UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE

NATIONAL DEVELOPMENT CORPORATION

In reply, please quote: BC.219/223/01A/09 13th November, 2026

To:

Potential Investors in Solar Power Projects Development

RE: INVITATION TO SUBMIT PROJECT PROPOSAL FOR THE JOINT DEVELOPMENT AND IMPLEMENTATION OF THE 100 MW SINGIDA SOLAR POWER PROJECT

Kindly refer to the heading above.

2. The National Development Corporation (NDC) of the United Republic of Tanzania is pleased to invite your esteemed organization to submit a proposal for the joint implementation of a 100 MW grid-connected solar photovoltaic power plant in Unyianga Village, Singida Municipal, Singida Region, United Republic of Tanzania. The Project site's coordinates are 4°49'S, 34°43'E.

3. NDC recognises the important role of strategic partnerships in mobilizing investment capital, advanced technology, technical expertise, and international best practices for the successful implementation of major projects. Accordingly, NDC seeks to identify a competent and financially capable partner with the experience and resources required to collaborate with NDC in the development, financing, construction, commissioning, ownership, and operation of the proposed solar power facility.

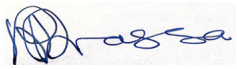
4. As a potential investor interested in development of renewable energy project, NDC welcomes you to submit comprehensive technical, financial, and commercial proposals outlining their proposed investment structure, financing plan, project implementation schedule, technology selection, operations and maintenance arrangements, and proposed partnership structure with NDC in accordance to the Terms of Reference for Invitation for Submission of Project Proposals.

Development House, Ohio Street/ Kivukoni, 6thFloor, P.O.BOX 2669, Dar es Salaam, TANZANIA
Tel : (+255 - 22) 2111460/1, 2111463/4, Fax: (+255 – 22) 2113618, Email: info@ndc.go.tz, ndc@ndc.go.tz
Website: http://www.ndc.go.tz

5. Preferred investor selection will highly be based on innovative and commercially sound proposals that can attract sustainable investment, achieve competitive electricity generation costs, and deliver long-term economic and development benefits to Tanzania. The proposed partnership will be pursued in accordance with applicable Tanzanian laws, regulatory requirements, and the relevant institutional approval procedures.

6. Please accept the assurances of our highest consideration.

7. Yours sincerely.



Digitally Signed By Revocatus Rasheli
Fri Nov 13 11:40:53 EAT 2026

Revocatus Rasheli

For: MANAGING DIRECTOR

Terms of Reference for Invitation for Submission of Project Proposals for the Joint Development and Implementation of the 100 MW Singida Solar Photovoltaic Power Project can be obtained at NDC Offices or Contact an investment liason officer Mr Keya Puppa +255 68500 9018

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE



NATIONAL DEVELOPMENT CORPORATION



Proposal Number: TRI 85/2026/2027/1NV/02

FOR

INVITATION FOR PROJECT PROPOSAL FOR DEVELOPMENT OF THE SINGIDA SOLAR POWER PROJECT

November, 2026

TERMS OF REFERENCE FOR SUBMISSION OF PROPOSAL FOR DEVELOPMENT OF SINGIDA SOLAR POWER PROJECT

1. INTRODUCTION AND BACKGROUND

1.1 About the National Development Corporation

The National Development Corporation (NDC) is a Government of the United Republic of Tanzania development corporation established to catalyse strategic industrial and economic development. Its mandate is to identify, promote and implement strategic projects in partnership with the private sector, leveraging Tanzania's natural resources and national endowments. In the implementation of energy projects, the Corporation acts as:

Strategic development partner;
Facilitator of project identification, land access, statutory approvals and public-sector coordination;
Interface with the Ministry of Energy, the Energy and Water Utilities Regulatory Authority (EWURA), the Tanzania Electric Supply Company Limited (TANESCO), the National Environment Management Council (NEMC) and Local Government authorities;

1.2 The energy context of the United Republic of Tanzania

Tanzania's electricity demand continues to grow on the back of sustained macroeconomic expansion, rapid urbanization, mining and industrial development, and the national electrification agenda. The Government's policy direction articulated through the National Vision 2050 and successive five-year development plans, prioritizes diversification of the generation mix, the accelerated deployment of indigenous renewable resources, and the reduction of exposure to hydrological and fuel-price risk.

Solar photovoltaic generation is a central element of this diversification strategy. Tanzania benefits from high and stable solar irradiation across much of its territory, and utility-scale solar PV is now cost-competitive with alternative technologies in the region. The Corridor from the Central Zone to the northern grid, anchored by the Singida node, offers both a strong solar resource and robust transmission infrastructure, making it one of the most attractive locations in the country for large-scale solar deployment.

1.3 The solar resource and infrastructure advantages of Singida

Singida Region is among the strongest solar areas in Tanzania. Planning-level resource assessments indicate a long-term average of approximately 6.0 – 6.2 kWh/m²/day of global horizontal irradiation, equivalent to roughly 6.2 peak sun hours per day, with low atmospheric attenuation, favourable temperatures and limited cloud cover in the dry season.

The region also benefits from:

- A strategically located hub substation at Singida with connection to the national high-voltage backbone;
- Existing road, water and telecommunication infrastructure, and proximity to the regional administrative centre;
- Availability of large, contiguous, low-competing-use land parcels suitable for photovoltaic deployment;
- Established local administrative structures able to support land acquisition, permitting and community engagement processes.

The project site is located approximately 14 - 18 km from Singida Municipality, Singida Region, Central Tanzania. Approximately 200 hectares of land has been identified and is under acquisition by NDC. The site is in proximity to the existing 220kV Singida Substation (TANESCO) / Singida - Arusha / Singida - Dodoma transmission corridor.

1.4 Regulatory environment

Projects of this nature are implemented within the following principal framework:

- The Electricity Act, 2008;
- The Energy and Water Utilities Regulatory Authority Act;
- The National Energy Policy, 2015;
- EWURA electricity licensing, tariff and grid-code regulations, including the EWURA model Power Purchase Agreements applicable to generation projects above 10 MW;
- The Environmental Management Act and NEMC environmental and social impact assessment requirements;
- Applicable Tanzanian land, investment, tax and local-content legislation.
- Grid-connected generation is subject to **EWURA licensing** and to **power purchase arrangements with TANESCO**, which NDC has initiated the engagement.

2. OBJECTIVES OF THIS INVITATION

This Invitation is issued in order to:

1. Identify a technically capable, financially credible and commercially competitive partner for the Corporation;
2. Obtain detailed, comparable and complete proposals that can be evaluated on a transparent and objective basis;
3. Structure a joint venture that delivers value for the Corporation and the Government of the United Republic of Tanzania;
4. Achieve the earliest practicable and bankable development of the Project;
5. Ensure the Project is developed to international standards of health, safety, environmental and social performance, with meaningful local content and community benefit.

3. SCOPE OF WORK

The Selected Developer shall be responsible for the following (EPC + O&M model):

1. Update Feasibility study & Engineering design: Detailed site survey, geotechnical studies, and final engineering design.
2. Procurement: Sourcing of high-efficiency PV modules, inverters, mounting structures, and balance-of-system components.
3. Construction: Civil works, installation of solar arrays, substations, and connection to the national grid.
4. Grid Interconnection: Coordination with TANESCO for grid connection, including the construction of necessary step-up substations if required by the Point of Interconnection (POI).
5. Commissioning: Testing, synchronization, and commercial operation date (COD) achievement.
6. Operation & Maintenance: Long-term O&M for a period of 20 - 25 years of post-COD.
7. Land & Social Compliance: Securing land rights and managing environmental and social impact mitigation.

4. PROPOSED PARTNERSHIP STRUCTURE

1. Joint Venture Company: NDC and the selected Developer will incorporate a Special Purpose Vehicle (SPV) / Joint Venture Company under the Laws of Tanzania.
2. Equity Structure: Proposed equity participation to be finalized during negotiations, the proponent should propose its preferred equity structure.
3. NDC Contribution: initial project development activities including project concept, feasibility study, land identification and sensitization, facilitation of government permits, licenses, Power Purchase Agreement (PPA) engagement support, local stakeholder engagement, and statutory JV partner.
4. Strategic Partner Contribution: Full project financing (debt and equity), EPC, technology, operation & maintenance (O&M), and international experience.

The JV will be responsible for obtaining Generation License from EWURA, signing PPA with TANESCO, and all other approvals.

5. ELIGIBILITY AND QUALIFICATION CRITERIA

Interested firms or consortia must demonstrate technical expertise, financial capability, and legal eligibility, including:

1. Corporate & Legal Requirements: Valid certificate of incorporation/registration and Power of Attorney for designated representative(s).

In the case of a Consortium, a legally binding Joint Venture Agreement or Memorandum of Understanding outlining roles and equity structure.

2. Technical Capability: Ability to implement the project and proven track record of developing, constructing, and operating utility-scale solar PV projects (minimum single plant capacity of 50 MW).

3. Financial Capability: Evidenced ability to mobilize project debt financing and equity commitment for projects.

6. INFORMATION REQUIRED IN THE PROPOSAL

The proposal shall be organized into the following parts:

1. Corporate and Compliance Information

- Letter of application;
- Company profile;
- Incorporation and registration documents;
- Experience references;
- Consortium agreement or memorandum of understanding, if applicable;
- Power of attorney; and
- Application fee payment slip.

2. Technical Proposal

- Project Technical Design: Preliminary layout, engineering and infrastructure requirements, technology choice (Monocrystalline vs. Polycrystalline), expected efficiency, and degradation rates;
- Proposed 10 – 30% battery energy storage system (BESS) option
- Project Implementation Plan:
  - Gantt chart showing timeline from JVA signing to commercial operation date;
  - Key milestones: Procurement, civil works, mechanical completion, electrical testing.
- EPC and commissioning strategy;
- Operations and maintenance strategy: Maintenance schedule, spare parts management, and performance guarantees.
- Environmental and social management approach; and
- Local content and technology transfer plan.

3. Commercial and Financial Proposal

1. **Financial model:** A fully functional, unlocked financial model (Excel) covering a minimum 20-year operating period, with full assumptions for capital expenditure, operating expenditure, energy yield, degradation, tariff, financing, taxes, depreciation and working capital, presented in the currency denominations used;

2. **Capital cost estimate:** Detailed breakdown of development, EPC, interconnection, contingency and owner's costs;
3. **Operating cost estimate:** Fixed and variable operating costs, O&M contract costs, insurance, land lease, management fees and major maintenance provisions;
4. **Tariff proposal:** According to TANESCO cap electricity tariff structure is 5 cents USD/kWh, proposer may include any escalation or indexation mechanism, the levelized cost of electricity, and the assumptions underpinning the tariff. Proposer must state whether the tariff is offered on a take-or-pay, pay-as-produced, or alternative basis, and how the proposal interacts with the TANESCO Power Purchase Agreement;
5. **Financing plan:** Proposed debt-to-equity ratio, debt quantum and tenor, debt providers, interest rate assumptions, hedging strategy, drawdown schedule, and the equity funding plan including the timing of equity injections;
6. Projected financial reports including the balance sheet, cashflows, and profit and loss statement

7. EVALUATION CRITERIA

Proposal will first be assessed for Corporate and Compliance Information in which non-compliance may result in disqualification. The qualified proposal will undergo technical evaluation based on criteria and weight shown in table 1 below:

Table 1: Technical evaluation criteria and weight

S/N	Criteria	Weight
1.	Technical Capability & Relevance Experience	20%
2.	Project Implementation Plan	15%
3.	Technical Design	20%
4.	BESS Option	10%
4.	Proposed Shareholding Structure	15%
5.	O&M plan and performance guarantees	10%
6.	Local content, employment and technology transfer	5%
7.	Environmental, social, health and safety approach	5%
	TOTAL	**100%**

Note: A minimum technical score of 70% is required to qualify for the Financial and Commercial Proposal evaluation.

The qualified technical proposal will be subjected to Financial and Commercial Proposal evaluation based on criteria and weight shown in table 2 below:

Table 2: Financial and Commercial Proposal evaluation criteria and weight

S/N	Criteria	Weight

1.	Financial model in excel (unlocked)	20%
2.	Capital cost estimate	20%
3.	Operating cost estimate	20%
4.	Tariff proposal	20%
4.	Financing plan	20%
	TOTAL	**100%**

Negotiation and due diligence: The highest-ranked Proposer will be invited to negotiate the definitive documentation, subject to confirmatory due diligence, reserve-price considerations and any required Government of Tanzania or regulatory approvals.

During negotiations, the NDC and successful applicant shall be required to:

i. Comply with all applicable laws;
ii. Negotiate on the equity structure for the Joint Venture Company, providing the basis and justification for any counter proposal considering NDC's contribution to the partnership; and
iii. Negotiate on the proposed Percentage of Gross Sales Revenue to be paid to NDC as a Custodian Fee, providing the basis and justification for any counter proposal.

Basis of award: The award will be made to the Proposer whose proposal is determined to be the most advantageous to the Corporation, taking into account the evaluation criteria, the results of negotiation, the feasibility of the proposed joint venture structure, and the ability of the Proposer to deliver the Project in accordance with the objectives of this Invitation. The Corporation is not bound to accept the lowest-priced proposal.

8. INSTRUCTIONS TO PROPOSERS

8.1 Cost of proposals

Each Proposer shall bear all costs associated with the preparation and submission of its proposal, the site visit, clarifications and any subsequent negotiation. The Corporation will not be responsible or liable for any such costs, regardless of the outcome of the process.

8.2 Clarifications

Requests for clarification must be submitted in writing not later than 5th December, 2026;

8.3 Pre-proposal conference and site visit

A pre-proposal meeting will be held on 28th November, 2026 at NDC Board room / online, at which the Corporation will present the Project and answer questions;

A site visit to the proposed project area in Singida will be on 25th November, 2026, Proposers wishing to attend the pre-proposal meeting or site visit must notify NDC before the date by contacting Eng. Godfrey Mahundi through email: godfrey.mahundi@ndc.go.tz or phone number +255 713 428 459.

Attendance at the pre-proposal conference and site visit is strongly encouraged but is not a condition of participation.

8.4 Confidentiality and use of information

All information provided by the Corporation is provided on a confidential basis and solely for the purpose of preparing a proposal. All proposals and supporting documents submitted become the property of the Corporation and will be treated as confidential.

9. SUBMISSION REQUIREMENTS AND FORMAT

9.1 Language and units

All proposal documentation must be in **English**;
All measurements must be in SI units, with monetary amounts in United States Dollars unless otherwise stated, or in Tanzanian Shillings where required, with the exchange-rate assumption clearly specified.

9.2 Format

Proposers must submit through email:

Electronic copy in PDF format;
The financial model in native Microsoft Excel format (unlocked).

9.3 Deadline for submission

Proposals must be received at the address in Section 12 **not later than 24th December 2026, 14:00 hours East Africa Time (EAT)**. Late submissions will not be considered.

9.4 Application fee

Each Proposer must pay application fee amounted to USD 1,000 or Tanzania Shillings equivalent and submit a payment copy as part of proposal submission.

10. EVALUATION OF SUBMITTED PROPOSALS

Evaluation of the project proposals and the allocation of this investment opportunity shall be guided by the NDC Investment Guide and Policy

11. INDICATIVE PROJECT TIMETABLE

The following timetable is indicative and may be amended by the Corporation whenever necessary.

S/N	Milestone	Indicative Date
1.	Issue of Invitation for Proposals	13th November, 2026
2.	Deadline for site-visit registration	4th December, 2026
3.	Site visit to the Singida Solar Power Project area	8th December, 2026
4.	Pre-proposal conference	11th December, 2026

5.	Deadline for requests for clarification	20th December, 2026
6.	Deadline for submission of proposals (16:00 EAT)	24th December, 2026
7.	Evaluation of proposals and shortlisting	28th – 31st December, 2026
8.	Internal approvals	4th – 8th January, 2027
9.	Notification of the Selected Proposer	January, 2027
10.	Negotiation of Joint Venture Agreement	January – February 2027
11.	JVA signing	February 2027
12.	Project implementation	March 2027 onwards

12. SUBMISSION INSTRUCTIONS

Proposal submission should be in soft copy and addressed to:

Managing Director,
National Development Corporation (NDC),
Development House,
Ohio Street/Kivukoni Front,
P.O. Box 2669,
Dar es Salaam, Tanzania
Email to: **procurement@ndc.go.tz**

APPENDIX I

FEASIBILITY STUDY REPORT

APPENDIX II

SOLAR INSOLATION REPORT

STANDARD POWER OF ATTORNEY

TO ALL IT MAY CONCERN

THAT BY THIS POWER OF ATTORNEY given on the *[insert date, month and year*],

WE the undersigned [*insert name of the company/donor*] of *[insert address of the company/donor*], by virtue of authority conferred to us by the Board Resolution No..... .....of .....day of .....[*insert year*], do hereby ordain nominate and appoint [*insert name of donee*] of [*insert address of the donee*] to be our true lawful Attorney and Agent, with full power and authority, for us and in our names, and for our accounts and benefits, to do any, or all of the following acts, in the execution of tender No. *[insert tender number*] that is to say;

To act for the company and do any other thing or things incidental for [*insert tender Number*] of *[insert description of procurement]* for the [*insert name of the Procuring EntityPE*];

AND provided always that this Power of Attorney will not revoke or in any manner affect any future power of attorney given to any other person or persons for such other power or powers will remain and be of the same force and affect as if this deed has not been executed.

AND we hereby undertake to ratify everything, which our Attorney or any substitute or substitutes or agent or agents appointed by him under this power on his behalf herein before contained will do or purport to do in virtue of this Power of Attorney.

SEALED with the common seal of the said *[[insert name of the company**]*** and delivered in the presence of us this *[insert date]* day of *[insert month] [insert year].*

IN WITNESS whereof we have signed this deed on this *[insert date]* day of *[insert month] [insert year]* at *[insert region]* for and on behalf of *[insert name of the company] ……*

SEALED and **DELIVERED** by the

Common Seal of [*insert name of the donor/coy]*

This *[insert date, month and year*]

.....

DONOR

BEFORE ME:

.....

COMMISSIONER FOR OATHS

ACKNOWLEDGEMENT

I [*insert name of donee*] doth hereby acknowledge and accept to be Attorney of the said [*insert name of the company/donor*] under the terms and conditions contained in this POWER OF ATTORNEY and I promise to perform and discharge my duties as the lawfully appointed Attorney faithfully and honestly.

SIGNED AND DELIVERED by the said

[*insert name of donee*] Identified to me

by ***[insert name]***

The latter known to me personally

This *[insert date, month and year*],

.....

DONEE

BEFORE ME

.....

COMMISSIONER FOR OATHS

Feasibility Study Report
On Development of a Solar Farm at Singida
United Republic of Tanzania



中国水电建设集团国际工程有限公司

SINOHYDRO CORPORATION LIMITED

October, 2017

EXECUTIVE SUMMARY

The feasible study of this project shows that this project is feasible in technology, and reasonable in economy.

TITTLE:
Feasibility Study Report on Development of a Solar Farm at Singida United Republic of Tanzania

DEVELOPER:
National Development Corporation of Tanzania (NDC)

CONTACT PERSON:
Mr. Shi Yong

Chief Representative, Tanzania

P.O Box 5998, Dar es Salaam

Email: shiyong@powerchina-intl.com

Mobile: +255 762769452

Name			Units	Quantity	Remarks
Solar energy resources	Average total radiation for years		MJ/m^2	8272.8	
	Mean sunshine duration		h	3219.8	
	Average temperature		℃	20.5	
	Annual precipitation		mm	708.4	
Main equipment	PV modules	Quantity	Piece(s)	330000	
		Maximum output power	W	320	
		Open circuit voltage	V	46.78	
		Short circuit current	A	8.98	
		Rated battery operating temperature	℃	45±2	
		Operating Temperature	℃	-40 to +85	
		Module conversion efficiency	%	16.48	
		Output power attenuation	%	80	25 years

Name			Units	Quantity	Remarks
		Installation mode of PV modules		Fixed inclination	
		Angle of fixed inclination	°	4	
	Inverter	Quantity	Piece(s)	100	
		Rated power	kW	1000	
		Maximum conversion efficiency	%	98.8	
		Power factor		> 0.99	
Construction time limit	Project duration		Month	12	
Project land occupation	Permanent land occupation		m^2	709	
	temporary land occupation		Km^2	1.132	
Investment index	Static investment (in year of preparation)		US $ 10,000	12,000	
	Static investment of unit kilowatt		US $/kW	1136.36	
	On-grid electricity price (Including VAT)		US $/kW·h	0.070	
Financial index	Financial internal rate of return of total investment		%	6.19	Pretax
	Financial internal rate of return of capital fund		%	13.66	
	Investment payback period		Year	13.21	

Acknowledgement

Sinohydro Corporation Limited wishes to acknowledge the following:

- ✧ Tanzania Electric Supply Company Limited (TANESCO) for providing the necessary data and information related to the grid, power demand forecast, electricity markets, generation, transmission and distribution systems in Tanzania.
- ✧ The National Development Corporation (NDC) for their guidance and assistance in carrying out the feasibility study, specifically facilitation works in relation to data collection, site survey and liaison with relevant Government Departments/Institutions in Tanzania.
- ✧ Special thanks are directed to several officials who assisted the team during the study particularly:
- ✧ Regional Commissioner, Districts Commissioners and District Executive Directors, village Authority at Unyianga Village in Singida Municipality and all departmental heads belongs to project area, and
- ✧ All other stakeholders consulted face-to-face, telephone, mailing and emails and others not mentioned.

Without you, we could not accomplish this work for the benefit of entire communities.

TABLE OF CONTENTS

EXECUTIVE SUMMARY i

Acknowledgement iii

TABLE OF CONTENTS iv

LIST OF TABLES viii

LIST OF FIGURES ix

List of Appendices x

List of Acronyms/Abbreviations xi

1. GENERAL 1

1.1 BACKGROUND TO THE PROJECT 1

1.2 PROJECT NAME, LOCATION, CONTRACTING PARTIES, SECTOR MINISTRY 3

1.2.1 Project name 3

1.2.2 Location 3

1.2.3 Proposed Project Structure and Contracting Parties 3

1.2.4 Sector ministry 4

2. PROJECT DESCRIPTION 7

2.1 BRIEF DESCRIPTION OF THE PROJECT 7

2.2 JUSTIFITION THE PROJECT 7

2.3 ESTIMATED CAPITAL COSTS 9

2.4 BASIS FOR CAPITAL COST ESTIMATION 9

2.4.1 Preparation principle 9

2.4.2 Main preparation basis and parameter basis 9

3. TECHNICAL ASPECTS 10

3.1 PROJECT DESIGN 10

3.1.1 Design Parameter 10

3.1.2 Plant Layout 11

3.1.3 Plant Indicative Performance 13

3.2 SITE CONDITION 15

3.2.1 Site Topographical and Geological Condition 15
3.2.2 Power resource assessment 15
3.2.3 Site Access for Equipment and Material Delivery 16
3.2.4 Topographical, and Seismic information 17
3.2.5 Hydrogeological condition 18
3.2.6 Site soil types and construction site classification 18
3.2.7 Site seismic effect and the ground motion parameter 18
3.2.8 Construction foundation evaluation 18
3.3 EQUIPMENT SPECIFICATIONS 19
3.3.1 Plant Capacity and Configuration 19
3.3.2 Potential Equipment Suppliers 22
3.4 ELECTRICAL SYSTEMS AND INTERCONNECTION TO THE GRID 24
4. PROJECT IMPLEMENTATION SCHEDULE 25
4.1 PROJECT DEVELOPMENT SCHEDULE 25
4.2 PROJECT CONSTRUCTION SCHEDULE 25
5. PROJECT COST 27
5.1 PROJECT SCOPE 27
5.2 TECHNICAL ASSUMPTIONS 27
5.3 ESTIMATE PROJECT COSTS 28
5.3.1 Cost estimate for auxiliary works of construction 28
5.3.2 Estimate of equipment and installation works 28
5.3.3 Cost estimate of construction works 28
5.3.4 Project Design Budget Estimate Table 28
5.4 FINANCIAL PARAMETERS 32
5.5 COST OF DEBT 35
5.6 ECONOMIC AND FINANCIAL ANALYSIS 35
6. FINANCING ARRANGEMENTS AND CASH FLOWS 37
6.1 SOURCES OF FINANCING 37
6.2 FINANCIAL VIABILITY 37
6.3 LEVELIZED COST OF ELECTRICITY (LCOE) 38

6.4 REVENUE STREAMS 39
6.5 EWURA'S REGULATORY AUTHORITY OVER PROJECT TARIFF 39
6.6 PROJECT CASH FLOW FORECAST AND NPV 41
6.7 SENSITIVITY ANALYSIS 43
7. INTERNAL RATE OF RETURN (IRR) AND WEIGHTED AVERAGE COST OF CAPITAL (WACC) 44
7.1 ASSUMPTIONS USED TO COMPUTE THE RATIOS 44
7.2 RESIDUAL VALUE OF PLANT AFTER THE CONTRACT PERIOD 44
7.3 ECONOMIC IRR 44
7.4 EQUITY IRR 46
7.5 FINANCIAL IRR 47
7.6 WEIGHTED AVERAGE COST OF CAPITAL 47
7.7 PROJECT PAYBACK PERIOD 47
8. PROJECT RISKS 49
9. PROJECT AFFORDABILITY 55
9.1 PROJECT'S COST OF ELECTRICITY 55
9.2 MARKET SENSITIVITY – CAN FINAL CONSUMER/OFFTAKER AFFORD THE CHARGES 55
9.3 TANESCO CONTRIBUTIONS FOR PROJECT VIABILITY 55
9.3.1 New Transmission Line to connect to the Plant to National Grid 55
9.3.2 Land Issues 56
10. GOVERNMENT SUPPORT AND CONTRIBUTIONS 57
10.1 PROJECT DEVELOPMENT FINANCE 57
10.2 VIABILITY GAP FUNDING 57
10.3 GOVERNMENT GUARANTEES 58
10.4 ANY OTHER GOVERNMENT SUPPORT NEEDED 58
11. VALUE FOR MONEY CONSIDERATIONS 59
11.1 DESCRIPTION OF LIFETIME VALUE FOR MONEY BENEFITS OF THE PROJECT 59
11.2 DESCRIPTION OF VARIOUS OPTIONS TESTED AND JUSTIFICATION FOR THE CHOSEN MODEL OF FINANCING 61

11.2.1 EPC+ Financing 61
11.2.2 Deferred Payment ..... **Error! Bookmark not defined.**
12. ENVIRONMENTAL ANALYSIS 64
12.1 TANZANIA ENVIRONMENTAL REGULATIONS 64
12.2 PROJECT SOCIAL AND ENVIRONMENTAL IMPACTS EVALUATION 67
12.3 ENVIRONMENTAL AND SOCIAL MONITORING PLAN 67
13. ECONOMIC AND SOCIAL ISSUES 73
13.1 COST BENEFIT ANALYSIS 73
13.2 ECONOMIC BENEFITS TO SOCIETY 74
13.2.1. With Project 74
13.2.2. Without Project 74
14. CLEARANCES 75
15. ATTACHMENTS 76

LIST OF TABLES

Table 3-1 PV Module Parameters 10
Table 3-2 Technical parameters of inverter 10
Table 3-3Floor space occupied by temporary construction facilities 12
Table3-4 Plant Indicative Performance 13
Table 3-5 Monthly radiation data 16
Table 3-6 Table of suggested value of the main physical and mechanical indexes of the layers 17
Table 3-7 Potential Equipment Suppliers 22
Table 5-1 Main works Quantities 27
Table 5-2 Project Design Budget Estimate Table 29
Table 5-3 Financing Scheme 32
Table 5-4 O &M Cost Unit：Thousand USD 34
Table 5-5 Depreciation Unit：Thousand USD 35
Table 5-6 Cost of debt Unit：Thousand USD 35
Table 6-1 The net cash flow of Singida project Unit: million USD 37
Table 6-2 The cost and production Unit: million USD 38
Table 6-3 The NPV for cost and production Unit: million USD/GWh 39
Table 6-4 The Revenue stream Unit: million USD 39
Table 6-5 List for financial planned cash flow Unit: thousand USD 41
Table 6-6 List of financial sensitivity analysis 43
Table 7-1 Cash flow for the project IRR Unit: thousand USD 45
Table 7-2 Cash flow for the Equity IRR Unit: thousand USD 46
Table 7-3 Cash flow for Financial Unit: thousand USD 47
Table 7-4 The payback time unit：million USD 48
Table 8-1 Risk Register 50
Table 11-1The cumulative cash flow (after-tax) of Singida project 59
Table 12-1 Environmental Monitoring Plan 70
Table 13-1 Cash flow for the Cost Benefit Analysis 73

LIST OF FIGURES

Figure 1-1 Tanzania solar energy resources distribution graph 1
Figure 1-2 Relative location of Project site and Singida Weather Station 2
Figure 3-1 Singida weather station daily sunshine hours variation chart..... 15
Figure 6-1 The net cash flow of Singida project (Unit: million USD)..... 37
Figure 9-1: Solar PV Plant Plan 55

List of Appendices

Drawing No.	Drawing Name
BJxxxGDK-K-01	Schematic diagram of photovoltaic array rack
BJxxxGDK-K-02	Drawing of photovoltaic array rack
BJxxxGDK-K-03	Foundation drawing of box-type substation
BJxxxGDK-K-04	Foundation drawing of centralized inverter
BJxxxGDK-K-05	Layout plan of 220kV step-up station
BJxxxGDK-K-06	Layout plan of the complex building
BJxxxGDK-K-07	Plan drawing of high-low voltage distribution room
BJxxxGDK-K-08	Layout plan of auxiliary rooms
BJxxxGDK-K-09	0.4kV substation wiring diagram
BJxxxGDK-K-10	Layout drawing of PV field area
BJxxxGDK-K-11	Layout plan of 220kV step-up substation outdoor electric equipment-1
BJxxxGDK-K-12	Layout plan of 220kV step-up substation outdoor electric equipment-2
BJxxxGDK-K-13	Photovoltaic sub-array system wiring diagram
BJxxxGDK-K-14	220kV step-up substation main wiring diagram
BJxxxGDK-K-R2-01	Protection configuration (1) of 220KV step-up substation
BJxxxGDK-K-R2-02	Protection configuration (2) of 220KV step-up substation
BJxxxGDK-K-R2-03	Schematic diagram of 220kV step-up substation monitoring system
BJxxxGDK-K-R2-04	Schematic diagram of 220kV step-up substation DC system
BJxxxGDK-K-R2-05	Schematic diagram of 220kV step-up substation communication system
BJxxxGDK-K-R2-06	Panel layout of relay protection room and communication room
Attached figure 1	Construction general layout
Attached figure 2	Construction schedule
Attached figure 3	Drill hole column chart

List of Acronyms/Abbreviations

AC	Alternating Current
CCGT	Combined Cycle Gas Turbine
CCGT - CCS	Combined Cycle Gas Turbine with Carbon Capture and Storage
DC	Direct Current
DSCR	Debt Service Coverage Ratio
EIA	Environmental Impact Assessment
EWURA	Energy and Water Utilities Regulatory Authority
ICR	Interest Coverage Ratio
LCOE	Levelized Cost of Electricity
IGCC	Integrated Gasification Combined Cycle
IPGTs	Indicative Power Generation Tariffs
IRR	Internal Rate of Return
LRMC	long run marginal cost
ME	Ministry of Energy
NPV	Net Present Value
OCGT	Open Cycle Gas Turbine
PRC	People's Republic of China
PSMP	Power System Management Plan
PVC	Polyvinyl chloride
PV	Photovoltaic
REA	Rural Energy Agency
ROE	Return on Equity
ROI	Return of Investment
SPV	Special Purpose Vehicle
SVG	Static Var Generator
UPS	uninterruptible power supply
VAT	Value Added Tax
WACC	Weighted Average Cost of Capital

1. GENERAL

1.1 BACKGROUND TO THE PROJECT

Tanzania is located in southeast part of Africa, and constituted by mainland, Zanzibar Island and more than 20 islands. It lies in the east of Africa and south of the equator. Its mainland faces to the Indian in the east, links to Zambia, Malawi and Mozambique in the south, to Rwanda, Burundi and Democratic Congo in the west, and to Kenya and Uganda in the north. The length of continental coastline is 840 kilometers. The landform of Tanzania presents an appearance of ladder, with the elevation higher in northwest and lower in southeast. The eastern part along the coast is low land, the inland plateau in the west takes more than half of its total territory. From the Malawi Lake, the Grand East African Rift Valley is divided into eastern and western branches and stretched to both North and South.

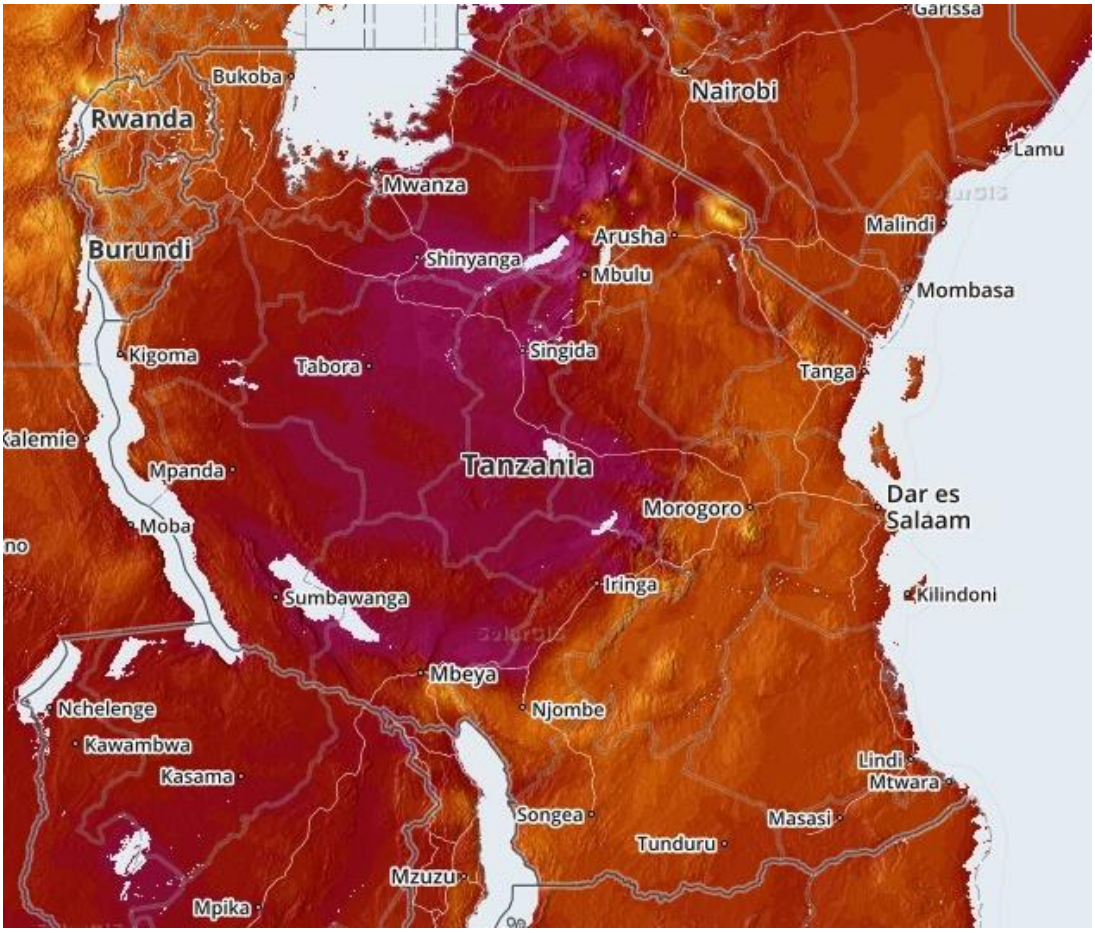


Figure 1-1 Tanzania solar energy resources distribution graph

(Source: collected from the SolarGis Database, which is a famous solar energy assessment and planning interactive software, and is developed by GeoModel solar s.r.o. Slovakia.)

Tanzania is close to the equator, therefore its solar energy resources are abundant. The

nation-wide total horizontal solar radiation is ranged from 1700 to 2400 kWh/m^2, converting into 6120 to 8640 MJ/m^2. According to the China National Standard "Assessment Method for Solar Energy Resources" (QX/T89-2008), all lands across Tanzania have Class I or Class II solar resource. The best solar resource exists in western and northern plateau areas, and is slightly poorer in eastern and southern plains.

By comprehensively taking into consideration of the main influence factors on selecting install capacity of the PV power plant, such as the condition of solar energy resources, conditions of development and construction, conditions of phased development for photovoltaic power generation works, development timing and etc., the install capacity of this project is 105.468 MWp, which is to be completed in the first phase.

This project adjoins the Singida Weather Station, whose geographical coordinate is 4°49′ southern latitude and 34°40′ eastern longitude, the altitude is 1499 meters, which is just 7 km away from the site area, its elevation drop is only about 20 meters, which is typical to the site.

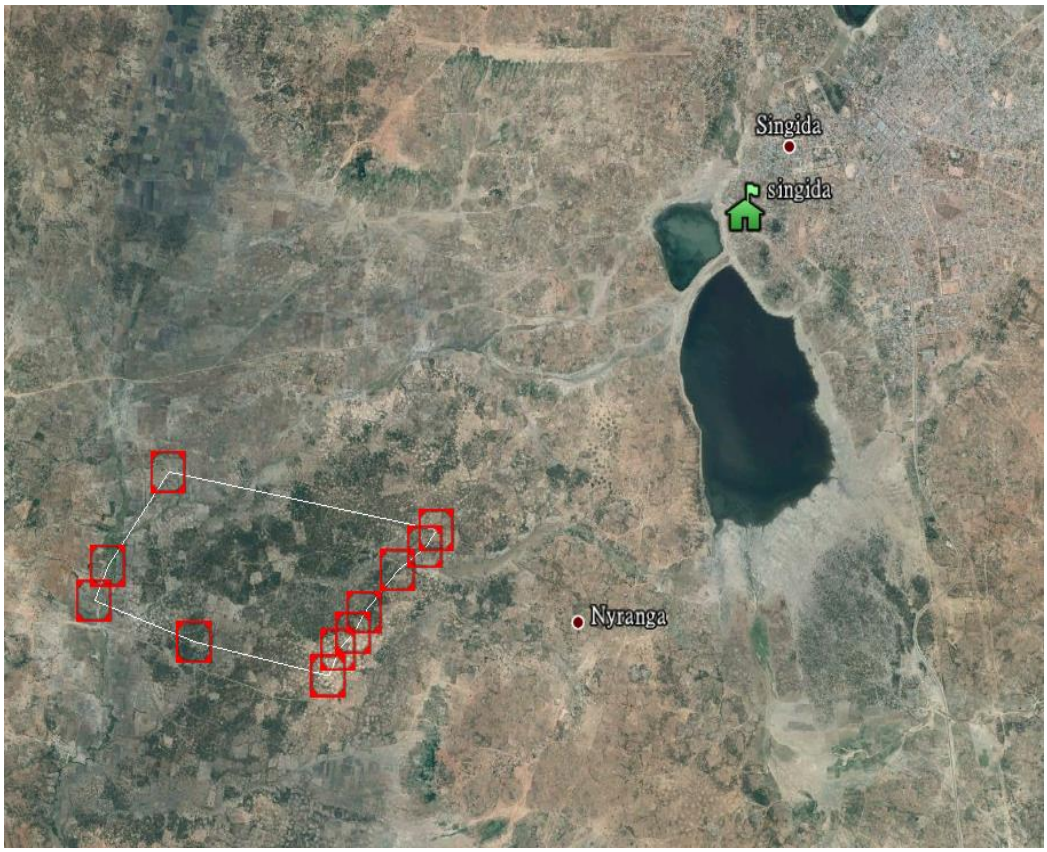


Figure 1-2 Relative location of Project site and Singida Weather Station

1.2 PROJECT NAME, LOCATION, CONTRACTING PARTIES, SECTOR MINISTRY

1.2.1 Project name

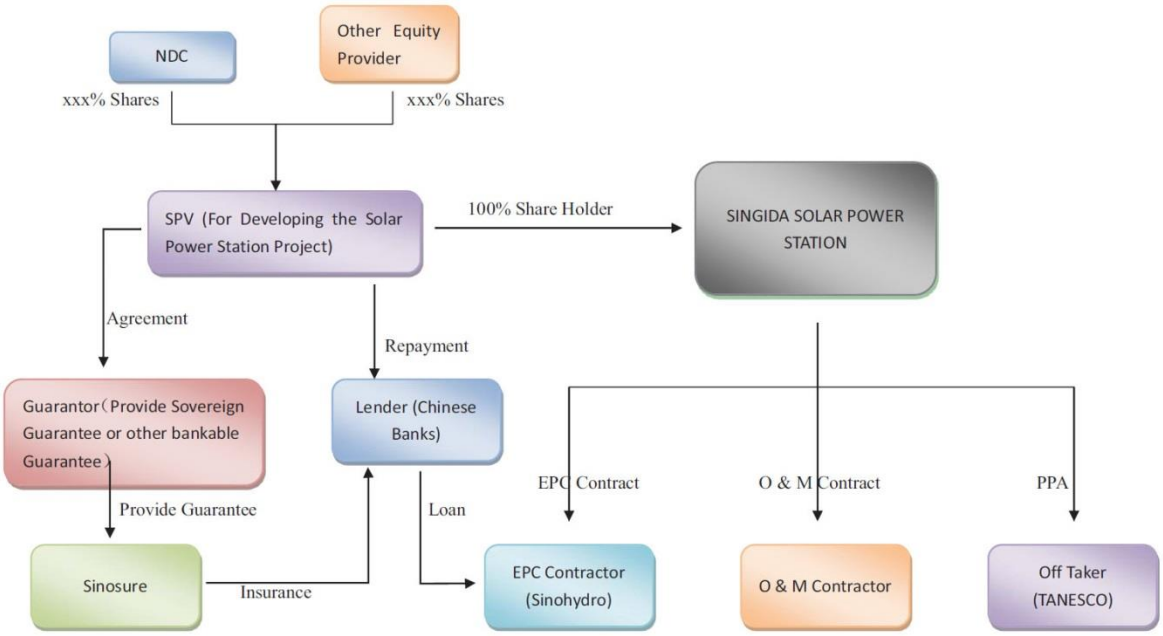
Solar Farm at Singida, United Republic of Tanzania

1.2.2 Location

This project adjoins the Singida Weather Station, whose geographical coordinate is 4°49′ southern latitude and 34°40′ eastern longitude, the altitude is 1499 meters, which is just 7 km away from the site area, its elevation drop is only about 20 meters, which is typical to the site.

1.2.3 Proposed Project Structure and Contracting Parties

A. Proposed Project Structure



B. Contracting Parties:

In the EPC Contract, the following parties shall be involved:

The Employer means Singida Solar Power Station Company as an SPV authorized by NDC and other equity provider to developing the Solar Power Station Project;

The Employer's Representative means the person named by the Employer in the Contract or appointed from time to time by the Employer who acts on behalf of the Employer;

EPC Contractor means**Sinohydro Corporation Ltd**. who is going to sign EPC Contract with the Employer for the planning, engineering, procurement,

construction/installation of the project and plant.

EPC Contractor's Representative means the person named by the Contractor in the Contract or appointed from time to time by the Contractor who acts on behalf of the EPC Contractor.

Subcontractor means any person named in the Contract as a subcontractor or any person appointed as a subcontractor, for a part of the Works; and the legal successors in title to each of these persons.

Lender means the financial institutions party to the Financing Agreements, or subsequent financial institutions that become parties to the Financing Agreements not objected to by the Employer in accordance with the terms of this Agreement, together with their respective successors and assigns. For this project, one of Chinese banks will be the Lender to finance the money to the project.

1.2.4 Sector ministry

Energy and Minerals resources play an important role in poverty reduction and in supporting socioeconomic development in Tanzania. The Ministry of Energy (ME) is mandated to facilitate development of energy and mineral sectors.

The Ministry delivers various services related to development of energy and minerals resources through the participation of various stakeholders including public, private, public-private partnerships, local communities, NGOs and civil society.

- The Energy Sector Overview

The energy balance is dominated by biomass-based fuels particularly fuel-wood (charcoal and firewood), which are the main source of energy to both urban and rural areas. Biomass-based fuel accounts for more than 90% of primary energy supply. Commercial energy sources i.e., petroleum and electricity, account for about 8% and 1.2%, respectively, of the primary energy used. Coal, solar and wind account for less than 1% of energy used.

Other abundant, but so far not fully tapped, indigenous energy sources which could be harnessed to meet the growing energy requirements include; hydropower, coal, natural gas, uranium, solar, wind, and geothermal energy. Hydropower potential is estimated at 4.7 GW, coal reserves are estimated at about 1,200 million tonnes, of which 304 million tonnes are proven. Natural gas is estimated at 45 billion cubic metres of proven reserves.

Tanzania continues to rely on imported petroleum products. Electricity generation is mainly hydro-based, while thermal plants provide electricity for peak loads. Development of natural gas for electricity is ongoing. The dissemination of renewable energy technologies have been limited to the promotion of improved stoves, improved charcoal production

techniques, solar, biogas and windmills and to a lesser extent photovoltaics. Initiatives to increase utilisation of coal for electricity generation are being explored.

- The National Energy Policy of 2003

The National Energy Policy objectives are to ensure availability of reliable and affordable energy supplies and their use in a rational and sustainable manner in order to support national development goals. The national energy policy, therefore, aims to establish an efficient energy production, procurement, transportation, distribution and end-use systems in an environmentally sound and sustainable manner.

- Investment in Rural Energy

85% of the total energy is consumed in the rural areas where the majority of Tanzanians live. Biomass, particularly wood-fuel, constitutes 90% of rural energy consumption, which has significant impact on the process of environmental degradation. Access to electricity in rural Tanzania is only about 1%.

The National Energy Policy of 2003 recognizes that improved energy supply in the rural areas through public and private sector participation, will contribute significantly to the improvement of the welfare of the rural population and to the attainment of sustainable economic growth. For these reasons, the Rural Energy Agency (REA) was established and entrusted with the role of promoting, stimulating and facilitating improved access to modern energy services in rural areas where more than 85% of Tanzanians live, through empowering both public and private sector initiatives in rural energy. (See Rural Energy Act, 2005).

Addressing energy requirements in rural areas is in line with the provisions contained in the Tanzania Development Vision 2025.

- Regulatory Regime

In accordance with the concepts of the market economy and in order to promote effective competition, economic efficiency, consumer interests and financial viability of suppliers the Energy and Water Utilities Regulatory Authority (EWURA) was established. (See Energy and Water Utilities Regulatory Authority Act, 2001).

Among the main functions of EWURA are the following: issuing, renewing and canceling licenses; establishing standards for goods and services; and regulating rates and charges.

- Mission & Vision

Mission: The Mission for the energy sector is to create conditions for the provision of safe, reliable, efficient, cost-effective and environmentally appropriate energy services to all sectors on a sustainable basis.

Vision: The Vision of the energy sector is to effectively contribute to the growth of the national economy and thereby improve the standard of living for the entire nation in a sustainable and environmentally sound manner.

By fulfilling its mission and vision, the energy sector will contribute to social economic development, and in the long-term perspective, poverty eradication.

- Mandate Documents
  - The National Energy Policy, 2003
  - The Rural Energy Act, 2005
  - The Electricity Act, 2008
  - The Petroleum Act, 2015

2. PROJECT DESCRIPTION

2.1 BRIEF DESCRIPTION OF THE PROJECT

The install capacity of Singida Solar Farm is 105.6MWp, which is to be completed in the first phase. This project adjoins the Singida Weather Station, whose geographical coordinate is 4°49′ southern latitude and 34°40′ eastern longitude, the altitude is 1499 meters, which is just 7 km away from the site area, its elevation drop is only about 20 meters, which is typical to the site.

2.2 JUSTIFITION THE PROJECT

(1) The development of solar energy is an effective means to alleviate power supply

Tanzania has a population of 49 million, and is one of the emerging countries having advantages in the natural resources exploitation and promising energy form development in Africa. At present, only 34% of its population can use electricity, and the backward of electric power industry has badly affected the modernization of Tanzania. According to the described result of PSMP (Power System Management Plan) made by Tanzania government in 2016, the estimated power demand should be 4915 MW in 2020. Compared with the national total installed capacity, which is only 1396.24 MW due to the stagnant power grid development and lack of power source, the power shortage problem becomes increasingly prominent.

To effectively alleviate the power shortage problem, the power source development must be sped up. But, because its construction and financing has a greater difficulty, the construction period of the hydro power plant is relatively long, and the distribution is limited by the resources, it becomes impossible to effectively relieve the strain on the power supply problem in a short time. Nonetheless the proven coal reserves reached 1.0 billion tons, major of them is located in the southwest of the underdeveloped areas, and encountered with the difficulty of transportation. In this case, the development of solar power has become one of the options to resolve the national power supply problem in the short to medium term.

(2) Development of wind energy and solar energy is the inevitable choice for energy security and diversification

The Tanzania power structure is dominated by hydro power and thermal power, but affected by weather change between rainy and dry seasons and aging of equipment in thermal power plant, the actual effective installed capacity is incapable to generate as the design output,

and tremendously affected the local power supply and result in power supply shortage in many regions.

Because the temporal distribution of solar resource has the feature of inadequate in rainy season and abundant in dry season, the solar resource and hydro resource in Tanzania are very complementary. To develop the solar resource can effectively alleviate the deficiency of hydro power

Therefore, development of solar energy fully exerts its resource potential of Tanzania, and is the inevitable choice for energy security.

(3) Development of wind energy and solar energy is the essential means to promote national economic development and improve people's living condition

To vigorously develop wind and solar energy resources will help to promote the economic development of Tanzania. The power sector is the important national infrastructure industry. By raising the level of technology in power sector and strengthening the overall strength, the development of other sectors of the economy will be greatly promoted. Development of solar projects will also have a positive impact on employment opportunities and national fiscal revenue increase.

(4) Development of wind energy and solar energy is the important choice of response to global climate change and sustainable development

Since the industrial revolution, a large number of human using fossil fuels such as coal and oil, has resulted in a large number of CO^2 emissions, intensified the greenhouse effect, caused rise in sea level, drought, storm, hurricane, cold wave, and other extreme weather condition constantly, and incurred serious environmental problems. To realize the sustainable development of human beings, the existing energy consumption patterns mainly composed by fossil fuel must be changed, and the carbon dioxide emissions must be sharply reduced. The United Nations framework convention on climate change is the common action for carbon dioxide emissions, climate change, protect human common homeland constituted by global nations.

As a developing country, Tanzania does not undertake a mandatory emission reduction obligations, but to further develop solar and other renewable resources is more conform to the tide of international energy development, and help to establish a good image of the "green" development on the international stage. Meantime, it also helps Tanzania to take initiative position in future international strategic of carbon emission reduction issues, and gain more benefits through carbon trading.

2.3 ESTIMATED CAPITAL COSTS

Total static investment of the project is126,443,456.53 USD, the static investment per unit kW is US $ 1,197.38/kW.

2.4 BASIS FOR CAPITAL COST ESTIMATION

2.4.1 Preparation principle

It is prepared in accordance with the requirements of relevant and applicable state and industry documents, cost quota and rate standards.

2.4.2 Main preparation basis and parameter basis

① The energy industry standard of the PRC NB/T31011 "Specification and calculation basis for cost estimate of solar power projects" issued by the National Energy Administration [2011] (Version 2011) ;

② The energy industry standard of the PRC NB/T31010 "Ration of cost estimation for solar power projects" issued by the National Energy Administration [2011] (Version 2011) ;

③ NB/T31007-2011 "Charging Rates for Investigation and Design of Solar power Projects" published by the National Energy Administration, "Administrative regulation for charging of investigation and design of projects" Jijiage [2002] No. 10 issued by National Development and Reform Commission and Ministry of Construction;

④ "Notice on the Relevant Matters on Unifying the Policies on Local Education Surcharges" Caizong [2010] No. 98 issued by of the Ministry of Finance;

⑤ Relevant design data provided by this project, information of market research in Tanzania;

⑥ "International Country Risk Guide of Tanzania" issued by the Ministry of Commerce of PRC.

3. TECHNICAL ASPECTS

3.1 PROJECT DESIGN

3.1.1 Design Parameter

Table 3-1PV Module Parameters

		PVM-1
Type	/	Polysilicon
Peak power	Wp	320
Efficiency	%	16.48%
Open circuit voltage	V	46.78
Work voltage	V	30.8
Short-circuit current	A	8.98
Work current	A	8.28
Power-temperature coefficient	%/K	-0.41
Voltage-temperature coefficient	%/K	-0.31
Dimension (L/W/H)	mm	1956/992/40
Weight	kg	18.5

Table 3-2 Technical parameters of inverter

No.	**Name**	**Unit**	**Parameters**
1 Input parameters	Maximum DC power	kW	1,120
	Maximum input voltage	V	1,000
	Starting voltage	V	500
	Minimum work voltage	V	460
	Maximum input current	A	2,440
	MPPT voltage range	V	460~850
2 Output parameters	Rated output power	kW	1,000
	Maximum AC input power	kW	1,100
	Maximum output current	A	2,016
	Permissible grid voltage range	V	252~362
	Permissible grid frequency	Hz	47~52

	range		
	Adjustable range of power factor		0.9 (ahead) ~0.9 (lagging)
3 Efficiency	Maximum efficiency	%	98.7
	China efficiency	%	98.2
4 Machine parameters	Dimension (W×H×D)	mm	2,538×2,470×2,050
	Weight	kg	4,200
	Operation temperature range	℃	-35~50
	Protection class		IP54
	Relative humidity		0~95
	Maximum altitude		6,000 (to be derated when exceeding 3,000)

3.1.2 Plant Layout

(1) Layout principles

The following principles shall be taken into consideration in the construction layout:

On one hand, general construction layout shall be implemented in line with detailed local conditions; on the other hand, it shall also be beneficial to production, convenient for life, easy for management, safe, reliable and applicable in practice;

① Solar PV module arrangement's features shall be fully considered in line with the actual situation of this project's construction;

② Special attention shall be paid to avoid environmental pollution during this project's construction period, and construction layout must meet relevant environmental requirements;

③ According to this project site's geological conditions and construction layout, an optimal plan must be formulated to make full use of the land resources; Properly arrange relevant construction equipment and temporary facilities as a whole, and combine temporary land acquisition and permanent land acquisition;

④ According relevant experience concluded from some finished project, closed-end management shall be applied to main construction areas during the construction process.

(2) Temporary facilities

Through full consideration, temporary construction facilities shall be arranged around the access road and the construction site. Yet, life are shall not be established near comprehensive warehouse area so as to avoid environmental influence. In order to guarantee normal civil engineering construction and PV equipment's foundation construction, the layout of comprehensive processing factory, comprehensive warehouse and temporary life area shall not exert any impact on the project site's transportation condition. However, all temporary construction facilities shall be arranged within the construction site, and there is no need to additionally acquire other lands. Please refer to Table 3-4 for the construction area of temporary facilities and land occupation details.

Table 3-3Floor space occupied by temporary construction facilities

No.	Project name	Floor space (m^2)	Remarks
1	Life Area	2500	Including construction organization's offices
2	Comprehensive processing factory	1000	Steel structure processing, mechanical maintenance and parking mechanical equipment
3	Comprehensive warehouse	1800	Store battery pack, battery holder, electromechanical equipment and rebars, etc.
	In total	5300	

(3) Construction road within the construction site

On the basis of the matrix layout within the PV field, vertical and horizontal roads between the matrixes can be used as construction roads. The total length can reach 16.5km, and macadam pavement will be put into service(such road is 4.0m wide and roadbed 5.0m).

(4) Installation site

For the convenience of PV equipment's foundation construction and installation, some installation sites shall be created on the marginal land. However, every installation site shall be 40m in length and 30m in width with an area of 1200m^2. Installation site shall be applied with different functions on different stages. For example, it shall serve as steel & wood processing site during the equipment's foundation construction period, and equipment assembly site during the equipment's installation period. All installation sites are

established within the PV filed without additionally acquiring other lands. Please refer to general construction layout for details.

(5) Construction water supply, power supply and building materials

1) Construction Water Supply: A well shall be drill for the purpose of water supply. A reservoir shall be built in the construction site, and 100mm (diameter) PVC pipes shall be applied to transfer water to the construction reservoir while the output of supplying water shall reach 15m^3/h.

2) Construction Power Supply: The Substation in Singida Town located 8km away from the construction site will provide temporary construction power supply, and electric transmission lines shall be put up to link with various construction spots. Peak construction power consumption can even reach 250kVA.

3) Building Materials: Main building materials needed in this project (including concrete, steels, wood, fuel and sand & stones, etc.) shall be purchased from the nearby market in Singida Town.

Please refer to Tanzania PV project's general construction layout for details (Attached Diagram 1).

3.1.3 Plant Indicative Performance

Table3-4Plant Indicative Performance

Name			Units	Quantity	Remarks
Solar energy resources	Average total radiation for years		MJ/m^2	8272.8	
	Mean sunshine duration		h	3219.8	
	Average temperature		℃	20.5	
	Annual precipitation		mm	708.4	
Main equipment	**PV modules**	Quantity	Piece(s)	330000	
		Maximum output power	W	320	
		Open circuit voltage	V	46.78	
		Short circuit current	A	8.98	
		Rated battery operating temperature	℃	45±2	

Name			Units	Quantity	Remarks
		Operating Temperature	℃	-40 to +85	
		Module conversion efficiency	%	16.48	
		Output power attenuation	%	80	25 years
		Installation mode of PV modules		Fixed inclination	
		Angle of fixed inclination	°	4	
	Inverter	Quantity	Piece(s)	100	
		Rated power	kW	1000	
		Maximum conversion efficiency	%	98.8	
		Power factor		> 0.99	
Construction time limit	Project duration		Month	12	
Project land occupation	Permanent land occupation		m^2	709	
	temporary land occupation		Km^2	1.132	
Investment index	Static investment (in year of preparation)		US $	126,443,456.53	
	Static investment of unit kilowatt		US $/kW	1,197.38	
	On-grid electricity price (Including VAT)		US $/kW·h	0.070	
Financial index	Financial internal rate of return of total investment		%	6.19	Pretax
	Financial internal rate of return of capital fund		%	13.66	

Name		Units	Quantity	Remarks
	Investment payback period	Year	13.21	Pretax

3.2 SITE CONDITION

3.2.1 Site Topographical and Geological Condition

The proposed site is located in Unyianga village in mid and north part of Tanzania, 14 km away from Singida City western along the Mwankoko Road, and about 700 km away from Dar es Salaam. The land of this project is smooth in topography, and covered with lush vegetation, mainly shrubs. The altitude of the proposed site is about 1499 meters.

3.2.2 Power resource assessment

Because there's no radiation observation point around the Singida Weather Station, the radiation resource data used to assess the resource of this project is from SolarGis database. SolarGis provides the monthly horizontal total radiation and its direct solar radiation component as well as its scattered radiation component. See Figure 3-1 and Table 3-6 for statistical data.

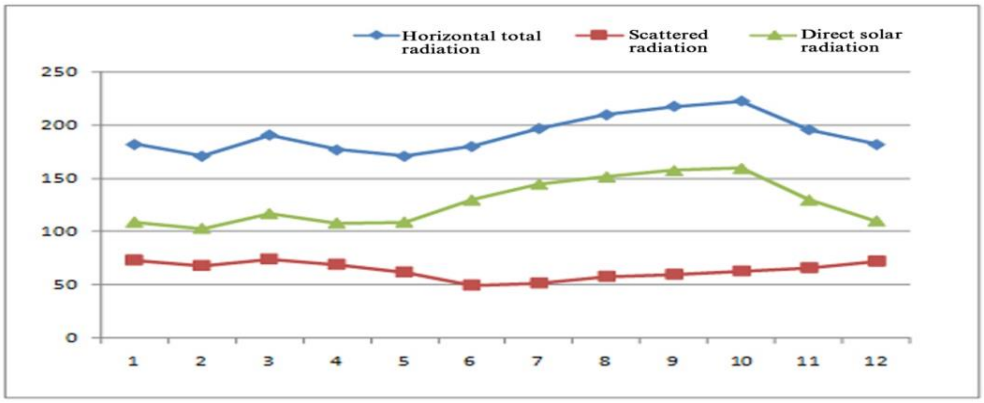


Figure 3-1Singida weather station daily sunshine hours variation chart

Table 3-5 Monthly radiation data

Month	Horizontal total radiation (kWh/m²)	Scattered radiation (kWh/m²)	Direct solar radiation (kWh/m²)	Average temperature (℃)
1	182	73	109	20.6
2	171	68	103	20.9
3	191	74	117	20.7
4	177	69	108	20.1
5	171	62	109	19.7
6	180	50	130	19.0
7	197	52	145	18.6
8	210	58	152	19.4
9	218	60	158	21.0
10	223	63	160	22.0
11	196	66	130	22.3
12	182	72	110	21.3
Year	**2298**	**767**	**1531**	**20.5**

From the chart and the table above, the resource situation is relative fine with the total horizontal radiation reaching 2298 kWh/m^2, equivalent to 8272.8 MJ/m^2. As the site nears the equator, the radiation received by solar modules will not raise sharply even the inclination changed in the later phase. Among the total radiation, the direct solar radiation dominates and takes 66% of it, which will benefit the photovoltaic power generation. However, the average temperature reaches up to 20.5℃, and the excessively high temperature will reduce the efficiency of the solar module to a certain extent.

It can be observed from the monthly variation that the radiation is relatively larger between July and October with a lower portion of scattered radiation, and smaller between December to next April with a higher portion of scattered radiation. And analysis by comparison with the measured data of the weather station, it is able to see that the total radiation and direct solar radiation is relatively lower during the months with more rainfall, and the condition is opposite in dry season. This analysis proves that the SolarGis data change trend is preferably matching to the reality.

3.2.3 Site Access for Equipment and Material Delivery

This project site is located at Unyianga Village (central north region in Tanzania), and there are accesses to SINGIDA, IHANJA and MWANKOKO passing through the village. Since the project site is right situated beside the road to MWANKOKO, and its road transportation conditions are favorable and excellent.

Roads within the site have put 4m-wide macadam pavement and 5m-wide roadbed into service. Trunk line has connected various inverter rooms to form a loop on the whole, and simple pavement is established between solar panels. However, various roads in the site shall be able to satisfy relevant inspection tour and maintenance demands.

On the basis of the matrix layout within the PV field, vertical and horizontal roads between the matrix can be used as construction roads. The total length can reach 16.5km, and macadam pavement will be put into service(such road is 4.0m wide and roadbed 5.0m).

3.2.4 Topographical, and Seismic information

Depending on the collected information, the surface of the site area is quaternary holocene tillage planting soil. Under this tillage planting soil is mixed-layer strata, mainly consist of clayey silts and sandy silt. From the top to the bottom lists as follows:

Tillage planting soil layer ①, which is isabelinus, a slightly wet, dense state, mainly consisted of silt, the surface contains plant roots and occasional gravel. The layer thickness is 0.2 m to 0.5 m.

Layer ② mainly consist of clayey silt and sandy silt mixed-layer. The layer thickness is 8m to 10m.

Sandy silt layer ②1, which is isabelinus to tawny, a slightly wet to wet, slightly dense to medium dense, medium to high compressibility, includes a few mica and ferric oxide. Characteristic value of subgrade bearing capacity is about 100 kPa to 120 kPa.

Clayey silt layer ②2, which is isabelinus to tawny, A slightly wet to wet, slightly dense to medium dense, medium to high compressibility, includes a few mica and ferric oxide. Characteristic value of subgrade bearing capacity is about 100 kPa to 140 kPa.

Depending on the collected information, the main physical and mechanical index values of geotechnical layers have been provided.

Table 3-6 Table of suggested value of the main physical and mechanical indexes of the layers

Geologic Age	Layer name	ρ (kN/m^3)	C (kPa)	φ (°)	Es (MPa)	f_{ak} (kPa)
Quaternary System	Sandy silt	1.8	10	20	6	100～120
Quaternary System	Clayey silt	1.9	12	25	5	100～140

3.2.5 Hydrogeological condition

Depending on the collected information, the embedded depth of groundwater in Tanzania region will change from about 5 to 10 meters with the seasons. Under this water level, it will not affect the foundation construction, but in rainy season, the groundwater level rising should be considered for avoid influence to foundation excavation. To confirm the groundwater distribution under the site area is recommended.

3.2.6 Site soil types and construction site classification

According to *Code for seismic design of buildings (GB50011-2010),* the soil type of the proposed site area is mainly mid soft soil, and preliminarily considered as Class Ⅲ. The area belongs to an area required to resist normal earthquake.

3.2.7 Site seismic effect and the ground motion parameter

According to Global seismic hazard analysis and seismic intensity zonation map and by reference to Seismic ground motion parameter zonation map of China (GB18306-2001), it is preliminarily considered that the ground motion peak acceleration of 10% exceedance probability among 50 years in this site area is 0.15g, and the corresponding seismic basic intensity is VII degree. To check with the local related seismic standard is recommended.

3.2.8 Construction foundation evaluation

Combined with the feature of this project, depending on the currently collected data, the engineering characteristics of foundation soil for all construction sections in the site area are evaluated as follows:

✧ Photovoltaic modules area

The proposed area is wide, flat and open terrain. Based on the collected information, the surface of the site area is quaternary holocene tillage planting soil. Under the tillage planting soil, there are mixed-layers mainly consisted of clayey silt and sandy silt. Considering the slightly high requirement of bearing capacity of the photovoltaic modules foundation, pile foundation initiatively recommended. For confirming the foundation design proposal and offering proposal on foundation processing scheme, to ascertain ground strata distribution and rock and soil physical and mechanical properties is recommended.

✧ Step-up substation area

Depending on the collected information, the surface of the site area is quaternary holocene tillage planting soil. Under the tillage planting soil, there are mixed-layers mainly consisted of clayey silt and sandy silt. Although the bearing capacity of clayey silt and sandy silt is

relatively low, depending on the related engineering experiences, the design requirement for bearing capacity of step-up substation area foundation is capable to satisfied, and the natural foundation is initiatively suggested to adopt. For confirming the foundation design proposal and offering proposal on foundation processing scheme, to ascertain ground strata distribution and rock and soil physical and mechanical properties is recommended.

3.3 EQUIPMENT SPECIFICATIONS

3.3.1 Plant Capacity and Configuration

1) Plant Capacity

Tanzania 100MW PV grid-connected power station is composed of 100 sets of 1MW PV power generation subsystem, with final stage up to 100MW. For the design, the 100MW PV power station will be linked through a 220kV Power Transmission Line and the National Grid at Singida Substation, 14km away from power station.

2) Selection of main electric equipment

①Unit step-up transformer

Considering the needs for operation, maintenance and inspection, the project's step-up transformers are based on indoor dry transformers. According to the requirements of inverter selection parameters and relevant complete equipment, the specific performance parameters of the project's step-up transformer are as follows:

Among others, "the capacity of transformer number 1 to 100 is 1000kV dry transformers …"

Type:	Dry transformer
Model:	S11-1000/37/0.315/0.315
Capacity:	1000kVA
Voltage-regulating mode:	High voltage side regulation
Impedance:	6%
Connection groups:	Y, D, D

② Main transformer

When power is generated from PV power station, the power flow is from PV power station to power grid; when the power is not generated from PV power station, the power flow is from the system to the PV station, which has a high voltage fluctuation. Moreover, for

facilitating the operation and maintenance, it adopts three-phase copper-core double-winding on-load tap changing oil-immersed type transformer.

Model:	SZ11-50000/220
Rated capacity:	2×50MVA
Rated voltage tapping range:	230±8×1.25%/37kV
Connection symbol:	YNd11
Impedance voltage:	14%

The neutral point of transformer is earthed via neutral point protective device. Bushing current transformer is furnished on the high and low voltage sides of main transformer and inside central point bushing ascending flange.

③ 220kV circuit breakers

220kV circuit breakers will choose outdoor AC high-voltage porcelain pillar type SF6 circuit breakers.

Model:	LW□-252
Rated voltage:	220 kV
Max. operating voltage:	252 kV
Rated current:	4000A
Rated frequency:	50Hz
Rated breaking current:	50kA
Rated short-circuit closing current:	125kA
Rated short-time withstand current:	50kA,2S
Rated peak withstand current:	125kA
Motor voltage of spring operating mechanism:	AC/DC220V
Opening and closing coil voltage:	DC220V

④220kV isolating switch

Three-column horizontal rotary isolating switch is recommended. The main knife switch is an electric operating mechanism. The earthing knife switch is a manual operating mechanism. The technical parameters are as follows:

Model:	GW□-252
Rated voltage:	220kV
Max. operating voltage:	252kV

Rated current: 3150A

Rated peak withstand current: 125kA

Rated short-time withstand current: 50kA,2S

⑤ 220kV current transformer

Type: LVQB-220W2

Rated voltage: 220kV

⑥ 220kV voltage transformer

Type: TYD-220/√3

Rated voltage: 220kV

⑦ Lightning arrester

Y10W1-204/532W zinc oxide arrester is selected

Rated voltage (valid rate): 204 kV

Continuous operating voltage (valid value): 159kV

Residual voltage of switching impulse current not more than (peak value): 452kV

Residual voltage of nominal impulse current not more than (peak value): 532kV

Residual voltage of steep impulse current not more than (peak value): 594kV

Creepage distance not less than 6.3cm/kV

⑧ 33kVgrounding transformer

Type: Dry transformer

Capacity: 315kVA

Voltage: 37±2×2.5%/0.4kV

Connection group: Dyn11

⑨ 10kV station service transformer

Type: Dry transformer

Capacity: 315kVA

Voltage: 10±2×2.5%/0.4kV

Connection group: Dyn11

⑩ Reactive power compensation device

33kV busbars are provided with 2 groups of reactive power compensation devices (SVG), with preliminary compensation capacity at 15Mvar, which is subject to further determination according to the requirements of access power system report and electric

energy quality report.

⑪ 33kV switchgear cubicle

33kV power distribution room chooses indoor withdrawal closing switchgear. Primary element mainly includes circuit breaker, operating mechanism, current transformer, lightning arrester etc. The specific technical parameters are as follows:

A. Model (5 incoming cubicles) KYN-40.5

Vacuum circuit breaker 1 set VEP-40.5T-1250D

B. Model (1 outgoing line cubicle) KYN-40.5

Vacuum circuit breaker 1 set

C. Model (1 PT and lightning arrester switchgear cubicle) KYN-40.5

Primary harmonic eliminating device 1 set

D. Model (1 auxiliary transformer switchgear cubicle) KYN-40.5

Vacuum circuit breaker 1 set

E. Type (2 reactive power compensation cubicles) KYN-40.5

SF6 circuit breaker 1 set

F. Model (1 earthing transformer switchgear cubicle) KYN-40.5

Vacuum circuit breaker 1 set

⑫ Electric cable

1kV single-core low-voltage cables between the project's PV power generating modules and DC combiner box. PV array combiner cables are laid in an exposed way. The cables between DC combiner box and PV DC distributor box of control room are directly buried underground and laid in cable trench.

The step-up transformers of 1#~100# integrated power distribution room are connected to high-voltage power distribution room through 33kV cross-linked polyvinyl cables ZRC-YJV23/3, with 20 cables a string.

3.3.2 Potential Equipment Suppliers

Table 3-7Potential Equipment Suppliers

SQ	Major Items of Plant	Proposed Manufacturers	Origin
1	PV module	Trina Solar Energy Co., Ltd	China

SQ	Major Items of Plant	Proposed Manufacturers	Origin
		Jinko Solar	China
		Canadian Solar	China
2	Inverter	Sungrow Power Supply Co., Ltd.	China
		TBEA Xi'an electric technology Co., Ltd.,	China
		TMEIC	China
3	LV/MV Transformer (Box type)	Sunten Electric Equipment Co., Ltd	China
		TBEA Xi'an electric technology Co., Ltd.,	China
		Sanbian Sci-Tech Co., Ltd	China
4	Main Transformer	Sanbian Sci-Tech Co., Ltd	China
		Hangzhou Qiantang River Electric Group Co., Ltd	China
		TBEA Hengyang Co., Ltd	China
5	AIS	TAIKAI Group Co., Ltd	China
		Sieyuan Electric Co., Ltd.	China
		PINGGAO GROUP CO., LTD	China
6	Medium Voltage Switchgear	Ningbo Tianan Group Co., Ltd	China
		Daqo Group Co., Ltd	China
		TBEA Xi'an electric technology	China
7	Monitoring & Control system	NR Electric	China
		Hangzhou Huachen Electric Power Control Co., Ltd. (HCECE)	China

3.4 ELECTRICAL SYSTEMS AND INTERCONNECTION TO THE GRID

The power station is composed of 100 sets of 1MW PV power generation subsystem, with final stage up to 100MW. For the design, the 100MW PV power station will be linked through a 220kV Power Transmission Line and the National Grid at Singida Substation, 14km away from power station.

Main electrical connection

(1) Wiring of PV system

According to design of solar energy cell array, the power station adopts combination of one 1MWp sub-array plus two 500kW inverters, two inverters plus one 33kV step-up transformer. The whole station consists of modular units including 100 arrays plus inverters and step-up transformers.

(2) 220kV side wiring mode

The planned installed capacity of the solar farm project is 100MW. It is planned to build a 220kV step-up substation, set two main transformer with capacity of 50MVA and on-load tap changing transformer with voltage of 220kV/37kV.

As the substation is a terminal substation, only primary circuit is available for 220kV line. According to the provisions of Technical Specification for Design of 220kV-750kV Substation, when the final nature of 220kV substation is determined as a terminal substation, if the requirements are met, the wiring type shall be simplified. Therefore, the 220kV substation adopts line transformer bank wiring mode and is provided with one interval.

(3) 33kV side wiring mode

The 33kV side of step-up station adopts single busbar wiring mode. The busbar corresponds with one main transformer. 33kV power distribution unit adopts indoor withdrawal switchgear. 33kV busbars are provided with five incoming switchgear cubicles, one incoming switchgear cubicle, one PT and lightning arrester switchgear cubicle, two reactive power compensation device switchgear cubicles, oneearthing transformer switchgear cubicle and one auxiliary transformer switchgear cubicle, with a total of eleven cubicles together.

4. PROJECT IMPLEMENTATION SCHEDULE

4.1 PROJECT DEVELOPMENT SCHEDULE

Tentative Project development and implementation schedule is summarized by major milestones below:

- ESIA Study and Approval by July 2017
- Approval of Feasibility Study by TANESCO by November 2017
- Due Diligence concluded by end of December 2017
- Valuation report for PAP by December 2017
- EPC Contract between NDC and Sinohydro signed December 2017
- Negotiate PPA between NDC and TANESCO June 2017
- Financial Close by September 2018
- Compensations of PAP completed by December 2018
- Construction start by January 2019
- COD: January 2020

The preparation period of this project lasts 3 months. Items carried out during this period include preparation for the disembarkation of equipment (Photovoltaic modules equipment, transformers, construction equipment, and relevant equipment), preparation for the transportation of Photovoltaic modules equipment (including equipment preparation and detailed route survey) construction of water supply and power supply systems, construction of concrete mixing station, construction of road

4.2 PROJECT CONSTRUCTION SCHEDULE

Relevant construction organizations shall prepare corresponding materials, and deliver them to the construction site before February 1 in the second construction year.

Period for road construction, water and power supply route arrangement and site leveling is from February 1 to February 28 or 29 in the first year.

Period for PV module, box-type transformer and inverter’s foundation construction is from February 1 to September 30 in the first year.

Period for support installation is from March 1 to October 31 in the first year.

Period for PV equipment’s module installation and commissioning is from March 1 to

November 30 in the first year.

Period for box-type transformer and inverter installation is from April 1 to November 30 in the first year.

Period for 220kV step-up station's civil construction and main transformer's foundation construction is from February 1 to May 31 in the first year.

Period for power cable, communication and controlling optical cable line construction is from February 1 to October 31 in the first year.

Period for 220kV step-up station's electrical equipment installation and commissioning is from May 1 to June 30 in the first year.

Period for monitoring system's installation and commissioning is from February 1 to October 31 in the first year.

Trial operation period is from December 1 to December 14 in the first year.

Completion check and acceptance period is from December 15 to December 31 in the first year.

This project's construction shall last for 12 months.

Please refer to general construction schedule (Attached figure 2) for Tanzania PV project's general construction schedule details.

5. PROJECT COST

5.1 PROJECT SCOPE

Total number of 330,000 PV modules with individual power of 320Wp and total number of 100 pieces inverter with individual power of 1000kW will be installed, the total installed capacity of Singida Solar Farm is 105.6 MW. It is planned to build a 220kV step-up substation, set 2 main transformer with capacity of 2x50MVA and on-load tap changing transformer with voltage of 220kV/37kV.

The Singida Solar Farm power station will be linked to the National Grid at Singida Substation through a 220kV Power Transmission Line, 14km away from power station.

5.2 TECHNICAL ASSUMPTIONS

Table of Main works Quantities for This Project

Table 5-1Main works Quantities

No.	Items	Units	Quantity	Remarks
A	Main equipment			
1	Solar module (320Wp)	Piece(s)	330,000	
2	Container-type inverter (with DC combining control cubicle)	Piece(s)	200	
3	DC combining control cubicle	Piece(s)	1,200	
4	Box-type substation	Piece(s)	100	
5	1kV photovoltaic special cable	km	1,000	
B	Site road	km	16.5	
C	PV module, box-type substation equipment civil works			
1	Earthwork excavation	m^3	18,800	
2	Backfill of earthwork	m^3	9800	
3	Concrete	m^3	4640	
4	Rebar	t	350	
5	Steel	t	45	
D	Outgoing part (transmission line)			
1	Interval	piece	1	
2	Straight-line tower	t	223.6	
3	20-40° turn angle	t	102	
4	40-60° turn angle	t	90.4	
5	60-90° turn angle & terminal	t	50.4	
6	Conductor	km	14.5	

No.	Items	Units	Quantity	Remarks
7	Hardware fittings	t	7.92	

5.3 ESTIMATE PROJECT COSTS

5.3.1 Cost estimate for auxiliary works of construction

The auxiliary works of construction is composed of power supply works of construction, water supply works of construction and other auxiliary works of project.

5.3.2 Estimate of equipment and installation works

The equipment and installation works includes power station equipment and installation works, step-up substation equipment and installation works, control and protection and installation works, other equipment and installation works, and the ocean freight.

Prices of main electromechanical equipment

Solar photovoltaic power generation module USD 0.32/W

The prices for other equipment will be determined by reference to the data of similar projects.

5.3.3 Cost estimate of construction works

The construction works is composed of power station, step-up substation works, building construction works, traffic works and other works.

(1) Power generation equipment foundation contains, box-type substation foundation works, inverter foundation works and etc. It will be analyzed and calculated according to the works quantity multiplied by unit price of works.

(2) The length of newly built road in the site of traffic works is 16.5 km, the works will be calculated according to the design works quantity multiplied by the unit price of the works.

(3) Other works includes environmental protection and water and soil conservation works, labor safety and industrial hygiene works as well as fire protection works and etc.

5.3.4 Project Design Budget Estimate Table

Table 5-2Project Design Budget Estimate Table

No.	Name of works or cost	Equipment procurement cost	Construction installation works cost	Other costs	In total	Percentage (%)
Ⅰ	**Photovoltaic site area**					
A	Auxiliary works of construction		295,800.00		295,800.00	0.2%
1	Power supply works of construction		256,000.00		256,000.00	
2	Water supply works of construction		9,800.00		9,800.00	
3	Other auxiliary works of construction		30,000.00		30,000.00	
B	Equipment and installation works	64,257,197.31	13,366,219.96		77,623,417.26	**61.4%**
1	Power generation equipment and installation works	51,318,544.85	10,522,998.48		61,841,543.33	
2	Step-up substation equipment and installation works	1,877,029.58	214,912.56		2,091,942.14	
3	Control protection equipment and installation works	1,460,975.30	106,184.51		1,567,159.82	
4	Other equipment and installation works	495,454.55	1,097,169.85		1,592,624.40	

No.	Name of works or cost	Equipment procurement cost	Construction installation works cost	Other costs	In total	Percentage (%)
6	Marine insurance cost, port charge and land freight	7,896,859.70			7,896,859.70	
C	Construction works		14,445,349.57		14,445,349.57	11.4%
1	Power field works		12,965,248.17		12,965,248.17	
2	Step-up substation works		101,230.48		101,230.48	
3	Building construction works		626,919.49		626,919.49	
4	Traffic works		651,951.43		651,951.43	
5	Other construction works		100,000.00		100,000.00	
D	Temporary construction fee			2,666,192.67	2,666,192.67	2.1%
E	Commissioning fee			2,129,596.72	2,129,596.72	1.7%
F	Survey and design expenses			1,204,223.40	1,204,223.40	1.00%
G	Others				22,057,759.94	17.4%
H	Reserve funds				6,021,116.98	4.8%

No.	Name of works or cost	Equipment procurement cost	Construction installation works cost	Other costs	In total	Percentage (%)
I	Total investment of project (Parts A to H)				126,443,456.53	100.00%
	Static investment of unit kilowatt (USD/kW)				1,197.38	
	Dynamic investment of unit kilowatt (USD/kW)				1215.19	

5.4 FINANCIAL PARAMETERS

(1) Financing

Total static investment of the project is 126,443,456.53 USD.

Sources of fund: 15% of the static investment is the capital fund, the remaining is from the bank loan. The rate of interest is 2%. The Equal repayment of principal will be adopted and the repayment period is 20 years.(including construction period)

For the entire loan, there will be management fee with 0.5% rate and commitment fee with 0.5% rate.

With all the financing cost, the dynamic investment of the project is128,324,302.95USD.

The Financing scheme is shown in the table below:

Table 5-3Financing Scheme

	Loan	**Capital**	**Total**
1 Construction cost			
Principal	107,476,938	18,966,518	126,443,457
Interest during construction period	1,074,769		1,074,769
2 Investment insurance			
Principal	0	0	0
Interest during construction period	0		0
3 Sub-total			
Principal	107,476,938	18,966,518	126,443,457
Interest during construction period	1,074,769		1,074,769
4 Management fee		537,385	537,385
5 Commitment fee		268,692	268,692
Total	**108,551,707**	**19,772,596**	**128,324,303**

(2) Production

According to the solar energy evaluation and calculation of power generated by power station, the average on-grid electric energy of final operating period is 170,282.95MWh

(3) Total costs and expenses for power generation

The total costs and expenses for power generation include operating costs, depreciation expense, amortization charge and interest expenditure, in which operating costs include repair charge, salary and welfare for employees, labor insurance, housing accumulation funds, material expenses and other expenses.

1) Depreciation

The project's depreciation expense will be calculated based on the power station's value of

fixed assets multiplied by composite depreciation rate. The power station's value of fixed assets includes fixed asset investment and interest of construction period, worth of 128,324,302.95 US dollars, which will be based on 18 years of composite depreciation life and 3% of residual value rate.

2) Repair fee

The repair fee rate shall be based on 0% of investment upon fixed assets for the first two years, 0.8% for the 3rd to 10th years and 1.0% for the subsequent years.

3) Employees' salary and welfare, labor insurance, housing funds

The power station has 15 employees, with per-capital annual salary based on 14749 US dollars (equivalent to 100,000 yuan RMB). The employees' welfare, labor insurance and housing funds account for 60% of their salary.

4) Insurance

The insurance premium refers to fixed asset insurance and other insurance. The insurance premium will be paid based on 2.5‰ of fixed asset value.

5) Material expenses and other expenses

The material expenses are based on US$1.1799/kW and other expenses are based on US$5.8997/kW.

The costs and expenses of the project as shown in Table below:

Table 5-4O &M Cost **Unit：Thousand USD**

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Total	0.0	1404.6	1487.5	2711.9	2687.8	2663.6	2639.4	2615.2	2591.1
Repair	0.0	0.0	0.0	1011.5	1011.5	1011.5	1011.5	1011.5	1011.5
Salary	0.0	354.0	354.0	354.0	354.0	354.0	354.0	354.0	354.0
Insurance	0.0	303.0	285.2	267.3	249.5	231.7	213.9	196.1	178.2
Material	0.0	124.6	124.6	124.6	124.6	124.6	124.6	124.6	124.6
Other	0.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Total	2566.9	2542.7	2830.7	2806.5	2782.3	2758.2	2734.0	2709.8	2685.6
Repair	1011.5	1011.5	1264.4	1264.4	1264.4	1264.4	1264.4	1264.4	1264.4
Salary	354.0	354.0	354.0	354.0	354.0	354.0	354.0	354.0	354.0
Insurance	160.4	142.6	124.8	106.9	89.1	71.3	53.5	35.6	17.8
Material	124.6	124.6	124.6	124.6	124.6	124.6	124.6	124.6	124.6
Other	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0
Year	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	
Total	2674.5	2674.5	2674.5	2674.5	2674.5	2674.5	2674.5	2674.5	
Repair	1264.4	1264.4	1264.4	1264.4	1264.4	1264.4	1264.4	1264.4	
Salary	354.0	354.0	354.0	354.0	354.0	354.0	354.0	354.0	
Insurance	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	
Material	124.6	124.6	124.6	124.6	124.6	124.6	124.6	124.6	
Other	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	

Table 5-5Depreciation Unit：Thousand USD

Year	1	2	3	4	5	6	7	8	9
Depreciation	0	7129	7129	7129	7129	7129	7129	7129	7129
Residual value	128324	121195	114066	106937	99808	92679	85550	78420	71291
Year	10	11	12	13	14	15	16	17	18
Depreciation	7129	7129	7129	7129	7129	7129	7129	7129	7129
Residual value	64162	57033	49904	42775	35646	28517	21387	14258	7129
Year	19	20	21	22	23	24	25	26	
Depreciation	3279	0	0	0	0	0	0	0	3279
Residual value	3850	3850	3850	3850	3850	3850	3850	3850	3850

(4) Tax

The tax involved by the project is corporate income tax, with tax rate of 30%, which applies to all companies.

5.5 COST OF DEBT

The annual repayment of principal and interests are shown in below:

Table 5-6Cost of debt Unit：Thousand USD

Year	1	2	3	4	5	6	7	8
Total	0	7884	7770	7656	7541	7427	7313	7199
Principal	0	5713	5713	5713	5713	5713	5713	5713
Interests	0	2171	2057	1943	1828	1714	1600	1485
Year	9	10	11	12	13	14	15	16
Total	7084	6970	6856	6742	6627	6513	6399	6285
Principal	5713	5713	5713	5713	5713	5713	5713	5713
Interests	1371	1257	1143	1028	914	800	686	571
Year	17	18	19	20				
Total	6170	6056	5942	5828				
Principal	5713	5713	5713	5713				
Interests	457	343	229	114				

5.6 ECONOMIC AND FINANCIAL ANALYSIS

(1)Analysis of repayment ability

The project's fund sources for loan repayment include power generation profit, depreciation expense and short-term loans.

The after-tax profit of the solar power station is a balance of total profit deducted by income tax and offsetting the loss of previous years. No special fund will be considered in the

project's financial evaluation. The after-tax profit, after deducting of public welfare fund and profit payable, shall be undistributed profit, which can be used for loan repayment.

During the repayment of loans for investment on engineering construction, the repayment depreciation will be firstly used for repaying the loans while remaining part will be repaid with undistributed profit.

The calculation shows that, during the whole calculating period, the total undistributed profit is66.0853 million US dollars. The asset-liability ratio within the debt-paying term is high, with maximum up to 85.0% (the first year). The asset-liability ratio after repayment tends to be 0.

Through analysis and calculation, it shows that tax-inclusive on-grid tariff of US$0.070/kWh can ensure the power station's debt-paying capacity. During the debt-paying period, the composite interest coverage ratio and debt service coverage ratio are respectively 7.87 and 1.35, both more than 1. Thus, the project enjoys repayment ability.

(2)Analysis of profitability

Through calculation, the financial internal rate of return for capital fund is 13.66%. The financial internal rate of return for total investment is 6.19% (before tax) and 4.76% (after tax), while the payback period is 13.21 years (before tax) and 14.56 years (after tax).

Based on the analysis, the project enjoys certain earning capacity.

6. FINANCING ARRANGEMENTS AND CASH FLOWS

6.1 SOURCES OF FINANCING

Total static investment of the project is 126,443,456.53 USD, with all the financing cost, the dynamic investment of the project is 128,324,302.95 USD.

Sources of fund: 15% of the static investment is the capital fund, the remaining is from the bank loan. The rate of interest is 2%.

6.2 FINANCIAL VIABILITY

Based on the financial analysis, the net cash flow and Interest Coverage Ratio (ICR) and Debt Service Coverage Ratio (DSCR) of the project are shown in below.

Table 6-1The net cash flow of Singida project Unit: million USD

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Net cash flow		3.26	3.13	2.44	2.46	2.48	2.50	2.51	2.53	2.55	2.57	2.41	2.44
ICR		2.22	2.19	1.76	1.82	1.89	1.96	2.06	2.16	2.29	2.44	2.38	2.60
DSCR		1.41	1.40	1.32	1.33	1.33	1.34	1.35	1.36	1.37	1.37	1.36	1.37
Year	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
Net cash flow	2.47	2.49	2.52	2.55	2.57	1.44	0.47	6.20	6.13	6.07	6.00	5.94	9.72
ICR	2.88	3.24	3.76	4.54	5.83	25.22	78.31						
DSCR	1.38	1.39	1.40	1.41	1.43	1.24	1.08						

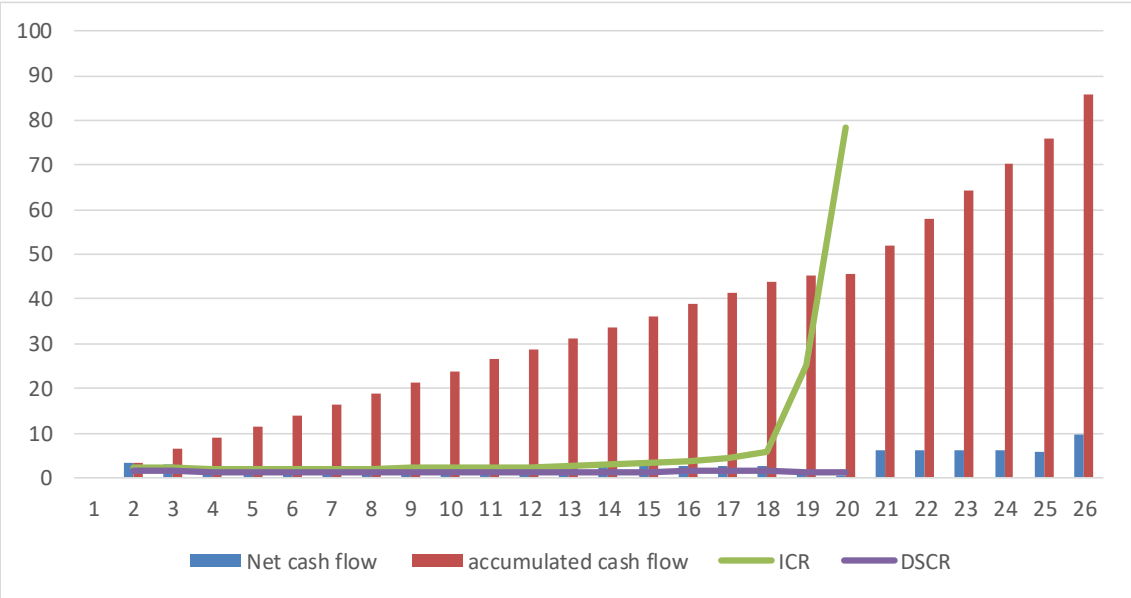


Figure 6-1The net cash flow of Singida project (Unit: million USD)

As can be seen from the table and figure, the net cash flow is always positive and the accumulated surplus therefore keeps increase, which means a financial viability of the project. And both the ICR and DSCR exceeds 1 in the whole payback period, shows an ideal repayment ability.

6.3 LEVELIZED COST OF ELECTRICITY (LCOE)

The LCOE is the total cost of installing and operating a project expressed in dollars per kilowatt-hour of electricity generated by the system over its life. The cost for life time and production can be seen below.

Table 6-2The cost and production Unit: million USD

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
O&M cost	0.00	1.40	1.39	2.38	2.36	2.34	2.33	2.31	2.29
Financing cost	0.00	2.17	2.06	1.94	1.83	1.71	1.60	1.49	1.37
Taxes	0.00	0.79	0.74	0.44	0.45	0.46	0.46	0.47	0.48
Construction	126.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Investment insurance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Financing Management & commitment	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production(GWh)	0.00	190.66	186.08	184.56	183.03	181.50	179.98	178.45	176.93
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
O&M cost	2.27	2.26	2.49	2.47	2.46	2.44	2.42	2.40	2.38
Financing cost	1.26	1.14	1.03	0.91	0.80	0.69	0.57	0.46	0.34
Taxes	0.49	0.49	0.43	0.44	0.45	0.46	0.47	0.48	0.50
Production(GWh)	175.40	173.88	172.45	171.11	169.78	168.45	167.11	165.78	164.44
Year	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	
O&M cost	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	
Financing cost	0.23	0.11	0.00	0.00	0.00	0.00	0.00	0.00	
Taxes	1.66	2.65	2.66	2.63	2.60	2.57	2.54	2.52	
Production(GWh)	163.11	161.77	160.44	159.10	157.77	156.43	155.10	153.76	

Take 2% as the discount rate, the net present value (NPV) for total cost and production is shown below:

Table 6-3The NPV for cost and production Unit: million USD/GWh

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Cost NPV	0.00	10.49	10.16	10.79	10.46	10.13	9.82	9.51	9.21
Production NPV	0.00	186.92	178.85	173.91	169.09	164.39	159.82	155.36	151.01
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Cost NPV	8.92	8.64	8.56	8.29	8.03	7.77	7.52	7.28	7.04
Production NPV	146.77	142.64	138.69	134.92	131.25	127.66	124.17	120.76	117.44
Year	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**Total**
Cost NPV	4.12	1.71	1.60	1.57	1.54	1.51	1.48	1.45	167.58
Production NPV	114.20	111.05	107.97	104.97	102.05	99.20	96.43	93.72	3353.24

Therefore the LOCE equals 4.9976 US cents.

6.4 REVENUE STREAMS

All the Revenue come from the electricity, therefore it can be calculated by times the production with the price of electricity that is 7.0US cents.

The annual revenue of lifetime is shown below:

Table 6-4The Revenue stream Unit: million USD

Year	1	2	3	4	5	6	7	8	9
Revenue	0	13.35	13.03	12.92	12.81	12.71	12.60	12.49	12.39
Year	10	11	12	13	14	15	16	17	18
Revenue	12.28	12.17	12.07	11.98	11.88	11.79	11.70	11.60	11.51
Year	19	20	21	22	23	24	25	26	
Revenue	11.42	11.32	11.23	11.14	11.04	10.95	10.86	10.76	

6.5 EWURA'S REGULATORY AUTHORITY OVER PROJECT TARIFF

1. Indicative Power Generation Tariffs (IPGTs) serve as benchmarks of tariffs for selected large power generation plants (above 10MW). The IPGTs were issued by the Energy and Water Utilities Regulatory Authority (EWURA) for the first time in September 2014. Changes in certain parameters including natural gas prices, capital costs and inflation have necessitated some changes to the IPGTs.

2. The IPGTs are pre-determined tariffs for projects yet to be identified and / or implemented. Thus, the indicative tariffs are meant to provide guidance on possible tariffs for large power plants, given underlying assumptions. The tariffs are premised on cost-reflective principles thereby reflecting justifiable pricing assumptions with a view to minimize cost generalizations. An attempt to capture unique cost characteristics of different

technologies for each resource base has been considered in order to arrive at reasonable indicative tariffs.

3. To determine IPGTs for selected technologies, a Levelised Cost of Electricity (LCOE) methodology has been used. The LCOE is a commonly used methodology and is premised on discounting of project lifetime cash flows which are then divided by the sum of discounted net generated units. Thus, tariffs have been levelised for a period of technology's lifetime.

4. A total of thirteen technologies including Open Cycle Gas Turbine (OCGT), Combined Cycle Gas Turbine (CCGT), Combined Cycle Gas Turbine with Carbon Capture and Storage (CCGT - CCS), Pulverised Coal, Pulverised with Carbon Capture and Storage, Integrated Gasification Combined Cycle (IGCC), hydro, Onshore and Offshore wind, Solar Photovoltaic (solar PV), Solar Thermal, and Flash and Binary geothermal plants, have been analysed.

5. Two scenarios have been considered for each selected technologies in order to capture variability of financial parameters. Scenario I, which is a lower limit, considers lower values of selected financial parameters and Scenario II, an upper limit, takes into account upper values. The two scenarios establish a range of indicative tariffs for each respective technology.

6. It is observed that Indicative tariffs for Solar thermal, Solar PV, Offshore wind and Pulverised-CCS technologies are exemplary high. It is obvious that reflecting the generation costs of such technologies into the existing system would lead to increased cost of generation unless the added plant replaces the more expensive plant or used as peaking plants. The availability and reasonable cost of resources, maturity of technology, and the impacts on the existing system be considered before allowing a certain technology to be implemented.

7. Based on the analysis, recommended indicative tariffs for base load as well as non-dispatchable technologies are as depicted below. Investors with justifiable investment costs be allowed to invest at a capped tariff. Conclusively, it should be noted that the cost competitiveness of electricity generating technologies depends on a number of factors which some are site specific and may vary from time to time, country to country and/or one region to another.

Technology	Scenario I			Scenario II			Range	Cap
	Capacity Cost	Energy Cost	Total	Capacity Cost	Energy Cost	Total		
Dispatchable Technologies								
Hydro	3.57	0.18	3.75	7.08	0.38	7.46	3.71	8.00
Flash-Geothermal	3.04	-	3.04	10.21	-	10.21	7.16	8.50
Binary-Geothermal	4.13	-	4.13	10.29	-	10.29	6.16	9.00
Pulverised Coal	1.10	4.07	5.17	4.21	4.13	8.34	3.17	8.50
OCGT	0.71	6.78	7.49	1.18	7.44	8.62	1.13	8.70
CCGT	0.88	4.80	5.67	2.15	5.455	7.60	1.93	8.00
CCGT-CCS	2.65	4.80	7.44	3.06	5.46	8.52	1.08	8.50
IGCC	4.23	3.86	8.09	6.46	4.14	10.60	2.51	10.60
Pulverised-CCS	5.49	5.96	11.44	8.10	6.61	14.71	3.27	12.50
Non Dispatchable Technologies								
Onshore Wind	-	4.11	4.11	-	11.84	11.84	7.73	7.98
Solar PV	-	5.89	5.89	-	13.32	13.32	7.42	8.00
Offshore Wind	-	8.02	8.02	-	14.49	14.49	6.46	10.00
Solar Thermal	-	9.82	9.82	-	16.08	16.08	6.26	12.00

6.6 PROJECT CASH FLOW FORECAST AND NPV

Based on the revenue and the cost, forecast the cash flow and calculated the annual NPV as shown below.

Table 6-5List for financial planned cash flow Unit: thousand USD

Year	1	2	3	4	5	6	7	8	9
1、inflow	127250	13346	13026	12919	12812	12705	12599	12492	12385
1.1 revenue	0	13346	13026	12919	12812	12705	12599	12492	12385
1.2 residual value recovery	0	0	0	0	0	0	0	0	0
1.3 capital	19773	0	0	0	0	0	0	0	0
construction	18966.52	0	0	0	0	0	0	0	0
investment insurance	0	0	0	0	0	0	0	0	0
M&C fee	806.077	0	0	0	0	0	0	0	0
1.5 Loan	107476.9	0	0	0	0	0	0	0	0
construction	107476.9	0	0	0	0	0	0	0	0
investment insurance	0	0	0	0	0	0	0	0	0
2、outflow	127250	10081	9893	10476	10352	10227	10103	9978	9854
2.1 O&M	0	1405	1387	2380	2363	2345	2327	2309	2291
2.2 capital repayment	0	5713	5713	5713	5713	5713	5713	5713	5713
2.3 interest	0	2171	2057	1943	1828	1714	1600	1485	1371
2.4 tax	0	792	736	440	448	455	463	470	478
2.5 construction	126443.5	0	0	0	0	0	0	0	0
2.6 investment	0	0	0	0	0	0	0	0	0

insurance									
2.7 M&C fee	806.077	0	0	0	0	0	0	0	0
3、Net cash flow	0	3265	3133	2443	2460	2478	2496	2514	2531
NPV	0	3201	3011	2302	2273	2244	2216	2188	2160
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1、inflow	12278	12172	12071	11978	11885	11791	11698	11604	11511
1.1 revenue	12278	12172	12071	11978	11885	11791	11698	11604	11511
1.2 residual value recovery	0	0	0	0	0	0	0	0	0
1.3 capital	0	0	0	0	0	0	0	0	0
construction	0	0	0	0	0	0	0	0	0
investment insurance	0	0	0	0	0	0	0	0	0
M&C fee	0	0	0	0	0	0	0	0	0
1.5 Loan	0	0	0	0	0	0	0	0	0
construction	0	0	0	0	0	0	0	0	0
investment insurance	0	0	0	0	0	0	0	0	0
2、outflow	0	0	0	0	0	0	0	0	0
2.1 O&M	2274	2256	2491	2473	2455	2437	2419	2402	2384
2.2 capital repayment	5713	5713	5713	5713	5713	5713	5713	5713	5713
2.3 interest	1257	1143	1028	914	800	686	571	457	343
2.4 tax	486	493	427	439	450	462	473	485	497
2.5 construction	0	0	0	0	0	0	0	0	0
2.6 investment insurance	0	0	0	0	0	0	0	0	0
2.7 M&C fee	0	0	0	0	0	0	0	0	0
3、Net cash flow	12278	12172	12071	11978	11885	11791	11698	11604	11511
NPV	10274	9985	9709	9445	9187	8936	8692	8453	8221
Year	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	
1、inflow	11417	11324	11231	11137	11044	10950	10857	14613	
1.1 revenue	11417	11324	11231	11137	11044	10950	10857	10764	
1.2 residual value recovery	0	0	0	0	0	0	0	3850	
1.3 capital	0	0	0	0	0	0	0	0	
construction	0	0	0	0	0	0	0	0	
investment insurance	0	0	0	0	0	0	0	0	
M&C fee	0	0	0	0	0	0	0	0	
1.5 Loan	0	0	0	0	0	0	0	0	
construction	0	0	0	0	0	0	0	0	
investment	0	0	0	0	0	0	0	0	

insurance									
2、outflow	0	0	0	0	0	0	0	0	
2.1 O&M	2376	2376	2376	2376	2376	2376	2376	2376	
2.2 capital repayment	5713	5713	0	0	0	0	0	0	
2.3 interest	229	114	0	0	0	0	0	0	
2.4 tax	1660	2650	2656	2628	2600	2572	2544	2516	
2.5 construction	0	0	0	0	0	0	0	0	
2.6 investment insurance	0	0	0	0	0	0	0	0	
2.7 M&C fee	0	0	0	0	0	0	0	0	
3、Net cash flow	11417	11324	11231	11137	11044	10950	10857	14613	
NPV	7994	7773	7558	7348	7144	6944	6750	8907	

6.7 SENSITIVITY ANALYSIS

While measuring the individual change of investment on fixed assets, effective electric quantity, and interest rate change, the result of sensitivity analysis on the project's financial internal rate of return, internal rate of return for capital fund and investment payback period are as shown as below.

Table 6-6List of financial sensitivity analysis

Scheme type	Range of change	Investment payback period (year)(after income tax)	Financial internal rate of return(%)(after income tax)	Financial internal rate of return for capital fund(%)
Analysis on investment change	-10.00%	13.31	5.78%	18.29%
	-5.00%	13.94	5.25%	15.84%
	0.00%	14.56	4.76%	13.66%
	5.00%	15.18	4.30%	11.71%
	10.00%	15.80	3.88%	9.96%
Analysis on output change	-10.00%	16.08	3.69%	9.21%
	-5.00%	15.28	4.23%	11.42%
	0.00%	14.56	4.76%	13.66%
	5.00%	13.91	5.27%	15.93%
	10.00%	13.32	5.77%	18.23%
Analysis on interest rate change	-10.00%	14.57	4.76%	14.22%
	-5.00%	14.57	4.76%	13.94%
	0.00%	14.56	4.76%	13.66%
	5.00%	14.56	4.76%	13.38%
	10.00%	14.56	4.76%	13.11%

7. INTERNAL RATE OF RETURN (IRR) AND WEIGHTED AVERAGE COST OF CAPITAL (WACC)

7.1 ASSUMPTIONS USED TO COMPUTE THE RATIOS

(1) Financing

Total static investment of the project is 126,443,456.53 USD.

Sources of fund: 15% of the static investment is the capital fund, the remaining is from the bank loan. The rate of interest is 2%. The Equal repayment of principal will be adopted and the repayment period is 20years.(including construction period)

For all the loan, there will be management fee with 0.5% rate and commitment fee with 0.5% rate.

With all the financing cost, the dynamic investment of the project is 128,324,302.95 USD.

(2) Operation period is 25 years and the construction period is 1 year.

(3) The cost of loan is 2%, while the cost of capital is 4.6%.

7.2 RESIDUAL VALUE OF PLANT AFTER THE CONTRACT PERIOD

The project's depreciation expense will be calculated based on the power station's value of fixed assets multiplied by composite depreciation rate. The power station's value of fixed assets includes fixed asset investment and interest of construction period, worth of 128,324,302.95 US dollars, which will be based on 18 years of composite depreciation life and 3% of residual value rate.

7.3 ECONOMIC IRR

The cash flow of project investment is shown as below, based on which the project IRR is 6.19% before tax and4.76% after tax.

Table 7-1 Cash flow for the project IRR Unit: thousand USD

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.inflow	0	13346	13026	12919	12812	12705	12599	12492	12385
1.1 revenue	0	13346	13026	12919	12812	12705	12599	12492	**12385**
1.2 residual value recovery	0	0	0	0	0	0	0	0	0
2、outflow	126443	1405	1387	2380	2363	2345	2327	2309	2291
2.1 O&M	0	1405	1387	2380	2363	2345	2327	2309	2291
2.2 Construction	126443	0	0	0	0	0	0	0	0
net cash flow(before tax)	-126443	11941	11639	10538	10449	10361	10272	10183	10094
Adjusted tax	0	-1444	-1353	-1023	-996	-969	-943	-916	-889
net cash flow(after tax)	-126443	10498	10286	9516	9453	9391	9329	9267	9204
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1.inflow	12278	12172	12071	11978	11885	11791	11698	11604	11511
1.1 revenue	12278	12172	12071	11978	11885	11791	11698	11604	11511
1.2 residual value recovery	0	0	0	0	0	0	0	0	0
2、outflow	2274	2256	2491	2473	2455	2437	2419	2402	2384
2.1 O&M	2274	2256	2491	2473	2455	2437	2419	2402	2384
2.2 Construction	0	0	0	0	0	0	0	0	0
net cash flow(before tax)	10005	9916	9581	9505	9429	9354	9278	9203	9127
Adjusted tax	-863	-836	-735	-713	-690	-667	-645	-622	-599
net cash flow(after tax)	9142	9080	8845	8792	8739	8686	8634	8581	8528
Year	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	
1.inflow	11417	11324	11231	11137	11044	10950	10857	14613	
1.1 revenue	11417	11324	11231	11137	11044	10950	10857	10764	
1.2 residual value recovery	0	0	0	0	0	0	0	3850	
2、outflow	2376	2376	2376	2376	2376	2376	2376	2376	
2.1 O&M	2376	2376	2376	2376	2376	2376	2376	2376	
2.2 Construction	0	0	0	0	0	0	0	0	
net cash flow(before tax)	9042	8948	8855	8762	8668	8575	8481	12238	
Adjusted tax	-1729	-2685	-2656	-2628	-2600	-2572	-2544	-2516	
net cash flow(after tax)	7313	6264	6198	6133	6068	6002	5937	9721	

7.4 EQUITY IRR

The cash flow of equity investment is shown as below, based on which the equity IRR is 13.66%.

Table 7-2 Cash flow for the Equity IRR Unit: thousand USD

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.inflow	0	13346	13026	12919	12812	12705	12599	12492	12385
1.1 revenue	0	13346	13026	12919	12812	12705	12599	12492	12385
1.2 residual value recovery	0	0	0	0	0	0	0	0	0
2.outflow	19773	10081	9893	10476	10352	10227	10103	9978	9854
2.1 O&M	0	1405	1387	2380	2363	2345	2327	2309	2291
2.2 Principal repayment	0	5713	5713	5713	5713	5713	5713	5713	5713
2.3 Interests	0	2171	2057	1943	1828	1714	1600	1485	1371
2.4 tax	0	792	736	440	448	455	463	470	478
2.5 Capital	19773	0	0	0	0	0	0	0	0
Net cash flow	-19773	13346	13026	12919	12812	12705	12599	12492	12385
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1.inflow	12278	12172	12071	11978	11885	11791	11698	11604	11511
1.1 revenue	12278	12172	12071	11978	11885	11791	11698	11604	11511
1.2 residual value recovery	0	0	0	0	0	0	0	0	0
2.outflow	9729	9605	9659	9539	9418	9298	9177	9057	8936
2.1 O&M	2274	2256	2491	2473	2455	2437	2419	2402	2384
2.2 Principal repayment	5713	5713	5713	5713	5713	5713	5713	5713	5713
2.3 Interests	1257	1143	1028	914	800	686	571	457	343
2.4 tax	486	493	427	439	450	462	473	485	497
2.5 Capital	0	0	0	0	0	0	0	0	0
Net cash flow	12278	12172	12071	11978	11885	11791	11698	11604	11511
Year	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	
1.inflow	11417	11324	11231	11137	11044	10950	10857	14613	
1.1 revenue	11417	11324	11231	11137	11044	10950	10857	10764	
1.2 residual value recovery	0	0	0	0	0	0	0	3850	
2.outflow	9978	10853	5032	5004	4976	4948	4920	4892	
2.1 O&M	2376	2376	2376	2376	2376	2376	2376	2376	
2.2 Principal repayment	5713	5713	0	0	0	0	0	0	
2.3 Interests	229	114	0	0	0	0	0	0	
2.4 tax	1660	2650	2656	2628	2600	2572	2544	2516	
2.5 Capital	0	0	0	0	0	0	0	0	
Net cash flow	11417	11324	11231	11137	11044	10950	10857	14613	

7.5 FINANCIAL IRR

The cash flow of financial is shown as below, based on which the cost of loan is 2%.

Table 7-3 Cash flow for Financial Unit: thousand USD

Year	1	2	3	4	5	6	7	8
1. inflow	0	7884	7770	7656	7541	7427	7313	7199
1.2 Principal repayment	0	5713	5713	5713	5713	5713	5713	5713
1.3 Interests	0	2171	2057	1943	1828	1714	1600	1485
2 outflow	109626.5	0	0	0	0	0	0	0
Loan for construction	108551.7	0	0	0	0	0	0	0
Loan for insurance	0	0	0	0	0	0	0	0
Interest during construction period	1074.769	0	0	0	0	0	0	0
Net cash flow	-109626	7884	7770	7656	7541	7427	7313	7199
Year	9	10	11	12	13	14	15	16
1. inflow	7084	6970	6856	6742	6627	6513	6399	6285
1.2 Principal repayment	5713	5713	5713	5713	5713	5713	5713	5713
1.3 Interests	1371	1257	1143	1028	914	800	686	571
2 outflow	0	0	0	0	0	0	0	0
Loan for construction	0	0	0	0	0	0	0	0
Loan for insurance	0	0	0	0	0	0	0	0
Interest during construction period	0	0	0	0	0	0	0	0
Net cash flow	7084	6970	6856	6742	6627	6513	6399	6285

7.6 WEIGHTED AVERAGE COST OF CAPITAL

Based on the assumption in section 7.1:

The cost of loan is 2% and the total loan is 108,551,707USD, while the cost of capital is 4.6% and the total capital is 19,772,596 USD, therefore, the WACC can be calculated as 2.40%.

7.7 PROJECT PAYBACK PERIOD

Based on the cash flow for project and equity, the project payback period can be obtained. They are 13.21 year for Project investment (before tax), 14.56 year for Project investment (after tax), 8.39 year for equity investment.

Table 7-4 The payback time unit：million USD

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Project net Cashflow(before tax)	-126.44	11.94	11.64	10.54	10.45	10.36	10.27	10.18	10.09
Accumulated	-126.44	-114.50	-102.86	-92.32	-81.88	-71.51	-61.24	-51.06	-40.97
Project net Cashflow(after tax)	-126.44	10.50	10.29	9.52	9.45	9.39	9.33	9.27	9.20
Accumulated	-126.44	-115.95	-105.66	-96.14	-86.69	-77.30	-67.97	-58.70	-49.50
Equity net Cashflow(after tax)	-19.77	3.26	3.13	2.44	2.46	2.48	2.50	2.51	2.53
Accumulated	-19.77	-16.51	-13.37	-10.93	-8.47	-5.99	-3.50	-0.98	1.55
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Project net Cashflow(before tax)	10.00	9.92	9.58	9.51	9.43	9.35	9.28	9.20	9.13
Accumulated	-30.96	-21.05	-11.47	-1.96	7.47	16.82	26.10	35.30	44.43
Project net Cashflow(after tax)	9.14	9.08	8.85	8.79	8.74	8.69	8.63	8.58	8.53
Accumulated	-40.36	-31.28	-22.43	-13.64	-4.90	3.79	12.42	21.00	29.53
Equity net Cashflow(after tax)	2.55	2.57	2.41	2.44	2.47	2.49	2.52	2.55	2.57
Accumulated	4.10	6.66	9.07	11.51	13.98	16.47	18.99	21.54	24.12
Year	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	
Project net Cashflow(before tax)	9.04	8.95	8.85	8.76	8.67	8.57	8.48	12.24	
Accumulated	53.47	62.42	71.28	80.04	88.71	97.28	105.76	118.00	
Project net Cashflow(after tax)	7.31	6.26	6.20	6.13	6.07	6.00	5.94	9.72	
Accumulated	36.84	43.10	49.30	55.44	61.50	67.51	73.44	83.16	
Equity net Cashflow(after tax)	1.44	0.47	6.20	6.13	6.07	6.00	5.94	9.72	
Accumulated	25.56	26.03	32.22	38.36	44.42	50.43	56.36	66.09	

8. PROJECT RISKS

Understanding and addressing the risks of this EPC project early is important for both the parties. Successful EPC project depends upon fair allocation and distribution of risks and responsibilities between the parties, keeping in view each party's ability to manage them effectively. The table presented in this section identifies most of Project risk within the following broad categories:

- ✧ Financial risk
- ✧ Design risks
- ✧ Construction risks
- ✧ Operating risk
- ✧ Environment risk
- ✧ Other risks

This risk register table has identified a number of major risks and is allocated and/or transferred to counterparty, with a brief note on measures to be taken for the purpose of mitigating, allocating or transferring the risks.

Table 8-1Risk Register

S.No	Risk	Description	Mitigation Measures	Allocation
1. Financial risk				
1)	Financing Closure risk	Sufficient finance will not be available for the project because of changes in market conditions or credit availability resulting in delays in the financial closure or failure of project	The Client shall engage a Financial Advisor right from project initiation stage to ensure that the project become bankable, and actively keep the linkage between the Government of Tanzania, financing institute and Sinohydro.	Client
2)	Exchange rate risk	Devaluation of currency in a foreign currency loan may result in reduction of the ability to repay the loan	A hedging must be arranged to protect from currency devaluation. If the currency value changes between the Term Sheet and Loan Agreement, the loan terms can be changed (market flex). A provision in PPA can stipulate a tariff correlated to the currency of loan.	Borrower (viz. the Client) and Lender
3)	Interest rate risk	Uncertainty of the rate will make the project suffer loss.	The interest rate increase can be contained by fixing the rate, capping it and hedging it. This shall be considered at the Term Sheet negotiation.	Borrower (viz. the Client) and Lender
4)	Price Inflation risk	Price escalation will increase the project cost. In particular, high inflation can result in the increase of the O & M costs.	Once the financial closure is achieved, the project shall commence immediately and completed in time to ensure the operation of the Plant can start as soon as possible. In particular, the O&M contract can be reached with a fixed % indexation/year and the risk of inflation hedged.	O&M Contractor
5)	Violation of Terms	This would result in default by the Lender.	Such risk, particularly related to political and commercial issue will need to be insured in the interest of Borrower, or accepted and managed by the Lender.	Borrower (viz. the Client) and Insurer.
2. Design risks				
6)	Design standards and	Design intent and design standards are not clear.	Coorelation between design standard and End user's	Client

	end users requirements		requirements will be clarified in detailed stage and include any mandatory design criteria.	
7)	Design defects	Design defect in parameters or the very design it self	Perform design audit on the design process by a consultant	Client
8)	EPC Design Efforts	Lack of experience and suitable resource during design activities will lead to errors resulting in an expensive rework.	Due diligence to the designer and design audit on the design process shall be performed by a consultant.	Client
9)	Probable Foreign EPC-Compliance to Tanzanian and International Practices	The EPC offer may be unable to comply with Tanzanian and International practice.	Correlation of EPC Country standards to international/Tanzanian standards and negotiation with EPC ahead of contract signing.	Client and EPC Contractor
3. Construction Risks				
10)	Delay in Land acquisition	Delay in obtaining land use right will result in delay in handover of the access and jobsite to the EPC Contractor	Exclusive land lease agreement with both the Local Government and the private landlord shall be put in place.	Client
11)	EPC Engineering Resources insufficient	EPC engineering resources and skills are insufficient and unable to meet the contract requirement	A Quality Management/Control team shall be put in place. Manpower loading schedule of the EPC Contractor shall be approved.	EPC Contractor
12)	Unforeseen ground/site conditions	During construction, unforeseen ground conditions will lead to cost increase or extension of time.	Detailed geotechnical study shall be performed	Client
13)	Technical risk	Technical availability	The panels and technology to be provided by the Manufacturer. Proven technology, quality components correctly dimensioned	Manufacturer and Client
14)	Cost overrun	Project cost increases beyond estimates.	The EPC Contractor shall enhance the project management ability, and provide the monitoring reports and performance	Manufacturer and EPC Contractor.

			reports. Also, project's budgeted costs will include cost contingency funds and provisional sum.	
15)	Shortage of skilled artisans on EPC side	Lack of skilled artisan resources, particularly the professional personnel including welders, operators, electricians will impact on the project	Ensure that all affected speciality discipline pre-qualification is done early.	EPC Contractor
16)	No sufficient definition of the extent of temporary facilities, logistics routes and temporary access roads.	The extent of temporary facilities, logistics routes and temporary access roads is not well defined and requires further definition.	For all major bulk materials such as the cement, steel, diesel, aggregate, etc., the sources, plant, roads, loading, truck fleets, etc. shall be investigated and supply/service contract signed to ensure the supply of the materials can meet the demand of project.	EPC Contractor
17)	Exceptional weather condition	The exceptional weather condition will affect on the execution of the project, and cause loss/damage to the Contractor	Once it happens, the EPC Contractor shall take all possible measures to mitigate the loss and impact, and retrieve the time lost by the extreme weather. Claim shall be submitted to the insurance company to recover the loss.	EPC Contractor, Insurer
18)	Equipment Delivery Delays	This delay will surely delay in completion of the project, causing the Client's loss revenue.	Design, manufacture, shipment and delivery of the equipment shall be in strict compliance with the project execution schedule. And clauses relating to the delay damages shall be set out in the EPC Contract.	Manufacturer and EPC Contractor
19)	Delay in completion of the project	Many reasons which may cause delay to the completion of the project, resulting in the loss of revenue, and penalty for late completion of project will be applied as per PPA	Penalty clauses shall be set out in the EPC Contract. Completion Guarantees, Monitoring reports, Monthly Performance Reports shall be in place. Actions to be taken shall depend on the specific event.	Manufacturer and EPC Contractor
20)	Quality management	If a quality management culture does not develop, the project may suffer from substandard outputs	Employ Quality Manager and QC inspectors, Project management plan and procedures.	EPC Contractor
21)	Unspecified Work and Variations	Design change or additional work	Carry out the work according to the variation order.	The Client and EPC Contractor

22)	Price escalation	During the period of project execution, the construction cost of EPC Contractor will increase due to the change in market price.	Establish the price adjustment mechanism in the Contract.	The Client and EPC Contractor
23)	Health and Safety risks	This is a major concern during construction.	Active measures shall be taken to minimize the safety accidents on site. Develop and implement safety management plan. Employ safety manager, safety officers, create a project tool box.	EPC Contractor
24)	Shortage of material	Shortage of the construction material such as cement, steel	Source the availability of construction material and sign contract with necessary suppliers	EPC Contractor, Suppliers.
25)	Force Majeure Event, including sabotage, terrorism, strike and lockout, etc.	The events beyond the control of either entity may occur, resulting in a material adverse impact on either party to perform its obligations, delay to stop of completion of project, and loss of revenue. All or parts of the solar park will be subject to sabotage, terrorism or theft and thus generate less electricity than planned.	Stringent security protection measures shall be taken. Political insurance shall be arranged with the special insurance company.	EPC Contractor, The Client
4. Operating risks				
26)	Changes in design required by O & M Contractor	The Operating Contractor may require changes in design to better the performance of the Plant, causing the increase of O/M price.	The O/M Contractor will either be given an opportunity to have any necessary input into the design at an early stage – if necessary, prior to financial close or during the EPC Contractor's design, or a consultant will be employed by the THE CLIENT to ensure that it is confident that operating contractor can operate to a fixed cost on the basis of design.	EPC and Operating Contractor's Risk
27)	Performance risk	The completed facility cannot be effectively operated or maintained to produce the expected capacity, output or efficiency.	Plant or equipment performance warranties and guarantees are required, including liquidated damages for non-performance. The minimum functional specification should include	Manufacturer and the Client

			operating characteristics, including the net capacity and operational criteria.	
28)	Climate and weather risk	Changes in electricity generation due to lack of sunshine, wind condition, temperatures	Appropriate measures to be incorporated in the installation design and insurance to be effected	The Client
29)	Safety operating risks	Accidents occur during the operating stage.	Comply with safety operating manual and compile safety plan, engage safety manager	O/M Contractor
30)	Revenue risk	Declining of market need or electricity rate may result in insufficient income.	Make assessment during feasibility study stage; establish minimum need and minimum price allocation mechanism	Client
5. Environmental risk				
31)		The risks are relating to occurrence of environmental incidents during the course of implementation, operation of the project.	The potential environmental impacts shall be addressed in detail in EIA report and the impacts shall be account in project schedule and cost. Stringent environmental procedures to be followed at construction and operations in accordance with the agreed Environmental action plan.	Client, EPC Contractor and O/M Contractor
6. Other risks				
32)	Development approvals	The approval procedure is complicated relating to many departments and working efficiency is low.	Simplify approval procedure and improve working efficiency	Client
33)	Payment failure by government of Tanzania	Due to income delay or Insufficient Income, the government cannot make payment on time.		Client
34)	Increases in taxes	The change of tax policies may affect the project benefit.	Establish the price adjustment mechanism in the EPC Contract, O/M Contract and PPA	Government and Client.
35)	Changes in law	The current legal/regulatory regime will change, having a material adverse impact on the project.	Establish the price adjustment mechanism in the Contract and PPA	Government and Client.

9. PROJECT AFFORDABILITY

9.1 PROJECT'S COST OF ELECTRICITY

The total cost (including the investment for construction, the O&M cost and the financial cost) of the project is203,587,524.07 USD, while the total production in the lifetime is 4,257,073.44MWh. Therefore, the average cost per unit electricity is 4.7823 US cents.

Considering the time value of the electricity and money, the LOCE is 4.9976 US cents based on the calculation on section 6.3.

With a reasonable expectation of gain for the investment, the final price for the electricity is 7.0 US cents.

9.2 MARKET SENSITIVITY – CAN FINAL CONSUMER/OFFTAKER AFFORD THE CHARGES

A high level assessment of the proposed solar project shows that it is fairly affordable based on the long run marginal cost (LRMC) of the system in the planning horizon from the years 2013 to 2036 provided in the Power System Mater Plan 2012 Update below. It will operationalize by replacing the most expensive technologies or used as a peaking plant. The long run marginal cost will be the basis of setting future tariffs to be used in the system. It can be seen from the table below that the LRMC reaches USc 18.1/kWh in the period 2013 – 2020 which is higher than the proposed tariff of USc 11/kWh.

	Marginal cost Production	Marginal cost Transmission	Marginal cost Distribution	Marginal cost of supply
Period	(US Cents/kWh)	(US Cents/kWh)	(US Cents/kWh)	(US Cents/kWh)
2013 to 2020	14.6	1.3	2.8	18.1
2021 to2036	5.9	0.6	2.8	8.7
2013 to 2036	9.1	0.8	2.8	12.1

Figure 9-1: Solar PV Plant Plan

9.3 TANESCO CONTRIBUTIONS FOR PROJECT VIABILITY

TANESCO will be fully involved during the development and implementation of the project starting with the approval of Feasibility Study Report, Transmission Line Agreement and Interconnection Agreement.

9.3.1 New Transmission Line to connect to the Plant to National Grid

Box-Transformers (0.69/33kV) will be installed near to each turbine with cabling works for interconnection and transmission of power to the High Voltage Step Up Transformer Station located within the farm. For evacuation of power from the project to the National

Grid, a HV Step up Transformer station will be installed within the Solar Farm for stepping up the voltage from 33 kV to 220 kV and finally transmission to the Grid substation located at Singida, some 14 km away. The metering point will be located at the step up transformer located at the Solar Farm and the Interconnection Agreement will be signed between the NDC and TANESCO. The Transmission Line Agreement will also be signed between the NDC and TANESCO for construction of the 220KV line from the Solar Farm to Grid substation located at Singida..

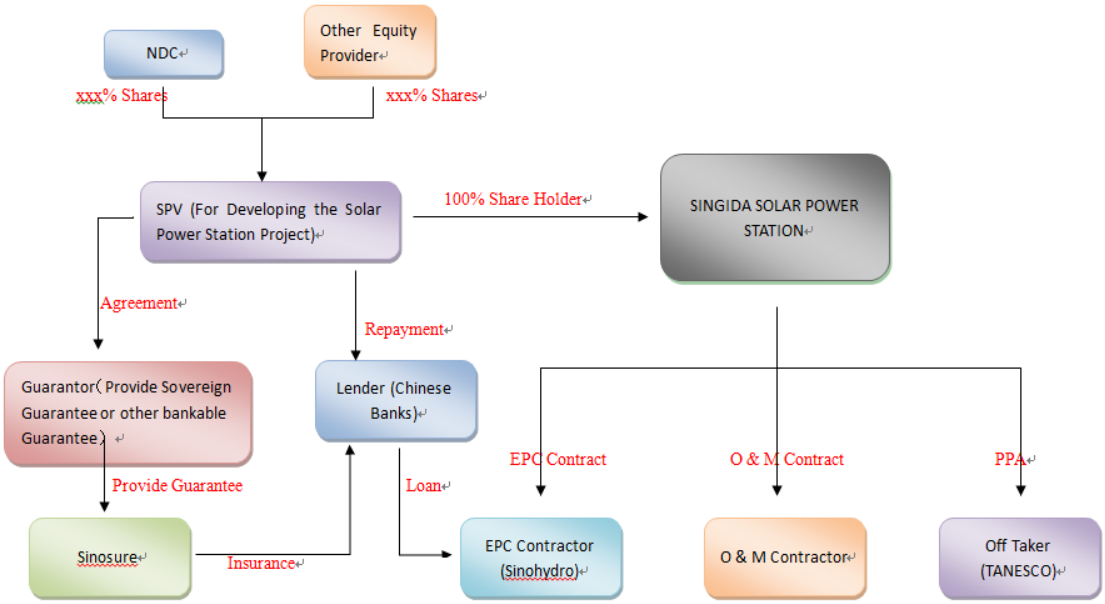
9.3.2 Land Issues

Land issues will be handled by NDC and TANESCO in collaboration with Regional/Municipal Authorities whereby about 150 ha will be acquired for the solar farm after compensation and relocation of project affected people (PAP). Land acquisition will also be arranged for the 220kV Way-leave required for construction of a 220kV Transmission Line to evacuate project power to the National Grid at Singida. The Regional and Municipal Authorities will be fully involved during land acquisition process including arrangement of meetings with villagers, awareness creation, negotiations, compensations and relocation of PAP.

10. GOVERNMENT SUPPORT AND CONTRIBUTIONS

10.1 PROJECT DEVELOPMENT FINANCE

The proposed project structure is as follows:



The proposed financial model is as follows:

Long-term buyer's credit loan(1+19years)

Borrower: NDC (National Development Corporation)

Repayment Payer: NDC(NationalDevelopment corporation)

Lender: ChineseBanks

EPC Contractor: Sinohydro CorporationLimited

Loanamount:85% of the total investment

Guarantor:Tanzania MinistryofFinance

Insurer: Sinosure(it will not be needed for soft loans)

Loan terms: not excess 20years (including 1years of grace period)

The interest and the fees to be discussed after Signing the EPC Contract

10.2 VIABILITY GAP FUNDING

From this proposal, the dynamic investment of the project is 128.324 million USD, 15% ofthe total investment is the capital fund, and the remaining is from the bank loan.

10.3 GOVERNMENT GUARANTEES

The mode of government guarantee is Sovereign Guarantee, or other bankable guarantee.

10.4 ANY OTHER GOVERNMENT SUPPORT NEEDED

The following reviews, permits and approvals will be required during development and implementation of the project:

- ✧ Approval of the Feasibility Study Report by the client
- ✧ Project Approval
- ✧ ESIA Permit including compensation and relocation of project affected people (PAP)
- ✧ Procuring Provisional Generation License by EWURA
- ✧ Signed MOU between NDC and Joint Venture Partner
- ✧ JVA Agreement/Shareholders Agreement
- ✧ Title Deed for the project area
- ✧ Due Diligence to joint venture partner, Financiers, EPC contractor, etc.
- ✧ Approval of the preferred bidder under the International competitive process in the Ministry of Energy
- ✧ Approved Power Purchase Agreement between TANESCO and Joint venture Company
- ✧ Financing Arrangements, including proof of funds such as credit lines, Loan Agreements, etc.
- ✧ Work/Resident Permits for experts, consultants undertaking reviews of studies and construction/commissioning works
- ✧ TRA/TIC Tax exemptions for construction materials

11. VALUE FOR MONEY CONSIDERATIONS

11.1 DESCRIPTION OF LIFETIME VALUE FOR MONEY BENEFITS OF THE PROJECT

The money benefit of Singida project is testified by project payback years and Equity IRR ratio; those two indicators are mostly considered by developers.

The designed running period of the project is 25 years. And Payback Period of Investment for the project is14years ((including 1 year construction period)) and the cumulative cash flow become positive from the 15th year. That is acceptable for loan banks in China. The cumulative of cash flow are as followed in Table 11-1.

Table 11-1The cumulative cash flow (after-tax) of Singida project

Unit: thousand USD

years	cumulative cash flow	years	cumulative cash flow
1	-126,443.46	14	-4,901.38
2	-115,945.76	15	3,785.04
3	-105,659.79	16	12,418.54
4	-96,144.17	17	20,999.12
5	-86,690.82	18	29,526.79
6	-77,299.72	19	36,839.87
7	-67,970.89	20	43,103.74
8	-58,704.32	21	49,302.22
9	-49,500.00	22	55,435.31
10	-40,357.95	23	61,502.99
11	-31,278.16	24	67,505.29
12	-22,432.98	25	73,442.18
13	-13,640.73	26	83,163.42

Based on the financial analysis, the net cash flow and Interest Coverage Ratio (ICR) and Debt Service Coverage Ratio (DSCR) of the project are shown in below.

Chinese Lenders would usually require DSCR be more than 1.2 for all payback years, which is achieved at this 7.0 cent/kwh price level.

The interest coverage ratio (ICR) represents the capability of repaying money to loan banks. It is clear that with the running of the project, ICR increases steadily and average ICR is much bigger than 2 (the lowest requirement of Chinese loan banks).

Table 11-1 the net cash flow of Singida project Unit: million USD

Year	1	2	3	4	5	6	7	8	9	10	11	12	13
Net cash flow		3.26	3.13	2.44	2.46	2.48	2.50	2.51	2.53	2.55	2.57	2.41	2.44
ICR		2.22	2.19	1.76	1.82	1.89	1.96	2.06	2.16	2.29	2.44	2.38	2.60
DSCR		1.41	1.40	1.32	1.33	1.33	1.34	1.35	1.36	1.37	1.37	1.36	1.37

Year	14	15	16	17	18	19	20	21	22	23	24	25	26
Net cash flow	2.47	2.49	2.52	2.55	2.57	1.44	0.47	6.20	6.13	6.07	6.00	5.94	9.72
ICR	2.88	3.24	3.76	4.54	5.83	25.22	78.31						
DSCR	1.38	1.39	1.40	1.41	1.43	1.24	1.08						

The cash flow of equity investment is shown as below, based on which the equity IRR is 13.66%. IRR of the project is positive for the concern of loan banks and developer.

Table 11-2 Cash flow for the Equity IRR Unit: thousand USD

Year	1	2	3	4	5	6	7	8	9
1.inflow	0	13346	13026	12919	12812	12705	12599	12492	12385
1.1 revenue	0	13346	13026	12919	12812	12705	12599	12492	12385
1.2 residual value recovery	0	0	0	0	0	0	0	0	0
2.outflow	19773	10081	9893	10476	10352	10227	10103	9978	9854
2.1 O&M	0	1405	1387	2380	2363	2345	2327	2309	2291
2.2 Principal repayment	0	5713	5713	5713	5713	5713	5713	5713	5713
2.3 Interests	0	2171	2057	1943	1828	1714	1600	1485	1371
2.4 tax	0	792	736	440	448	455	463	470	478
2.5 Capital	19773	0	0	0	0	0	0	0	0
Net cash flow	-19773	13346	13026	12919	12812	12705	12599	12492	12385
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1.inflow	12278	12172	12071	11978	11885	11791	11698	11604	11511
1.1 revenue	12278	12172	12071	11978	11885	11791	11698	11604	11511
1.2 residual value recovery	0	0	0	0	0	0	0	0	0
2.outflow	9729	9605	9659	9539	9418	9298	9177	9057	8936
2.1 O&M	2274	2256	2491	2473	2455	2437	2419	2402	2384
2.2 Principal repayment	5713	5713	5713	5713	5713	5713	5713	5713	5713
2.3 Interests	1257	1143	1028	914	800	686	571	457	343
2.4 tax	486	493	427	439	450	462	473	485	497
2.5 Capital	0	0	0	0	0	0	0	0	0
Net cash flow	12278	12172	12071	11978	11885	11791	11698	11604	11511
Year	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	
1.inflow	11417	11324	11231	11137	11044	10950	10857	14613	
1.1 revenue	11417	11324	11231	11137	11044	10950	10857	10764	
1.2 residual value recovery	0	0	0	0	0	0	0	3850	
2.outflow	9978	10853	5032	5004	4976	4948	4920	4892	
2.1 O&M	2376	2376	2376	2376	2376	2376	2376	2376	
2.2 Principal repayment	5713	5713	0	0	0	0	0	0	
2.3 Interests	229	114	0	0	0	0	0	0	
2.4 tax	1660	2650	2656	2628	2600	2572	2544	2516	
2.5 Capital	0	0	0	0	0	0	0	0	
Net cash flow	11417	11324	11231	11137	11044	10950	10857	14613	

11.2 DESCRIPTION OF VARIOUS OPTIONS TESTED AND JUSTIFICATION FOR THE CHOSEN MODEL OF FINANCING

11.2.1 EPC+ Financing with soft loans

This is a conventional model widely used in African countries.

Conventional Terms and Conditions:

a. Borrower: Government of Tanzania（Ministry of Finance）

b. Lender： The Export-import Bank of China

c. Guarantee: Sovereign Guarantee, without Sinosure

d. Facility Amount: 85%-100% EPC Contract Price

e. Equity: (1) Preferential Buyer's Credit model: 10% - 15% of EPC Contract Price

(2) Chinese Concessional Loan: No need for Equity from Employer

f. Credit Period: 15 years including Grace Period

g. Interest Rate: 1% - 3% (2% is recommended)

***Soft loan refers to Chinese Concessional Loan and Preferential Buyer's Credit. And it is the model between Government and Government**

Key Precedent Conditions for Loan Application:

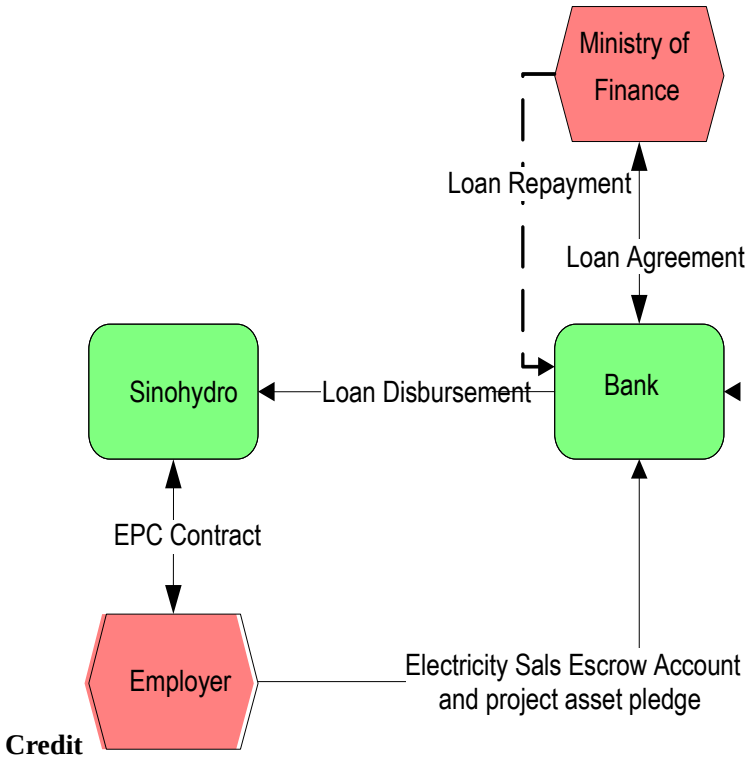
The following are precedent conditions for applying for and securing the loan from Exim Bank on an EPC+ Financing basis:

1) EPC Contract signed by the Employer and Sinohydro;
2) Feasibility study and environmental impact assessment and respective approvals from Authorities;
3) Detailed information about the Employer, including financial statements (if any) for the past 3 years;
4) Detailed information about the Borrower, including financial statements (if any) for the past 3 years;
5) Project introduction including, but not limited to, the project scope, technical data, background, economic benefit analysis, social benefit statement, operation and maintenance plan and other information required by the Lender;
6) Introduction regarding the interconnection grid and the electricity off-takers;
7) Letter of application for the loan;

Additional documents will be required by the Lender after signing the Loan Agreement.

1. Project Development Structure:

Concessional Loan and Preferential Buyer's



2. Project Development Schedule and Requirements:

    1) Exclusive MOU signed between the Employer and Sinohydro;
    2) Establishment of a special team to work with Sinohydroon technical and commercial document preparation and subsequent acquisition of approvals from relevant authorities;
    3) Completion by Sinohydro of the feasibility study or technical & commercial proposals for the Employer's evaluation;
    4) To finish the environmental impact assessment and obtain approval from environmental authority;
    5) Signature of the EPC contract;
    6) Submission by the Ministry of Finance a formal loan application to the Chinese bank with all the approved documentation, including the security package in parallel with arrangement for the down payment from the national budget;
    7) After loan facility agreement signed, become effective and advance payment disbursed, project construction will commence.

3. Time Schedule for Loan Application:

    1) The bank will undertake due diligence for 1 month after receiving acceptable documentation;
    2) The Bank will complete its internal evaluation within another 2-3 months;

3) If the facility amount exceeds USD 100 mil, an additional 2 months or more will be needed for approval by the China Ministry of Finance, China Ministry of Commerce and State Council.

The procedures of the EPC+Financing model with soft loans are recommended. Sinohydro will assist your Ministry to negotiate with the relevant financial institutions.

12. ENVIRONMENTAL ANALYSIS

12.1 TANZANIA ENVIRONMENTAL REGULATIONS

This section focuses on various policies which guide sustainable development vision which is mainly set in the National Environmental Policy, 1997 but have filtered through to the other sectors especially those governing natural resources access and utilization.

The national policies that address environmental management as far as this project is concerned and which form the corner stone of the present study include the following:

National Environmental Policy 1997

The NEP appropriately sets broad goals committing Tanzania to sustainable development of its natural resources heritage. The policy provides the framework for the formulation of plans, programs and guidelines for the achievement of sustainable development. The key objectives of the policy are to:

- ✧ Ensure sustainability, security and equity in the use of resources;
- ✧ Prevent and control degradation of life supporting land, water, vegetation and air;
- ✧ Conserve and enhance natural and man-made heritage;
- ✧ Improve the condition and productivity of degraded areas;
- ✧ Raise environmental awareness and promote public participation;
- ✧ Promote international co-operation on the environmental agenda.

The policy promotes the use of EIA as a planning tool to integrate environmental issues into the planning process, the implementation of the "polluter pays" principle and the use of precautionary principle (i.e., it is better to be roughly right in time, than to be precisely right too late). It also stipulates the use of numerous approaches in environmental management in Tanzania including; use of economic instruments, development of environmental standards/ indicators and their use, and that environmental legislation is an essential component of effective environmental management. The policy contends that "one of the corner stones of the EIA process will be the institution of public consultations and public hearings in the EIA procedures".

The policy identifies Environmental Impact Assessment as one of its instruments of implementation and makes it a mandatory condition for projects and especially nature of this project which is listed in the Third Schedule of the Act, before the final decision is made hence the reason for conducting this study.

Energy Policy of Tanzania 1997

The main purpose of the energy policy of Tanzania is to provide an input into the development

process of the country through establishment of an efficient energy production, procurement, transport, distribution, and end-use system in an environmentally sound manner and with due regard to gender issues. The Energy policy recognizes the increasing demand for natural forests as a major source of firewood and charcoal mainly for cooking, which is leading to serious deforestation and environmental degradation. Therefore the policy emphasizes the need to identify economically and financially cost effective methods for meeting the energy demand. The proposed project of power generation will enhance gird network expansion as it will be connected to the nearest substation, hence reduction of environmental degradation and deforestation among other advantages.

National Land Policy 1997

The National Land Policy among other-things advocates the protection of land resources from degradation for sustainable development. The policy addresses several environmental issues such as land use planning, which takes into consideration the land capability, ensures proper management of land resources, promote resource sharing and multiple land use techniques in area of conflict land use and lastly involves community in resource management, land use and conflict resolution. The legal acquisition procedures for the land will be done in later stages of the project and the resettlement of PAPs will be followed as guided by the policy. The changes of land use to allow establishment of solar plant and the passage of transmission lines and way leaves together with right of way will also follow guidelines from this policy. Moreover land ownership patterns in the proposed project areas are likely to change with the undertaking of the project. Changes in ownership rights will be guided by this policy.

National Water Policy 2002

The main objective of the National Water Policy of 2002 is to develop a comprehensive framework for sustainable development and management of the nation's water resources and putting in place an effective legal and institutional framework for its implementation. The policy aims at ensuring that beneficiaries participate fully in all stages of water resource management. The Policy recognizes the fundamental but intricate linkages between water and socio-economic development, including environmental requirements. The Policy expounds on the importance of water for domestic use, agriculture, livestock keeping, mining, energy, fisheries, environment, human health, wildlife and tourism, forestry, navigation and trans-boundary requirements. In view of this, the Policy calls for an Integrated Water Resource Management approach in Tanzania so that “there is equitable and sustainable use and management of water resources for socio-economic development, and for maintenance of the environment. The project proponent will adhere to the conservation and management of these

sources of water.

National Investment Promotion Policy 1996

National Investment Promotion Policy has stressed the need for modernization of equipment and technological upgrading of processes so as to enable optimal use of available resources, improved efficiency operation, importance of exploiting local natural resources, the need to promote indigenous participation in economic development of our nation and provide incentives to encourage private sector investment. Additional of solar power to the national grid will boost the grid capacity hence other investors like TANESCO and REA will be able to pull the power and supply to the villages. Provision of electricity to the villages along the distribution lines will support social-economic development e.g. operation of small industries like saw mills, grain mills and other small businesses which need electricity, thus encouraging investment and adhering to this policy.

Tanzania Development Vision 2025

The National Vision 2025 foresees the alleviation of widespread poverty through improved socio-economic opportunities, good governance, transparency and improved public sector performance. Their objectives do not only deal with economic issues, but also include social challenges such as education, health, sources of energy, the environment and increasing involvement of the people in working for their own development. The Vision stipulates the desirable condition or situation that is envisaged by the government and people of Tanzania. The Vision 2025 seeks to mobilize the people and resources of the nation towards achievement of shared goals and achieving sustainable semi-industrialized middle market economy by year 2025. The rural electrification project is contributing towards realization of the objectives of the 2025 goals as with the supply of electricity to the villages will improve the livelihoods of the local communities through direct and indirect employment opportunities and hence contributing to national GDP.

National Strategy for Growth and Reduction of Poverty

The strategy is viewed as an instrument for channelling national efforts towards broadly agreed objectives and specific inputs and outputs. The National strategy is to a large extent, an integral part of on-going macro-economic and structural reforms. Among the areas of the concentration is achieving the target of accelerated growth that requires significant efforts by different stakeholders to enhance productivity and increase investment in both human and physical capital. The proposed grid extension and distribution network project is conforming with the strategy as with supply of electricity in the villages will accelerate the rate of economic development, provide direct and indirect opportunities for poverty reduction.

National Employment Policy (1997)

The major aim of this policy is to promote employment mainly of Tanzania Nationals. Relevant sections of this policy are (i) 10 which lays down strategies for promoting employment. Section 10.1 is particularly focusing on industry and trade sectors; section (ii) 10.6 deals with employment of special groups i.e. women, youths, persons with disabilities and section (iii) 10.8 deals with tendencies of private sectors/ contractors employing expatriates although there might be equally competent nationals. NDC and Sino Hydro adhere to observing the above policy requirements in undertaking the project.

12.2 PROJECT SOCIAL AND ENVIRONMENTAL IMPACTS EVALUATION

The project has both potential negative and positive impacts that have been identified and assessed based on professional experience, consultations with stakeholders, modeling, and legal requirements. The project is compatible to various national policies that aim to stimulate economic growth, and, most importantly, impart modern technology in farming to boost development to local communities. However, the NDC and SINOHYDRO management should develop an environmental management plan to ensure that implementation of Solar PV Plant do not impair the surrounding environment.

The project has high socio-economic benefits to the proposed area, surrounding communities, Singida region, and Tanzanian society at large through promoting grid support which may result in a more secure energy supply for energy users in the local area, as a generating facility increases the locality's priority distribution network and therefore potentially reduces the risks of future load shedding in the area.

Potential negative impacts identified are manageable through the proposed EMP. The NDC and SINOHYDRO committed to implement this project in an environmentally sustainable manner, which has been demonstrated through various activities implemented at site and surrounding communities through the pilot study. In so doing, the proposed environmental management plans are geared to ensure that the project activities are conducted in compliance with the country's environmental requirements with internationally accepted good practices.

In conclusion, the proposed project should be allowed to proceed as the identified impacts will be managed by the proposed EMP making it possible to realize the benefits of the project.

12.3 ENVIRONMENTAL AND SOCIAL MONITORING PLAN

The significance of an environmental monitoring plan is to provide room for assessing the accuracy of assessed impacts, implemented mitigation measures and to allow for prompt

corrective action to be taken to correct deviations in the impacts that might have been overlooked during the EIA so that appropriate mitigation measures are put in place to ensure efficiency and sustainability.

RESPONSIBILITIES FOR MONITORING

The responsibilities of monitoring lie with different positions within the organization however the lead SHE Personnel of Sinohydro or TANESCO &NDC will be responsible for coordination and ensuring implementation. General environmental monitoring will be the responsibility of the environment section or appointed and will be responsible for interpretation, storage and reporting of its data and will submit to the NEMC on a frequent basis to allow for inclusion in the site monitoring report.

MONITORING PROTOCOLS

Sinohydro or TANESCO &NDC management will prepare monitoring procedure for each individual environmental setting as per local and international acceptable standards. This will ensure that Monitoring plan for the given mitigation measures are accurately and properly done. The procedure will detail of the attributes to be monitored, frequency, and institutional responsibility.

ASPECTS OF ENVIRONMENTAL MONITORING SYSTEM

In order to meet the objectives of the ESMP which are to minimize the adverse impacts of the project as low as practicable with the current best practice, local conditions and in a cost effective manner, the monitoring program will include the below aspects of the physical, biological and social environment:

- ✧ **Water Resources:** Water quantity and quality, Water abstraction and usage, Storm water quality
- ✧ **Operations Aspects:** Health and safety data, visitor's management, handling and storage of finished goods, different types of wastes generated, treated, recycled and disposed, environmental training, Incidences and potential incidences of environmental risks e.g. worker's injuries, noise impact, unpermitted land disturbance.

MONITORING SCHEDULE

Frequencies of monitoring are originally based on the regulatory requirements and best practice and will be reviewed periodically upon assessment of the gathered monitoring data. The system includes the relevant parameters; namely, monitoring frequency, sampling area, measurements and measuring devices, as well as target levels or standards to be achieved. To ensure effective implementation, roles and responsibilities for monitoring and management of collected data have also been included.

QUALITY CONTROL AND QUALITY ASSURANCE

The data and information gathered should have a high as possible level of confidence. This will be achieved by

- ✧ Use of personnel with the relevant qualifications and training
- ✧ Use of appropriate methodologies, best available technology and equipment suitable for local conditions.
- ✧ Maintenance of equipment in good working order by ensuring that they are timely calibrated, serviced and properly used
- ✧ Have a monitoring procedure including the monitoring protocol
- ✧ Putting in place a system for information storage and back up that will ensure its integrity is maintained within the required retention periods and can be easily retrieved for use
- ✧ Use of recognised or accredited third party laboratory facilities for water and soil samples
- ✧ Applying resampling, field blanks, trip blanks, multiple personnel and independent/third party monitoring
- ✧ Constantly Checking of the data and comparing with historical records and baseline
- ✧ Where appropriate using statistical methods to verify the confidence of the data

PROPOSED IMPLEMENTING THE MONITORING SYSTEM

A number of activities will be required to enable the company implementation of the monitoring system. The table below show those activities which need to be monitored during the whole project phase.

Table 12-1 Environmental Monitoring Plan

Potential Impacts	Parameter for Monitoring	Monitoring Frequency	Monitoring Area	Measurement Unit	Target level/ Standard	Responsibility	Estimated Cost
Generation of employment to local community	• Number of casual labor employed • Succession plan to senior people • Generated business to support operations	Monthly	Onsite	Number	As much as possible to empower local community	Sinohydro and or NDC	NA
Occupational health and safety impacts – personal injuries	Record of injuries/accident/near miss and work related diseases	Continuous	On site	OSHA specific units	Zero accident/incident or injury	Sinohydro and or NDC	1,000,000
Fire and Explosion Risk Monitoring	All electrical appliances and connections such as switches, panel boxes, the Electronic Data Verification System and other equipment.	As per operational requirements	On site and TL	-	Zero	Sinohydro and or NDC	500,000

Potential Impacts	Parameter for Monitoring	Monitoring Frequency	Monitoring Area	Measurement Unit	Target level/ Standard	Responsibility	Estimated Cost
Fire extinguishers	Availability and Expire dates and if they are checked on time.	Once after three months	On site	Tagging	To be checked and updated	Sinohydro and or NDC /Fire team	500,000
Waste management	Amount of water generated, returned to supplier, re-used, recycled and land disposal amount of wastes	Continuous	Onsite	Kg and numbers	As minimal as possible	Sinohydro and or NDC	5,000,000
Water Quality (human consumption)	Quality will be check based on all parameters as per standards for human consumption.	Monthly basis during the wet seasons	Retention pond and if available Upstream and downstream of the creek drain from site.	As stated in manual	As minimum as possible	Sinohydro and or NDC	1,000,000
		After 3 months during the dry season	Plant and or Community boreholes	As stated in manual	As minimum as possible	Sinohydro and or NDC	1,000,000

Potential Impacts	Parameter for Monitoring	Monitoring Frequency	Monitoring Area	Measurement Unit	Target level/ Standard	Responsibility	Estimated Cost
Water Quantity (from site borehole or and retention ponds)	Quantity from site boreholes which will be used for factory activities, amount of water harvested from rainfall and recycled water storage	Daily	At the point of intake	litres	As permitted by license and maximize the recycled water available	Sinohydro and or NDC	500,000
						ESTIMATED MONITORING COST (TZS)	**9,500,000**

13. ECONOMIC AND SOCIAL ISSUES

13.1 COST BENEFIT ANALYSIS

The total cost of Singida project is128,324,302.95 USD for the initial investment, then the O&M cost and financial cost in the operational period.

The benefits to the society include the electricity, and the incoming tax.

Based on information from section 9.2, the marginal cost is 18.1 USc/kWh in the period 2013 – 2020, which will be taken as the benefits to the society.

Based on the assumption above, the cash flow is calculation as the table below:

Table 13-1 Cash flow for the Cost Benefit Analysis

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
inflow		14138	13762	13359	13260	13161	13061	12962	12863
Revenue	0	13346	13026	12919	12812	12705	12599	12492	12385
Tax	0	792	736	440	448	455	463	470	478
outflow	128324	3576	3444	4323	4191	4059	3927	3795	3663
O&M cost	0	1405	1387	2380	2363	2345	2327	2309	2291
Interests	0	2171	2057	1943	1828	1714	1600	1485	1371
Capital	19772.6	0	0	0	0	0	0	0	0
Loan	108551.7	0	0	0	0	0	0	0	0
net cash flow	-128324	10563	10318	9036	9069	9102	9135	9168	9201
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
inflow	12764	12665	12498	12417	12335	12253	12171	12089	12007
Revenue	12278	12172	12071	11978	11885	11791	11698	11604	11511
Tax	486	493	427	439	450	462	473	485	497
outflow	3530	3398	3519	3387	3255	3123	2991	2859	2727
O&M cost	2274	2256	2491	2473	2455	2437	2419	2402	2384
Interests	1257	1143	1028	914	800	686	571	457	343
Capital	0	0	0	0	0	0	0	0	0
Loan	0	0	0	0	0	0	0	0	0
net cash flow	9233	9266	8979	9029	9080	9130	9180	9231	9281
Year	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	
inflow	13078	13974	13887	13766	13644	13523	13401	13280	
Revenue	11417	11324	11231	11137	11044	10950	10857	10764	
Tax	1660	2650	2656	2628	2600	2572	2544	2516	
outflow	2604	2490	2376	2376	2376	2376	2376	2376	
O&M cost	2376	2376	2376	2376	2376	2376	2376	2376	
Interests	229	114	0	0	0	0	0	0	
Capital	0	0	0	0	0	0	0	0	
Loan	0	0	0	0	0	0	0	0	
net cash flow	10473	11484	11511	11390	11269	11147	11026	10904	

According to the table 13-1, the IRR will reach 5.64%, and the accumulated NPV is 61,909,602.22 USD if taking a discount rate of 2%.

13.2 ECONOMIC BENEFITS TO SOCIETY

13.2.1. With Project

The project enjoys favorable conditions in construction. The operation of the project will produce potential benefit to improving the district's energy utilization structure, driving the growth of local economy, pushing forward the sustainable development of social economy.

(1) Driving the economic development of local area

To accelerate the project's construction is conducive to the vigorous development of relevant industries of local area and promoting the employment and development of tertiary industry.

(2) Helping improving the power supply capacity of Tanzanian power grid

The project's annual on-grid electric quantity is 170282.94MWh, which is complementary with hydropower to each other. It can ease the current short power supply in Tanzania.

(3) The construction of solar power station can coordinate with environmental protection

The exploitation of utilization of solar energy resource can reduce the consumption to fossil energy from national economy, decrease the emission of exhaust gas and help promote the coordinated development between economy and environmental protection.

13.2.2. Without Project

If there is no Singida project, some other power plant is required to compensate the lack of electricity that originally generated by Singida solar power plant. Usually a hydro power plant or a thermal power plant is possible solution. However, considering the long construction period, potential conflict on international river and seasonal variation of water resource, it will face some difficulties for hydro power plant option. With a notable amount of coal reserves, the low exploit ability limit the installed capacity of coal-fired power plant. Therefore, it will take long time to meet the requirement of electricity if the Singida project is delayed

14. CLEARANCES

The following permits and approvals will be required before Financial Close:

- ✧ Approval of Feasibility Study Report
- ✧ Approval of ESIA Report
- ✧ TIC Certificate of Incentive
- ✧ Provisional Generation License
- ✧ Land Right for project area
- ✧ Topographical land survey for approved layout plan
- ✧ Signed EPC Contract
- ✧ Power Purchase Agreement (PPA)
- ✧ Interconnection Agreement
- ✧ Transmission Line Agreement
- ✧ Financing Arrangements and proof of funds for project implementation e.g. lines of credit, loan agreements, equity funds, etc.
- ✧ Work permits for experts
- ✧ TRA/TIC Tax exemptions for construction materials

15. ATTACHMENTS

- MEorandum of Understanding between parties
- Certificate of Occupancy – Title deed for the land
- GRID INTEGRATION STUDY FOR 105 MW SINGIDA SOLAR GENERATION FACILITY

REPORT ON THE ASSESSMENT OF SOLAR ENERGY POTENTIAL RESOURCES IN UNYIANGA VILLAGE SINGIDA REGION-TANZANIA

PREPARED BY:

SINO-HYDRO TANZANIA LIMITED

Executive Summary

Solar energy resource has a crucial role in providing clean, sustainable and improved energy services. Thus, the main objective of this assignment was to assess the Solar Energy potential and Economic in Unyianga village in Singida Region. The output from the study is data and figures indicating potential solar insolation in the proposed area.

The field measurement was conducted in the proposed site using Solarimeter (Electrocorder, PV-3). Visualization of solar energy potential was achieved using ArcGIS 10.1 software deploying Kriging numerical solver and Hommer software.

The data obtained from indicated that Solar Potential at Unyianga village is ranging 28,346 and 47,853 $Wh/m^2/day$

Further analysis of the data revealed that the unit generation cost from PV farm at the proposed area based on 100 MW plant ranges between 0.058 and 0.078 USD/kWh. Additionally, the calculated simple payback period ranged from 6 to 8 years at Feed-In-Tariff (FIT) of 0.08 USD/kWh against Standardized Power Purchase Tariff of 197.31 Tsh/kWh (0.12 USD/kWh) approved by EWURA on July 2014.

LIST OF ACRONYMS

EP	Economical Potential
EWURA	Energy and Water Utilities Regulatory Authority
FIT	Feed-In-Tariff
kWh	Kilo Watt hour
MW	Megawatt
PV	Photovoltaic
SPP	Simple Payback Period
USD	United States Dollar

Table of Contents

Executive Summary 1
LIST OF ACRONYMS 2
Table of Contents 3
1 INTRODUCTION 4
1.1 Background 4
1.2 Objectives of the Study 4
1.3 Scope of the Work 4
2 METHODOLOGY 5
2.1 Study Area 5
2.2 Solar Radiation Data 5
2.3 Selection of Solar Technologies 6
2.4 PV Plant/Farm Site Suitability 7
2.5 Assessing the Solar Radiation for Unyianga village in Singida Region 7
2.6 Evaluating Geographical Potential 7
2.7 Evaluating Technical Potential 7
2.8 Assessing Economic Potential 8
3 RESULTS AND DISCUSSIONS 8
3.1 Introduction 8
3.2 Solar Radiation 9
3.3 Economical Potential 15
3.4 Sensitivity Analysis and Data Quality 15
3.5 Performance ratio for an analysis at Unyianga Village. 15
4 CONCLUSIONS AND RECOMMENDATIONS 16
4.1 Conclusions 16
4.2 Recommendations 16

1 INTRODUCTION

1.1 Background

Tanzania is endowed with a number of energy resources including solar, biomass, hydropower, geothermal , wind etc. In order to construct power PV plant it is proposed to have ground solar radiation measurement for at least one year which will lead in the power plant sizing and economic analysis. Other analysis such as techno-economic for large scale power generation is still unknown. In most cases,analyses on technology and economic aspects provide extensive guidance on making decision for investment.

Generally there are three evaluation categories for assessing solar energy potential of a particular location. These categories include evaluation of

1. Geographical potential,
2. Technical potential and
3. Economic potential.

The geographical potential refers to total annual solar radiation over the area excluding constrained areas such as game reserves, national parks and water bodies. Technical potential refers to total geographical potential that can be converted to useful energy such as electricity and heat. The amount of technical potential depends highly on the efficiency of the technology deployed for utilization of solar energy. While economic potentail expresses the total technical potential that can be generated at competitive cost with respect to alternatives sources.

This report provides analyses on solar energy resources in Unyianga Village at Singida Region detailing geographical, technical and economical requirements.

1.2 Objectives of the Study

The main objective of this work is to assess solar energy potential resources for power generation at Unyianga village in Singida region.

In achieving the main objective, the following are specific objectives:

(i) Determine Geographical potential;
(ii) Determine Technical potential and;
(iii) Determine Economic potential.

1.3 Scope of the Work

A comprehensive analysis would be very expensive and time consuming. Because of this aspects, a number of simplications have been considered and consequently a scope of this work drawn. The scope of this assignment is limited to:

(i) Desk study for reviewing relevant documents
(ii) Field survey for spot measurement of solar radiation
(iii) Development of diagram of solar energy potential at the proposed site.

2 METHODOLOGY

2.1 Study Area

The study area is located in Singida region in Tanzania Eastern Africa between Longitude 33^{o} and 35^{o} East and between Latitude 0.4^{o} and 0.6^{o} South as shown in Figure 2.1. The total area of the study area is 560 Hectares.



Figure 2.1: Geographical map of Tanzania showing Singida region

2.2 Solar Radiation Data

Solar radiation data deployed for this assignment were obtained from two sources, namely i.e field measurement from the proposed site and from literature.

Data acquisition for solar radiation during field measurent were recorded at 1.2 m high from the ground using solarimeter of the Electrocorder, PV-3 model as shown in Figure 2.1. Data logging was set at an interval of 10 minutes for 365 consecutive days. The PV-3 was capable of measuring solar radiation ranging 0-1500 W.m^{-2} with accuracy of $\pm$5 % of the full scale.



Figure 2.2: Set-up for solar radiation measurement using solarimeter

2.3 Selection of Solar Technologies

Solar energy is utilized through Solar thermal and Photovoltaic (PV) technologies for various applications. Solar thermal generates heat energy which is useful for water heating, space heating and cooling, drying of agricultural and other products, thermal processing as well as power generation using steam turbines. The PV technology converts solar radiation into electricity using solar array. Generally, PV technologies have been recognised to have minimum environmental impact as they are clean and silent

compared to solar thermal. Therefore, the PV technologies are chosen for evaluating the solar energy potential at the proposed site.

2.4 PV Plant/Farm Site Suitability

Solar site suitability for large PV farms is determined by three factors detailed in Table 2.1 which are: Technical, Economical and Environmental. These factors depend on the geographical location, biophysical attributes and socio-economical infrastructure of the country under study.

Table 2.2: Classification of factors affecting optimum locations for large PV farms

Technical	Economical	Environmental
Solar Radiation	Grid proximity	Sensitive areas
Land Accessibility	Land slope	Hydrographic line
Land use	Load poles	Sand/dust risk

In general, PV farms are particularly suitable where the insolation is high and the location is in close proximity to the existing grid thus, reducing significantly transmission losses. The distance from the grid connection i.e. TANESCO Substation to the proposed site is approximately fifteen (15) kilometres.

2.5 Assessing the Solar Radiation for Unyianga village in Singida Region

Assessing the solar potential in the proposed area was measured using Electro coder PV-3 Solarimeter. Furthermore analysis was performed using Hommer Software.

In this assignment, the annual solar radiation data were calculated based on the ground measurement taken for 365 days.

2.6 Evaluating Geographical Potential

Determination of geographical potential of solar energy involves identification of suitable land areas for PV power generation. Unyianga village is categorised as built-up. In this study, the geographical potential was determined using Equation bellow.

$$GP = \mathrm{SR} \times \mathrm{CA} \times \mathrm{AF}$$

Where SR is the solar radiation received per horizontal surface area (GWh/km^2/year), CA is the calculated total area (km^2) and AF is the factor for solar exploitable area which is 0.06.

2.7 Evaluating Technical Potential

Technical potential analysis involved determining the available solar energy based on the efficiency of the PV systems. Untill recent, the efficiency of various PV technologies range between 7.9 % and 45 % . In this study, the technical potential was determined using bellow equation.

$$TP = \mathrm{GP} \times \eta$$

Where GP is the geographical potential and η is the efficiency of the PV systems which was taken as 0.15 based on the performance of mono-crystaline module .

2.8 Assessing Economic Potential

Economic potential of solar energy was conducted to provide guidance as the feasibility of the PV systems. Distribution of solar PV system cost was established taking into account the cost of alternative systems. The unit cost of the power generation, P_{C_i}, in location i, was calculated using Equation bellow. The investment cost is estimated to be 1,500,000 USD/MW at the proposed site.

$$P_{C_i} = \frac{L + C_{o\&m}}{E_i}$$

$$L = I \frac{r(1+r)^N}{(1+r)^N - 1}$$

Where I is the initial investment, assumed to be a loan from bank; L is the annual loan payment, E_i is the energy yield in location i,r is the discount rate, assumed to be constant and taken to be r=0.10 and N is the life time of the PV system set to be 25 years.

The unit cost analysis intended to focus on cost maximization and to respond on:

(i) How much solar energy is available at or below a given price;

(ii) For a given desired installed capacity, how much will the delivered energy cost?

The Financial and Economic feasibility of the PV investment at Unyianga area have been assessed using the Simple Payback Period (SPP) method. This method provides information on the risk and uncertainty of project investment in terms of time.

$$SPP_i = \frac{I}{B_n}$$

Where B_n is the annual income from PV production for the n^{th} year obtained by multiplying the annual output energy and the Feed-In-Tariff (FIT). The FIT considered in this study was 0.080 USD/kWh against 197.31 Tsh/kWh (0.12 USD/kWh) approved by EWURA on July 2014.

3 RESULTS AND DISCUSSIONS

3.1 Introduction

This chapter presents the results for the assessment and measurement of solar Energy Potential at Unyianga Village in Singida region. Data's are presented as well as on daily basis at the interval of ten minutes. Data's were recorded from early in the Morning at 500AM to 1830PM. Major Findings from data shows that the there exists solar energy potential in the proposed area.

3.2 Solar Radiation

The availability of solar energy in Unyianga village in Singida Region is presented in terms of monthly and annual solar radiation. Table 3.1 Summarizes the amount of Solar Radiation in W/m2 as measured from 5:00AM to 1830PM for the period of one year.

Table 3.1: Summary of Solar Radiation measuered at the period of one year at Unyianga village in Singida region.

Month	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Time	Watt/ Square meter (W/m2)											
5:00:00 AM	0	0	0	0	0	0	0	0	0	0	0	0
5:10:00 AM	0	0	0	0	0	0	0	0	0	0.3	0.3	0
5:20:00 AM	0	0	0	0	0	0	0	0	0	4.5	2.1	0
5:30:00 AM	0	0.3	0	0	0.2	0	0	0	3.3	13.7	4.6	0
5:40:00 AM	3.3	4.1	2.8	0	4.8	0.3	0	2.3	9.7	25.8	15.6	0
5:50:00 AM	9.9	10.3	11.1	1.5	9.4	6.3	3.2	6.9	17	44.5	22.1	8.3
6:00:00 AM	16.6	17.7	19.5	9.5	16.2	13.3	9.1	12.1	36.6	71.1	13.7	46.7
6:10:00 AM	30.4	35.4	34.9	17.8	33.7	22	15.5	23.8	69	105.3	15.5	93.1
6:20:00 AM	61.1	70.6	61	32.4	63.8	43.8	33.2	49.5	108.2	135.6	16.7	137.2
6:30:00 AM	106.1	126.5	99.7	59.7	109.8	78.6	63.1	87	143.6	168.6	37.1	175.3
6:40:00 AM	154.6	175.1	145.2	93.3	147.7	120	101.8	125.6	177.2	204.6	45.7	212.5
6:50:00 AM	188.2	212.5	188.4	127.7	183.6	153.9	139.1	158.8	215.9	243.8	76.6	255.9
7:00:00 AM	243	233.2	229.9	174.3	225	188	173.7	190.6	259	282	100.9	300
7:10:00 AM	286.5	276	276.8	235.1	262.2	223.3	210.7	225.7	301.6	316.7	170.9	343.9
7:20:00 AM	332.5	321.4	319.7	267	300.4	260.4	247.8	264.5	345.6	352.4	158.8	385.6
7:30:00 AM	375.3	367.5	365.8	301.6	341.8	297.5	288	305.9	390.1	402.9	118.3	427.4
7:40:00 AM	418.5	410.4	408.4	267.2	383	334.3	327.1	348.1	432	450	107.8	468.3
7:50:00 AM	460.4	457	454.2	311.3	432.3	370.8	365.8	389.5	472.4	530	154.5	508.9
8:00:00 AM	503.1	500.4	496	310.9	444.8	405.1	404	431.8	510.3	535.4	201.5	545.3
8:10:00 AM	545	541.6	536.9	264.8	504.5	439.4	442.1	472.4	554.3	512.1	180.8	584.7
8:20:00 AM	585.5	580.4	572.9	308.2	532.6	470.8	480.5	511	593.1	577.2	208.5	620.2
8:30:00 AM	624	619.7	608.5	483.7	569.1	508.6	516.6	546.8	631.2	633.3	282	656.5
8:40:00 AM	664.5	660.5	653.8	556.5	602.8	544.6	551.3	583.1	666.8	673.1	389.3	689.7

8:50:00 AM	702.4	699.6	697.2	672.6	634.2	568.3	586.7	618.1	702	701.5	562.2	724.2
9:00:00 AM	737	737	734.5	645	665.9	586.7	620.6	653.8	736.5	743.5	618.9	751.6
9:10:00 AM	771.7	773.3	768.6	777.5	695.8	613.1	652	685.5	771.2	786	674.5	781.7
9:20:00 AM	805.3	803.2	803.2	725.1	724.2	637.6	682.3	718.3	798.3	832.5	507.9	811.9
9:30:00 AM	836.5	840.4	834.8	875.9	753.1	658.2	711.5	750.6	825.2	866.4	602	841.6
9:40:00 AM	865.3	872.3	862.3	855.9	779.1	696.3	739.5	777.5	851.3	886.6	803.7	864.1
9:50:00 AM	893.2	901.7	896.3	876.5	802.1	745	763.9	803.2	882.4	918.4	790.8	892
10:00:00 AM	919	929.6	920.2	934	823	758.3	787.6	826.3	846.7	808.6	885.4	917.7
10:10:00 AM	944.2	954.5	943.6	953.8	842.1	770.2	808.1	847.9	787.6	665.4	650.7	864.1
10:20:00 AM	968.2	978.7	945.5	966.2	861.7	791.3	828	867.6	811.4	525.4	877	964.2
10:30:00 AM	991.4	1000.1	959.7	983.3	878.2	816.3	843.3	885.4	925.9	280.5	1002.2	974.1
10:40:00 AM	1011	1019.3	981.3	953.2	892.6	842.1	860	901.7	982.7	334.5	1145.9	996.1
10:50:00 AM	1026.9	1036	976.7	1081.1	905.4	855.9	874.7	915.9	995.4	317.9	855.4	1019.3
11:00:00 AM	1045.1	1049.4	992	1006.2	914	861.7	888.4	930.3	996.7	346.3	190.3	1015.8
11:10:00 AM	1072.3	1063	1029.7	863.5	921.5	866.4	897.5	939.1	990.7	910.3	286.9	1025.5
11:20:00 AM	1075.3	1070.9	1048.7	998.8	628.6	743.5	906	945.5	911.6	1035.3	656.5	1034.6
11:30:00 AM	1070.9	1078.2	1057.9	539.1	36.1	55.8	482.4	738.5	466.7	1119.8	749.1	1045.1
11:40:00 AM	1115.3	1083.3	998.1	231.5	35.5	54.4	39.7	58.5	595.5	1193.4	1023.4	983.3
11:50:00 AM	1056.5	1076.7	583.5	782.8	100.9	56.5	42	55.7	998.1	1095.8	915.9	1038.8
12:00:00 PM	1117.6	1046.5	1013.8	1081.8	889.6	335.4	54.4	476.3	1017.2	755.2	498	1039.5
12:10:00 PM	1137.4	1089.9	1019.3	524.3	907.2	868.2	877	942.3	1015.8	265	454.2	1063
12:20:00 PM	777.5	1088.4	1022	835.3	929	865.3	914.6	941.7	1022	440	786.5	635
12:30:00 PM	1108.5	1081.1	1036	771.2	937.2	886.6	909.1	947.4	1047.9	719.3	218.8	1048.7
12:40:00 PM	1175	1078.9	1043.7	745.5	964.9	889.6	896.3	935.3	843.3	224.7	471.8	851.3
12:50:00 PM	795.1	1069.4	1052.9	864.7	886.6	473.7	890.8	920.9	1134.3	279.2	426.2	875.9
1:00:00 PM	689.2	1058.6	979.4	727.6	875.9	353.8	879.4	909.1	708.2	783.3	1151.3	715.9
1:10:00 PM	789.2	1057.2	818	692.5	925.2	894.4	864.1	892.6	289.4	859.4	1058.6	975.4

1:20:00 PM	546.4	1049.4	781.2	619.3	875.3	938.5	845.6	882.4	513.4	693	400	752.6
1:30:00 PM	584.3	815.8	1037.4	927.1	895	546.1	833.1	858.3	569.9	860	169	988.7
1:40:00 PM	963.6	970.8	981.3	872.3	808.6	238	813	841	468.6	867	256.2	809.7
1:50:00 PM	821.9	986.7	933.4	929	831.4	321.6	789.7	813	444.5	352.9	240.2	892.6
2:00:00 PM	1020	960.3	806.4	748.6	639.8	626.5	766	793.4	546.4	227.3	307	871.1
2:10:00 PM	702.4	924.6	969.5	853.6	592.3	766.5	746	763.4	547.5	220.3	345.6	780.7
2:20:00 PM	319.2	904.2	500.7	706.2	782.2	538.4	713.4	736	393	726.1	615.6	639.3
2:30:00 PM	488.7	869.4	682.7	824.7	760.8	161.2	678.6	706.2	174.8	498.7	552.8	758.8
2:40:00 PM	896.3	833.1	569.9	779.1	530.8	616	652	680.9	412	780.7	249.4	743.5
2:50:00 PM	847.9	797.8	701	686.4	491.3	596.3	615.2	634.2	722.2	665.9	166	696.7
3:00:00 PM	810.3	761.9	697.2	642	307.8	564.9	583.9	604.8	657.3	494	163.3	647.6
3:10:00 PM	781.7	719.8	677.2	663.6	542.4	542.4	545.7	561.8	656.9	579.6	202.3	518.3
3:20:00 PM	733.5	685.5	563	621.8	468.3	530.8	507.6	530	555	528.2	576.4	570.6
3:30:00 PM	663.6	634.6	454.5	545	68.4	354.3	472.1	490.3	283.2	493.7	579.6	530.8
3:40:00 PM	277.7	597.1	298.3	454.9	322.5	425.7	436.5	448.7	69.8	486.7	448.4	487.4
3:50:00 PM	85.7	562.2	120.8	488.4	284.2	388	397.5	409.3	72.1	455.5	353.6	446.9
4:00:00 PM	51.1	511.4	108	441.5	404.3	347.9	359.4	363.1	225.9	219.9	395.1	400.8
4:10:00 PM	34.4	460.7	133.9	390.6	121.8	300	302.2	320.5	328.2	51.9	187.3	363.8
4:20:00 PM	24.5	418.5	114.3	345.8	41.2	246.3	192	276.8	144	67.8	310.7	318.2
4:30:00 PM	29.5	370.3	90.3	301	32.5	206.9	225.7	237.7	68.7	68.7	255.3	264.7
4:40:00 PM	30.8	323.8	70.6	251.2	38.6	168.5	148.1	194.8	55.6	44.8	165.5	214.6
4:50:00 PM	28.4	263.6	48.3	199.4	54.6	126.8	126	152.2	51.2	31.5	160.9	164.4
5:00:00 PM	28.2	171.4	38.2	152.1	52.4	82.4	88	110.4	56.9	23	40.7	117.2
5:10:00 PM	26.1	28.2	32.2	111.2	25.9	39.8	56.4	71.5	37.5	7.2	9.3	72.3
5:20:00 PM	17.4	20.7	20	67.8	8.5	17.5	28.1	36	18	0.7	5.9	26.4
5:30:00 PM	9.5	23.9	14.4	25.6	2.2	4.8	7.9	10.9	5	0	2.6	0
5:40:00 PM	5.8	19.8	7	3.2	0	1.5	2	2.7	0.4	0	0.2	0

5:50:00 PM	2.5	7.2	0.8	0	0	0	0	0	0	0	0	0
6:00:00 PM	0	2	0	0	0	0	0	0	0	0	0	0
6:10:00 PM	0	0.1	0	0	0	0	0	0	0	0	0	0
6:20:00 PM	0	0	0	0	0	0	0	0	0	0	0	0
6:30:00 PM	0	0	0	0	0	0	0	0	0	0	0	0

The Maximum Solar Insolation at proposed project location ocurs at the Month of December and January. Figure 3.1 Shown solar insolation ranges from January to December and Figure 3.2 Shows power curve from morning to evening.

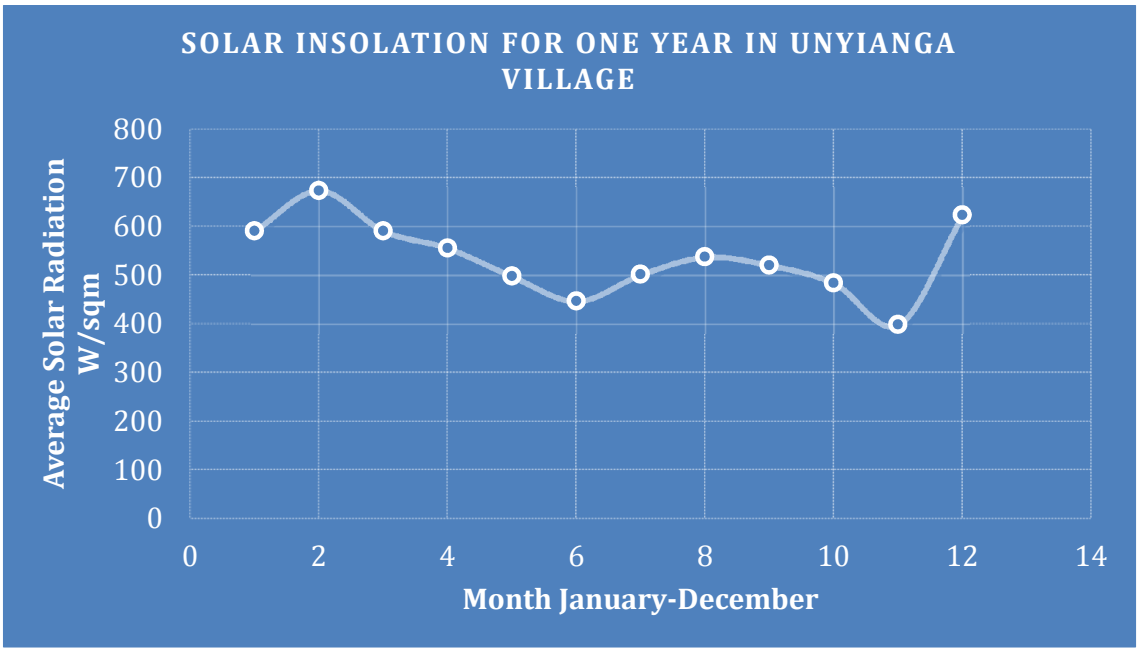


Figure 3.1: Monthly Solar Insolation ranges at Unyianga Village in Singida region

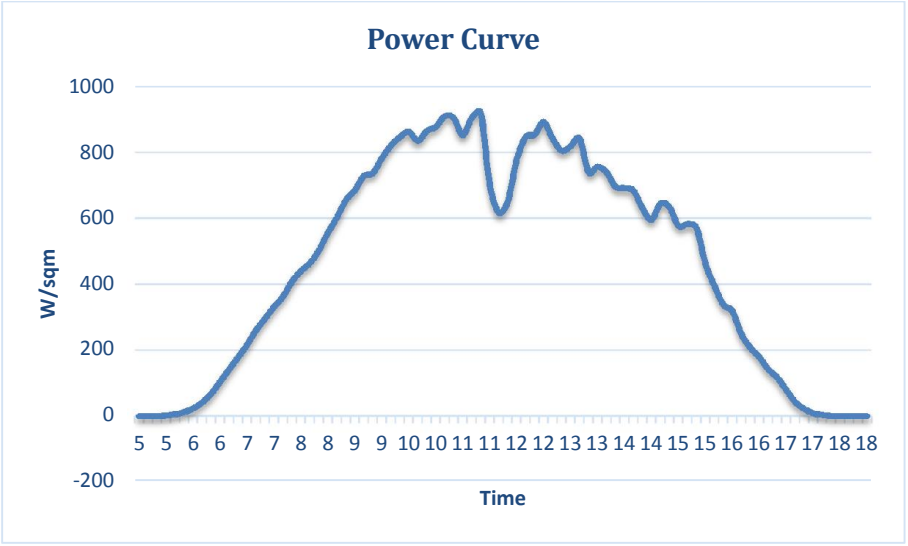


Figure 3.2: Average yearly power Curve

3.3 Economical Potential

The economic potential of the solar PV farm at the proposed site is presented for the purpose economic pre-feasibility for power production projects. Simple payback period (SPP) has been chosen as an indicator for economic viability of the proposed projects. It have been noted that 100 MW of solar PV farm, the expected payback period ranges between 6 and 8 years. It should be noted that the assumed electricity Feed-In-Tariff (FIT) was 0.08 USD/kWh which is below the standardized small power purchase tariff of 197.31 Tsh/kWh (0.12 USD/kWh) as recommended by EWURA for 2014.

3.4 Sensitivity Analysis and Data Quality

Sensitivity analysis was conducted in order to provide guidance on selecting appropriate technology for large scale solar PV systems. The efficiency was chosen for investigation due to the fact that exploitable area and solar energy potential are highly dependent on it. Figure 3.2 presents the effect of solar PV system efficiency on technical potential. The results indicate that technical potential is highly affected by the efficiency of the solar PV system. In general, depending on the performance of the selected technology, the exploitable technical potential in in the proposed project area can reach as high as 80,000 GWh/year.

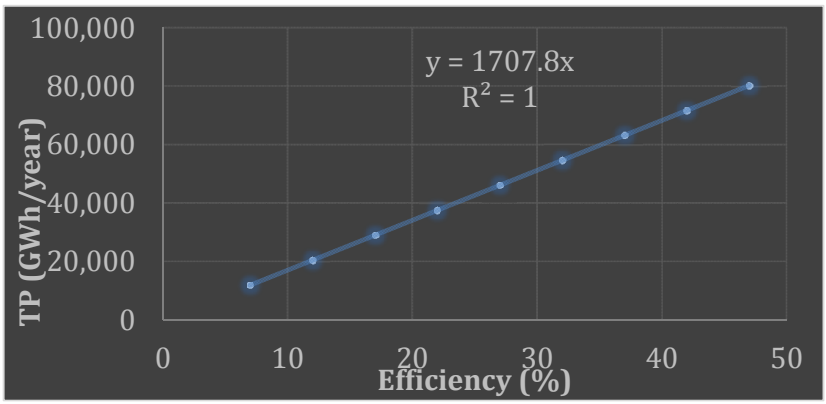


Figure 3.2: Sensivity analysis on total technical potential at different solar PV system efficiences

3.5 Performance ratio for an analysis at Unyianga Village.

In order to calculate performance ratio for proposed Unyianga Solar Power Plant following data were used:

E = A * r * H * PR

E = Energy (kWh)
A = Total solar panel Area (m^2)
r = solar panel yield (%)
H = Annual average solar radiation on tilted panels (shadings not included)
PR = Performance ratio, coefficient for losses (= 0.75)

From our data

A=667,000m^2

R=15%

H=2318.84kW/m^2 /annum

Generation time 8Hrs/day

PR=0.75.

Therefore **E=188,979,626** kWh/annum assuming all total losses as 20%.
Therefore by using the proposed tariff of 0.08 US Cent the selling price per 100MW per annum will be 15,118,370 USD. By considering the Investment cost of 1MW equivalent to 1.5M USD this mean that 100MW will be constructed by 150M USD. Hence by considering full generation the Payback period for the Project will be 10 Years.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

An analysis of solar energy resources at Unyianga village s have been carried out in order to construct 100MW solar PV power plant at that area. The techniques have been able to establish the results for the three defined resources scenarios. From this assignment, it can be concluded that:

(i) The solar energy distribution at the proposed site is promising for Large power plant investment;
(ii) Opportunities for investment on solar PV power generation have been proved.
(iii) Annual power generation based on 8 hours full generation will reach
(iv) Simple Payback Period for power generation from solar PV farm with lifespan of 25 years ranges 6-8 years at proposed Feed-In-Tariff (FIT) of 0.08 USD/kWh is feasible.

4.2 Recommendations

The study on solar energy assessment at Unyianga village recommends the following:

(i). Solar PV farms can be constructed at Unyianga village should put into consideration of construction of 15km Transmission Line from TANESCO substation to the proposed site;
(ii). Assessment of Singida Sub-station is essential to determine if power generated can be accommodated;
(iii). Grid Stability Study is mandatory in order to know the capacity of Renewable Energy which can be injected into the TANESCO grid network at a time.