioners, and stakeholders to understand and manage linked production, utilisation, and security of FEW systems.

As already suggested above under recommendation 1b, it's worth having a retrospective socio-economic survey done for the 28 farmers who've received the SWPs and equally so the next lot of 1,440 be surveyed too (*even if it's a simple primary field research exercise done in consultation with the institutions of higher learning and education who can use their PhD and Master's students*) to assist with data collection from the targeted farmers as a priority. The socio-economic survey interventions going forward must be more targeted and part of the potential beneficiary farmers' recruitment process. Even if it's at their own costs through Master and Doctoral students as a start so that their students can graduate, this will assist the project immensely. Some typical indicators that can be used at the impact level of this project's socio-economic survey can be:

- Number of farmers whose main livelihood(s) (crop land, livestock, other) is managed using PEWP initiated practices as a result of SWP support;
- (j) Productivity levels and volumes of crop yields before receiving a SWP and after receipt;
- (k) Levels of agricultural produce diversification e.g. crops only, animals only, crops and animals etc;
- (I) 'Conventional' development or well-being indicators such levels of food security, nutrition, savings, assets, employment etc.;
- (m) Number of farmers covered by good enough sustainable agriculture extensions service activities which results in improved implementation practice as a result of support;

<sup>&</sup>lt;sup>24</sup> is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice (Rosenfield 1992). <u>https://www.obesity-cancer.wustl.edu/en/about/what-is-transdisciplinary-research</u>

<sup>&</sup>lt;sup>25</sup> is defined as research efforts conducted by investigators from different disciplines working jointly to create new conceptual, theoretical, methodological, and translational innovations that integrate and move beyond discipline-specific approaches to address a common problem. https://www.hsph.harvard.edu/trec/about-us/definitions/

<sup>&</sup>lt;sup>26</sup> A bursary is a monetary award made by an institution to individuals or groups of people who in return for the bursary the individual is usually obligated to be employed at the institution for the duration as the bursary. <u>https://www.gov.uk/1619-bursary-fund</u>

<sup>&</sup>lt;sup>27</sup> is a qualitative method where researchers observe and/or interact with a study's participants in their real-life environment? Also called fieldwork, involves observation of and interaction with the persons or groups being studied in the group's own environment, often for long periods of time. https://hbr.org/2009/03/ethnographic-research-a-key-to-strategy
- (n) Reduction in SDG losses due to SWP;
- (o) Level of satisfaction with SWP; and
- (p) State of the farmers' environment.

A strong and vibrant SWP applied research programme can be developed with institutions of higher learning to use PEWP fully funded or part funded conditional SWP project focused internships of bursaries for PhD and Master's degree students to track and update socio-economic indicators suggested above as their thesis research work under specific disciplines or areas off study – an indicative illustration is given below of how this could look like for consideration in order to enable the demonstration of the value and savings in implementation of a PV pumping programme that can be presented to the relevant authorities for inclusion in the fiscal plan and concession lists.



**Recommendation 4b** (*Responsible Party: UNDP & MWRE*): The installation of remote online SWP performance (*e.g. via online linked PS communicators*) for all the 28 pilot project installations is required. Going forward, all new SWP installations must be done with this remote SWP performance on them so that the performance of the pumps (*current and historical*) can be tracked, recorded, monitored and evaluated to aid developing a set of lessons learned through the implementation of the project. AT present only a handful of installations have this functionality installed on them and not all of them – the remainder of the 28 pilot pumps needs to be done as soon as possible so that their remote SWP performance tracking, recording, monitoring and evaluating can be initiated without any further delays. Without this, it is difficult to tell if all these 28 SWP installations are achieving value for money by performing optimally, below par or beyond expectations because information to make this call for the 28 installed SWPs isn't available yet. Farmer satisfaction or happiness alone isn't enough of an indicator to show us the technical performance of the SWP and this needs to be addressed.

**Recommendation 4c** (*Responsible Party: UNDP & MWRE*): the development and use of an integrated counterfactual scenarios M&E system as "ground-based monitoring and modelling at local-to-regional scales; incorporating human and institutional behaviour in models; partnerships among universities, industry and government to develop socio-economic relevant data and systems modelling to evaluate trade-offs associated with FEW decisions" is still a key challenge, yet its key to creating a supportive

enabling environment and scaled-up implementation. A delayed context in kick starting project implementation which the PMU found itself in requires adaptive learning to be drawn out of it and that the replication plans other localities and state need to factor this risk very well and how it can be mitigated. This MTR does acknowledge the existence of a December 2017 "Baseline Survey Report: A Financial mechanism of the national fund" (*from Page 26 of 211*) which gives a regional specific current social and economic situation of small pump farmers in the northern State. However, adopting a targeted approach for the remaining Adaptive learning to retrospectively capture pre-intervention and post intervention socio-economic data for all the 28 SWP beneficiaries alongside the expected 1,440 that await benefiting would be more strategic and impactful. This integrated use of counterfactual scenarios M&E system needs to cover the following aspects of activities separately but in an integrated manner:

- Monitoring performance of all the 28 pilot pumps remotely.
- Track and monitor the socio-economic status of SWP farmers pre and post installations to track change in socio-economic indicators and build the case for further SWP roll out.
- Monitoring the farmers' ability to repay the PV pump fund loans based on full farm utilisation all year round.
- Development of a tool, or look-up table, to provide appropriate sizing for flow rate, informed by monitored parameters under Outcome 1.
- Evaluation of underground water resource and determination of sustainable pumping rates.
- Develop a set of lessons learned through the implementation of the project.
- Demonstration of the value and savings in implementation of a PV pumping programme.

As demonstrated in recommendations 4a – 4b, due to increased water security from the SWP intervention there are a number of ways of comparing increased yield, production, measured losses, damages and changes in wellbeing indicators with a 'no-intervention' counterfactual. These ways include:

- (d) Where formal comparisons based on randomised control studies cannot be made, the likely impact of shocks and stresses with and without an increased water security adaptation intervention like PEWP can still be estimated or modelled. This may involve comparing the effects of shocks/stresses on a target community with those in 'similar enough' communities outside the area in which the intervention takes place. Another way is to compare the impact of similar shocks before and after the intervention. If the intervention is being introduced in phases, the effects of shocks might be compared between communities representing different phases of the intervention (i.e. with more or less 'adaptation'). These approaches are sometimes referred to as 'quasi-experimental approaches' and statistical analysis may be possible in such cases which recommendations 4b can feasibly achieve. However, care should be taken in attributing differences between comparison cases to an intervention, and attention should be paid to other potential drivers of change that might be unrelated to the intervention.
- (e) Using an experimental design in which the effects of shocks/stress can be compared between communities that have been targeted by PEWP adaptation interventions and those that have not. Such comparisons, based on the methodology of randomised control trials originating in the health sector, are increasingly common in development contexts (Stern et al. 2012; Gilbert 2013; Hughes 2013). These approaches are statistically powerful, but may not be possible in practice for a number of reasons that include the availability of a suitable control community/population, resource limitations that make the gathering of control data impractical, and ethical objections to the use of a population as a control when they do not benefit from an intervention. Bamberger and White (2007) estimate that randomised control trials may be applicable to as little as 5% of development finance, a figure cited by Prowse and Snilstveit (2009) and by DFID in the context of programme impact evaluations (Stern et al. 2012).
- (f) Even where statistical analysis is not possible due to lack of data or lack of a 'similar enough' counterfactual, the concept of the counterfactual can be extremely useful in qualitative evaluation. The monitor or evaluator can ask 'what would have been the likely impact of this shock/stress without PEWP adaptation?' Participatory exercises can be undertaken with communities and key informants to ground such comparisons firmly in local knowledge and to ensure significant rigour. These

exercises can be used to ask how and why the consequences of a shock/stress may have been different before the PEWP intervention. Such qualitative approaches can also take the discussion a stage further and ask how and why an intervention did (or did not) affect the consequences of a stress or shock.

Some interventions like PEWP are likely to use a combination of the approaches described in (1) and (3) above, combining qualitative and quantitative information. All the approaches described in (1) to (3) above require some specialist skills. If these are not available within the PEWP team for implementing the SWP intervention, then it is recommended that the PMU obtains some specialist advice to device operational socio-economic indicators in the context of a monitoring and evaluation system

**Recommendation 4d (***Responsible Party: UNDP, Ministry of Finance & MWRE***)**: The liquidity crunch is identified as a risk to outcome 1 that needs to be carefully managed with other financing modalities/product options being explored which aren't liquidity dependent. Ethiopia has some interesting financing options which include cash micro-financing schemes the UNDP Sudan Country office have been exposed to that could be worth to look at and learn from with the local banks. Another international example that is liquidity crunch resistant which might be of interest to also look at and learn from is the Bangladesh Grameen Bank https://en.wikipedia.org/wiki/Grameen\_Bank.

The Grameen bank is a microfinance organisation and community development bank founded in Bangladesh. The bank grew significantly between 2003 and 2007. As of January 2011, the total borrowers of the bank number 8.4 million. Grameen Bank is founded on the principle that loans are better than charity to interrupt poverty: they offer people the opportunity to take initiatives in business or agriculture, which provide earnings and enable them to pay off the debt. The bank is founded on the belief that people have endless potential, and unleashing their creativity and initiative helps them end poverty. Grameen has offered credit to classes of people formerly underserved: the poor, women, illiterate, and unemployed people. Access to credit is based on reasonable terms, such as the group lending system and weeklyinstalment payments, with reasonably long terms of loans, enabling the poor to build on their existing skills to earn better income in each cycle of loans. Grameen has diversified the types of loans it makes. It supports hand-powered wells and loans to support the enterprises of Grameen members' immediate relatives. It has found that seasonal agricultural loans and lease-to-own agreements for equipment and livestock help the poor establish better agriculture. The bank has set a new goal: to make each of its branch locations free of poverty, as defined by benchmarks such as having adequate food and access to clean water and latrines. ... almost all Grameen borrowers have their school-age children enrolled in regular classes. This in turn helps bring about social change, and educate the next generation. Solidarity lending<sup>28</sup> is a cornerstone of microcredit, and the system is now used in more than 43 countries. Although each borrower must belong to a five-member group, the group is not required to give any guarantee for a loan to its members. Repayment responsibility rests solely on the individual borrower. The group and the centre oversee that everyone behaves responsibly and none gets into a repayment problem. No formal joint liability exists, i.e. group members are not obliged to pay on behalf of a defaulting member. But, in practice the group members often contribute the defaulted amount with an intention to collect the money from the defaulted member at a later time. Such behaviour is encouraged because Grameen does not extend further credit to a group in which a member default.

<sup>&</sup>lt;sup>28</sup>Hossain, Mahabub (February 1988) [1988]. Credit for Alleviation of Rural Poverty: The Grameen Bank in Bangladesh. Int Food Policy Res Inst IFPRI. p. 7. ISBN 0-89629-067-0.

### 7.0 Annexes

### Annex 1: Mid Term Review (MTR) Evaluative Matrix

Term of Reference	Method	Expected Result	Team Member
Project Strategy			
<b>TOR 1:</b> Assessment of the Project Strategy	Literature review, key informant interviews	An assessment of the project strategy, the project design, problem conceptualization including indicators of achievement of the output and the outcome.	Both Team members
TOR1.1: Review Project design	Literature review, key informant interviews, Stakeholder analysis, field visits	Review the problem addressed by the project and the underlying assumptions. Review the relevance of the project strategy and assess whether it provides the most effective route towards expected/intended results. Review how the project addresses country priorities. Review country ownership. Was the project concept in line with the national sector development priorities and plans of the country (or of participating countries in the case of multi-country projects)? Review decision-making processes: were perspectives of those who would be affected by project decisions, those who could affect the outcomes, and those who could contribute information or other resources to the process, taken into account during project design processes? Review the extent to which relevant gender issues were raised in the project design.	Both Team members
TOR 1.2: Results Framework / Logframe	Literature review, key informant interviews, Stakeholder analysis, field visits	Critical analysis of the project's logframe indicators and targets, assess how "SMART" the midterm and end-of-project targets are (Specific, Measurable, Attainable, Relevant, Time-bound), and suggest specific amendments/revisions to the targets and indicators as necessary. Determine if the project's objectives and outcomes or components are clear, practical, and feasible within its time frame? Examine if progress so far has led to, or could in the future catalyse beneficial development effects (i.e. income generation, gender equality and women's empowerment, improved governance etc) that should be included in the project results framework and monitored on an annual basis. Examine to ensure broader development and gender aspects of the project are being monitored effectively. Develop and recommend SMART 'development' indicators, including sex-disaggregated indicators and indicators that capture development benefits.	Both Team members

Progress Towards Results			
TOR 2: Progress OutcomesTowards Analysis(Outcomes 1 - 4)29	Literature review, key informant interviews, Stakeholder analysis, field visits	Review the logframe indicators against progress made towards the end-of-project targeting the Progress Towards Results Matrix and following the <i>Guidance For Conducting Midterm Reviews of UNDP-Supported, GEF-Financed Projects</i> ; colour code progress in a "traffic light system" based on the level of progress achieved; assign a rating on progress for each outcome; make recommendations from the areas marked as "Not on target to be achieved" (red).	Both Team members
In addition to the progress towards outcomes analysis	Literature review, key informant interviews	Compare and analyse the GEF Tracking Tool at the Baseline with the one completed right before the Midterm Review. Identify remaining barriers to achieving the project objective in the remainder of the project. Reviewing the aspects of the project that have already been successful, identify ways in which the project can further expand these benefits.	Both Team members
Project Implementation and A	daptive Management		
<b>TOR 3.1</b> : Management Arrangements.	Literature review and key informant interviews	Review overall effectiveness of project management as outlined in the Project Document. Have changes been made and are they effective? Are responsibilities and reporting lines clear? Is decision-making transparent and undertaken in a timely manner? Recommend areas for improvement. Review the quality of execution of the Executing Agency/Implementing Partner(s) and recommend areas for improvement.	Both Team members
		Review the quality of support provided by the GEF Partner Agency (UNDP) and recommend areas for improvement.	

<sup>&</sup>lt;sup>29</sup> Outcomes:

Outcome 1: Development of pilot projects as a demonstration of the viability of the technology and accompanying

financing mechanism for continued finance of projects

Outcome 2: Development of standards and guidelines to promote quality and sustainability of water pumping

Outcome 3: Development of a NAMA to support solar water pumping

Outcome 4: Developing a supporting environment to encourage scaling up and further replication

TOR 3.2: Work Planning	Literature review and key informant interviews	Review any delays in project start-up and implementation, identify the causes and examine if they have been resolved. Are work-planning processes results-based? If not, suggest ways to re-orientate work planning to focus on results? Examine the use of the project's results framework/logframe as a management tool and review any changes made to it since project start.	Both Team members
TOR 3.3: Finance and co- finance	Literature review and key informant interviews	Consider the financial management of the project, with specific reference to the cost- effectiveness of interventions. Review the changes to fund allocations as a result of budget revisions and assess the appropriateness and relevance of such revisions. Does the project have the appropriate financial controls, including reporting and planning, that allow management to make informed decisions regarding the budget and allow for timely flow of funds? Review the physical financial progress of the different project outcomes at MTR to see if there is need for any budget relocation. Informed by the co-financing monitoring table to be filled out, provide commentary on co-financing: is co-financing being used strategically to help the objectives of the project? Is the Project Team meeting with all co-financing partners regularly in order to align financing priorities and annual work plans?	Both Team members
TOR 3.4: Project-level Monitoring and Evaluation Systems	Literature and Key informant and logframe analysis	Review the monitoring tools currently being used: Do they provide the necessary information? Do they involve key partners? Are they aligned or mainstreamed with national systems? Do they use existing information? Are they efficient? Are they cost-effective? Are additional tools required? How could they be made more participatory and inclusive? Examine the financial management of the project monitoring and evaluation budget. Are sufficient resources being allocated to monitoring and evaluation? Are these resources being allocated effectively?	Both Team members

TOR 3.5: Stakeholder Engagement	Key informant and literature review; field visits	Project management: Has the project developed and leveraged the necessary and appropriate partnerships with direct and tangential stakeholders? Participation and country-driven processes: Do local and national government stakeholders support the objectives of the project? Do they continue to have an active role in project decision-making that supports efficient and effective project implementation? Participation and public awareness: To what extent has stakeholder involvement and public awareness contributed to the progress towards achievement of project objectives?	Both Team members
TOR 3.6: Reporting	Key informant interviews, Review of relevant project documents and work plans	Assess how adaptive management changes have been reported by the project management and shared with the Project Board. Assess how well the Project Team and partners undertake and fulfil GEF reporting requirements (i.e. how have they addressed poorly-rated PIRs, if applicable?). Assess how lessons derived from the adaptive management process have been documented, shared with key partners and internalized by partners.	Both Team members
TOR 3.7: Communications	Review of project document, work plans; key informant interviews	Review internal project communication with stakeholders: Is communication regular and effective? Are there key stakeholders left out of communication? Are there feedback mechanisms when communication is received? Does this communication with stakeholders contribute to their awareness of project outcomes and activities and investment in the sustainability of project results? Review external project communication: Are proper means of communication established or being established to express the project progress and intended impact to the public (is there a web presence, for example? Or did the project implement appropriate outreach and public awareness campaigns?) For reporting purposes, write one half-page paragraph that summarizes the project's progress towards results in terms of contribution to sustainable development benefits, as well as global environmental benefits.	Both Team members
Sustainability			

TOR 4: Sustainability TOR 4.1: Financial risks to sustainability	Key informant interviews; field visits Project literature review; key informant interviews	Validate whether the risks identified in the Project Document, Annual Project Review/PIRs and the ATLAS Risk Management Module are the most important and whether the risk ratings applied are appropriate and up to date. If not, explain why. What is the likelihood of financial and economic resources not being available once the GEF assistance ends (consider potential resources can be from multiple sources, such as the public and private sectors, Independent Private Partnership, income generating activities, and other funding that will be adequate financial resources for sustaining project's outcomes)?	Both Team members Both Team members
TOR 4.2: Socio-economic risks to sustainability	Project literature review; key informant interviews	Are there any social or political risks that may jeopardize sustainability of project outcomes? What is the risk that the level of stakeholder ownership (including ownership by governments and other key stakeholders) will be insufficient to allow for the project outcomes/benefits to be sustained? Do the various key stakeholders see that it is in their interest that the project benefits continue to flow? Is there sufficient public / stakeholder awareness in support of the long-term objectives of the project? Are lessons learned being documented by the Project Team on a continual basis and shared/ transferred to appropriate parties who could learn from the project and potentially replicate and/or scale it in the future?	
TOR 4.3: Institutional Framework and Governance risks to sustainability	Project literature review; key informant interviews	Do the legal frameworks, policies, governance structures and processes pose risks that may jeopardize sustenance of project benefits? While assessing this parameter, also consider if the required systems/ mechanisms for accountability, transparency, and technical knowledge transfer are in place.	Both Team members
TOR 4.4: Environmental risks to sustainability	Project literature review; key informant interviews	Are there any environmental risks that may jeopardize sustenance of project outcomes?	Both Team members

### Annex 2: MTR TOR (excluding ToR annexes)

#### Terms of Reference (ToR) for the UNDP-GEF Midterm Review (MTR) For an Assignment Requiring the Services of an Individual Contract (IC)

- Consultancy Title: UNDP-GEF midterm Review (MTR)
- Project Name: "Promoting the use of electric water pumps for irrigation in Sudan (ID: 00094271)"
- Period of assignment: 30 working days
- Duty Station: Khartoum with 1 visits to project sites in Northern State (7 Localities)

#### 1. INTRODUCTION

This is the Terms of Reference (ToR) for the UNDP-GEF Midterm Review (MTR) of the *full-sized* project titled **Promoting the use of electric water pumps for irrigation in Sudan** (PIMS5324) implemented through the Ministry of Water Resources, Irrigation and Electricity which is to be undertaken in 2016. The project started on the 25<sup>th</sup> of February 2016 and is in its *third* year of implementation. In line with the UNDP-GEF Guidance on MTRs, this MTR process was initiated before the submission of the second Project Implementation Report (PIR). This ToR sets out the expectations for this MTR. The MTR process must follow the guidance outlined in the document *Guidance For Conducting Midterm Reviews of UNDP-Supported, GEF-Financed Projects* (http://web.undp.org/evaluation/documents/guidance/GEF/mid-term/Guidance\_Midterm%20Review%20\_EN\_2014.odf)

2. PROJECT BACKGROUND INFORMATION

The project aims to support the adoption of solar PV technology for water pumping for irrigation in agriculture in Sudan, particularly in the North State. Adoption of renewable energies has been identified as a priority in Sudan, as is reduction of dependence on fossil fuels which are imported. The application of solar PV to pumping has been on a relatively limited scale globally, but is seeing increased commercial interest in the past years. Solar PV technology in general is not widespread in Sudan.

The project includes four components: the development of pilot projects as a demonstration of the viability of the technology and an accompanying financing mechanism for continued finance of projects; development of standards and guidelines to promote quality and sustainability of water pumping; development of a NAMA to support solar water pumping; and developing a supporting environment to encourage scaling up and further replication.

The project aims to help Sudan and Sudanese farmers reduce their reliance on fossil fuels, reduce their cost of production (via decreased diesel expenditures), increase the sustainability of water use, and increase their income. Give that agriculture is a main component of the economy in Sudan, the project will help increase Sudan's energy security and decouple its GDP from fluctuations in fossil fuel prices and availability. The project has been designed to play a catalytic role in the transformational scaling up of solar power for productive use in Sudan's agricultural sector.

UNDP-GEF MTR ToR Standard Template 1 for UNDP Procurement Website

1

### Annex 3: MTR mission itinerary

#### Ministry of Water Resources, Irrigation& Electricity Promoting the Use of Water Electric Pumps for Irrigation in Sudan Mid-Term Review Mission

Date/Time	Agenda/Activity	Venue	Contact Person
<b>Monday, September 17, 2018</b> 9:00 – 09:30 AM	Meeting with UNDP	UNDP Offices	Mr. Nouralla Ahmed
<b>Monday, September 17, 2018</b> 10:30 AM – 01:00 PM	Meeting with project staff and RE- MWRIE	MWRIE-RE Office	Mr. Abdelmonem Hassan Idris
<b>Monday, September 17, 2018</b> 01:00 PM – 02:00 PM		LUNCH BREAK	
<b>Monday, September 17, 2018</b> 02:00 PM – 02:30 PM	Meeting with Undersecretary, Ministry of Water Resources, Irrigation and Electricity (MWRIE)	Undersecretary's Office	Mr. Mamoun Bakheet
<b>Monday, September 17, 2018</b> 03:00 PM – 03:30 PM	Meeting with Ministry of Finance and National Economy	Development office	Mrs. Safia Mahmoud Abdelgadir TEL: 0919695781
<b>Tuesday, September 18, 2018</b> 09:00 AM – 10:00 AM	Meeting with National Energy Research Centre	Director's Office	Dr. Ali Omer
<b>Tuesday, September 18, 2018</b> 10:30 AM – 11:30 AM	Meeting with Ministry of Environment, Forestry & Physical Development (MEFPD) Sudan GEF Focal Point	MENRPD, GEF Focal Point Office	Dr. Hana Hamadalla
<b>Tuesday, September 18, 2018</b> 12:00 PM – 12:30 PM	Higher Council for Environment and Natural Resources (HCENR)	(HCENR) Offices	Dr. Hana Hamadalla
<b>Tuesday, September 18, 2018</b> 12:30 PM – 01:30 PM	LUNCH BREAK		
<b>Tuesday, September 19, 2018</b> 02:00 PM – 02:30 PM	Meeting with Ministry of Agriculture (MoA)	(MoA) Offices	

Date/Time	Agenda/Activity	Venue	Contact Person
<b>Tuesday, September 18, 2018</b> 03:00 AM – 04:00 AM	Meeting with Sudan Standards & Metrology Organization (SSMO)	(SSMO) Offices	Eng. Abdullah Abu-Obaida
Wednesday, September 19, 2018 09:00 AM – 10:00 AM	Meeting with Central Bank of Sudan (CBOS)	(CBOS) Offices	Mr. Mamoun
Wednesday, September 19, 2018 – Saturday, September 22, 2018 11:00 AM	Travel to Northern State (Site visits)		Eng. Mohammed Hassan
<b>Sunday, September 23, 2018</b> 11:00 AM – 01:00 PM	Debriefing to UNDP Senior management	UNDP Offices	Mr. Nouralla Ahmed
<b>Sunday, September 23, 2018</b> 01:30 PM – 02:30 PM	LUNCH BREAK		
Monday, September 24, 2018	Travel back home to South Africa		

## Annex 4: List of People Interviewed and/or Institutions Consulted

Name	Position	Address
Ibtihaj BerEltom	Labs manager	ibtihagelmustafa@gmail.com
Intisar Mohamed Osman	Unit & engineering TC	wdidy@yahoo.com
Abdullahi Abu-Obaida M. Alkhalifa	Head of Maintenance Office	Attaj555@gmail.com
		TEL: +249913717777

#### Sudan Standards & Metrology Organization (SSMO)

#### Central Bank of Sudan (CBOS)

Name	Position	Address
Abubaker Mohamed	Head, Finance Dept	Abubakr.mohamed@cbos.gov.sd
Mohamed Abdalla	Finance department	Mohamed.abdelgader@cbos.gov.sd
Mohamed Ahmed Osman	Finance department	Mohamed.Aosman@cbos.gov.sd
Nahid Omer Hassan	Finance department	Nahid.hassan@cbos.gov.sd
Fadwa Khalil Elhaj	Finance department	Fadwa.elhaj@cbos.gov.sd
Bushra KhairElhaj	Finance department	Bushra.elhaj@cbos.gov.sd
Hamid Gibreel	Director, Finance Dept	hamidg@live.com
Khalda Osman Yassin	Deputy Manager, Finance Dept	Khalda.yassin@cbos.gov.sd

#### **United Nations Development Programme (UNDP)**

Name	Position	Address
Nouralla Ahmed Yassin	Programme analyst	Nouralla.ahmed@undp.org
Mint Htut Yin	Team leader	min.htut.yin@undp.org
Selva Ramachandran	UNDP Country Director	selva.ramachandran@undp.org
Intisar Ali Salih	Programme analyst	TEL: +249912173502

#### Ministry of Environment, Forestry & Physical Development (MEFPD)

Name	Position	Address
Dr. Hana Hamadalla	GEF Focal Point	hanahamadalla2@yahoo.com
		TEL: +249920020045

#### National Energy Research Centre (NERC)

Name	Position	Address
Dr. Ali Omer	Associate researcher	Aliomer017@yahoo.com
		TEL: +249912274825
Dr. Nezar Elfadil	Associate researcher	Abualneez999@yahoo.com
		TEL: +249124940194

Name	Position	Address		
Mrs. Safia Mahmoud Abdelgadir	Development	Amtwassul1999@gmail.com		
		TEL: +249919695781		
Mrs. Samia Salih	Contracts and Purchase	TEL: +249912716757		
		TEL: +249123606356		

Ministry of Finance and National Economy (MoFNE)

#### Ministry of Water Resources, Irrigation and Electricity (MWRIE)

Name	Position	Address
Musa Omer AbuElGasim	Undersecretary	musa@wre.gov.sd
MahjoubEisa Khalil	General Director- Ren. Energy	mahjoubeisa@hotmail.com
		TEL: +249123494010
Mr. Mamoun Bakheet	Undersecretary office	Undersectretary2017@gmail.com
		TEL: +249123494151

### Project Management Unit (PMU)

Name	Position	Address
Abdelmonem Hassan Idris	Project Manager	a.abuhassan1996@gmail.com
Abdelrahman Ali Osman	Project Engineer	abdelrahman.aliosman@gmail.com
Nadir Fath	Project Finance & Admin	nadirftah@gmail.com
Mohamed Hassan	Project M&E	+ 249122739659

### Farmers visited in the Northern State

Name	Position	Address
HE Tilal Eisa Abdelrahman	State Minister, Ministry of	Agri.northern@gmail.com
	Agriculture, Northern State	
Dr. Elrasheed Abdalla	Director, Agricultural	rasheedfageeri@yahoo.com
Fageeri	Research Station, Dongola	
Yousif Elzubair Hamad	Farmer, Musanarti	0908122973
Elzubair		
Mohieldin Shaikheldin	Farmer, Algabriah Wasat	0123707735
Mohamed Hussain		
Adil Eltayeb Hamad	Farmer, Eldofoufa Sharig	0906808553
Mohamed Khidir Taha	Farmer, Gazirat Tahtawi	0915222252

## Annex 5: Example questions or interview guide used for data collection

The following set of outline questions was prepared based on the ToRs and used in part / whole in structured interviews as appropriate / relevant.

The project aims to support the adoption of solar PV technology for water pumping for irrigation in agriculture in Sudan, particularly in the North State. Adoption of renewable energies has been identified as a priority in Sudan, as is the reduction of dependence on fossil fuels which are imported. The application of solar PV to pumping has been on a relatively limited scale globally, but is seeing increased commercial interest in the past years. Solar PV technology in general is not widespread in Sudan.

#### Background

The project includes four components: (1.) the development of pilot projects as a demonstration of the viability of the technology and an accompanying financing mechanism for continued finance of projects; (2.) development of standards and guidelines to promote quality and sustainability of water pumping; (3.) development of a NAMA to support solar water pumping; and (4.) developing a supporting environment to encourage scaling up and further replication.

#### Interview guiding questions

- 1) What is the name and role of the organisation/entity that you work for on this project?
- 2) So far does this pilot project demonstrate the viability of the technology and an accompanying financing mechanism for continued finance of projects and if so how?
- 3) Has this project enabled the development of standards and guidelines to promote quality and sustainability of water pumping in Sudan?
- 4) How has the development of a NAMA to support solar water pumping been enabled by this project?
- 5) Has the project enabled developing a supporting environment to encourage scaling up and further replication if yes, how has this been done?
- 6) Has this project assisted to help Sudan and Sudanese farmers to?
  - a) reduce their reliance on fossil fuels?
  - b) reduce their cost of production (via decreased diesel expenditures)?
  - c) increase the sustainability of water use? and
  - d) increase their income?
- 7) Has this project helped increase Sudanese farmers energy security and decouple its agricultural GDP from fluctuations in fossil fuel prices and availability?
- 8) In relation to this project, how has it been designed to play a catalytic role in the transformational scaling up of solar power for productive use in Sudan's agricultural sector?
- 9) How has adaptive learning and replication plans been supported?

### Annex 6: List of documents reviewed and documents consulted

- 1. PIF
- 2. UNDP Initiation Plan
- 3. UNDP Project Document
- 4. UNDP Environmental and Social Screening results
- 5. Project Inception Report
- 6. All Project Implementation Reports (PIR's)
- 7. Quarterly progress reports and work plans of the various implementation task teams
- 8. Audit reports
- 9. Finalized GEF focal area Tracking Tools at CEO endorsement and midterm Climate Change Mitigation
- 10. Oversight mission reports
- 11. All monitoring reports prepared by the project
- 12. Financial and Administration guidelines used by Project Team

# Annex 7: Co-financing table

Previously included in the body of the report

# **Annex 8: Ratings Scales**

Previously included in the body of the report