



REQUEST FOR CEO ENDORSEMENT

PROJECT TYPE: Full-sized Project

TYPE OF TRUST FUND: GEF Trust Fund

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PART I: PROJECT INFORMATION

Project Title: Scaling up small hydropower (SHP) in Nigeria			
Country(ies):	Federal Republic of Nigeria	GEF Project ID: ¹	5375
GEF Agency(ies):	UNIDO	GEF Agency Project ID:	120119
Other Executing Partner(s):	Federal Ministry of Power (FMP), Federal Ministry of Environment (FME), Rural Electrification Agency (REA), Energy Commission of Nigeria (ECN)	Submission Date: Resubmission Date:	10/24/2014 01/26/2015
GEF Focal Area (s):	Climate Change (CC)	Project Duration (Months)	48
Name of Parent Program (if applicable): ➤ For SFM/REDD+ <input type="checkbox"/> ➤ For SGP <input type="checkbox"/> ➤ For PPP <input type="checkbox"/>		Project Agency Fee (\$):	255,520

A. FOCAL AREA STRATEGY FRAMEWORK²

Focal Area Objectives	Expected FA Outcomes	Expected FA Outputs	Trust Fund	Grant Amount (\$)	Cofinancing (\$)
CCM-3 Promote investment in Renewable Energy (RE) technologies	Investments in RE technologies increased	RE capacity installed	GEF TF	2,689,680	17,200,000
Total project costs				2,689,680	17,200,000

B. PROJECT FRAMEWORK

Project Objective: To promote investments in SHP technology and strengthen local manufacturing of SHP turbines in Nigeria

Project Component	Grant Type	Expected Outcomes	Expected Outputs	Trust Fund	Grant Amount (\$)	Confirmed Cofinancing (\$)
1. Human and institutional capacity building	TA	1.1 Improved awareness, knowledge and capacity on SHP technology	1.1.1. Capacity of SHP technology centre in Nigeria strengthened 1.1.2. Capacity building of at	GEF TF	200,000	572,614

¹ Project ID number will be assigned by GEFSEC.

² Refer to the [Focal Area Results Framework and LDCF/SCCF Framework](#) when completing Table A.

			<p>least 100 policy makers</p> <p>1.1.3. Capacity building of at least 50 project developers, relevant RE institutions including financial institutions</p>			
2. Upgrading the capacity for local fabrication of SHP turbines and control systems in Nigeria	TA	2.1. Capabilities for locally fabricated SHP turbines and control equipment up to 300 kW capacity are available in the country	<p>2.1.1. Enhanced local fabrication capacity for micro hydro turbines and control equipment up to 300 kW</p> <p>2.1.2. National standards developed for SHP electromechanical equipment in Nigeria</p>	GEF TF	300,000	1,215,770
3. Promoting investments in SHP sector	TA	3.1. Conducive investment environment for scaling up of SHP projects available	<p>3.1.1. Incentive systems designed for SHP projects</p> <p>3.1.2. Detailed feasibility studies prepared for the replication SHP plants</p>	GEF TF	481,600	2,113,185
	INV	3.2. Technical and economic viability of SHP technology established	<p>3.1.3. SHP of 3.1 MW cumulative capacity established</p> <p>3.1.4. Promotion of replication projects of 69.2 MW cumulative capacity</p>		1,500,000	12,137,281
4. Monitoring and Evaluation	TA	4.1. Effectiveness of the outputs	4.1.1. Mid-term evaluation	GEF TF	80,000	392,670

(M&E)		assessed, corrective actions taken and experience document	report prepared			
		4.2. Acceptance of technical and economic viability of SHP plants	4.1.2. Final evaluation report prepared 4.1.3. Lessons learning and information dissemination 4.1.4. Methodologies and tools developed for better planning and decision making			
Subtotal					2,561,600	16,431,520
Project Management Cost (PMC) ³				GEF TF	128,080	768,480
Total project costs					2, 689,680	17,200,000

C. SOURCES OF CONFIRMED CO-FINANCING FOR THE PROJECT BY SOURCE AND BY NAME (\$)

Please include letters confirming co-financing for the project with this form

Sources of Co-financing	Name of Co-financier (source)	Type of Co-financing	Co-financing Amount (\$)
Federal Government of Nigeria	Federal Ministry of Environment	Cash	500,000
Federal Government of Nigeria	Federal Ministry of Environment	In-kind	500,000
Federal Government of Nigeria	Federal Ministry of Power	Cash	10,000,000
Federal Government of Nigeria	Rural Electrification Agency	Cash	5,000,000
Federal Government of Nigeria	Energy Commission of Nigeria	In-kind	1,000,000
GEF Agency	UNIDO	Grant	60,000
GEF Agency	UNIDO	In-kind	140,000
Total Co-financing			17,200,000

Co-financing letters are provided in Annex J.

D. TRUST FUND RESOURCES REQUESTED BY AGENCY, FOCAL AREA AND COUNTRY¹

GEF Agency	Type of Trust Fund	Focal Area	Country Name/ Global	(in \$)		
				Grant Amount (a)	Agency Fee (b) ²	Total c=a+b
N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Grant Resources				0	0	0

¹ In case of a single focal area, single country, single GEF Agency project, and single trust fund project, no need to provide information for this table. PMC amount from Table B should be included proportionately to the focal area amount in this table.

² Indicate fees related to this project.

³ PMC should be charged proportionately to focal areas based on focal area project grant amount in Table D below.
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F. CONSULTANTS WORKING FOR TECHNICAL ASSISTANCE COMPONENTS:

Component	Grant Amount (\$)	Cofinancing (\$)	Project Total (\$)
International Consultants	390,000	130,000	520,000
National/Local Consultants	116,000	348,000	464,000

G. DOES THE PROJECT INCLUDE A “NON-GRANT” INSTRUMENT? No

(If non-grant instruments are used, provide in Annex D an indicative calendar of expected reflows to your

Agency and to the GEF/LDCF/SCCF/NPIF Trust Fund).

Not applicable

PART II: PROJECT JUSTIFICATION**A. DESCRIBE ANY CHANGES IN ALIGNMENT WITH THE PROJECT DESIGN OF THE ORIGINAL PIF⁴****A.1 National strategies and plans**

In the approved PIF, project component 3 envisaged that three outputs would be achieved during the project implementation. However, during the PPG stage the project component was revised to provide technical assistance for developing detailed feasibility studies for the replication sites and therefore a new output 3.4 "promotion of replication projects" has been added. This is based on the several requests received from potential private investors to assist in developing bankable Detailed Project Report (DPR) for about 20 potential sites. Two sites with DPRs have been selected as the demonstration projects; the selected sites have increased the cumulative capacity to be installed from 3 MW to 3.1 MW.

The co-financing amount has increased from USD 14,870,000 in the approved PIF to USD 17,200,000. The Federal Ministry of Power increased its grant from USD 5,600,000 to USD 10,000,000; Energy Commission of Nigeria (ECN) increased its grant from USD 300,000 to USD 1,000,000. The Rural Electrification Agency (REA) has been included to replace Federal Ministry of Water Resources that dropped out due to budget constraints; REA is contributing USD 5,000,000 (in cash) to the project. The proposed project will support the new renewable energy master plan 2011.

During the PPG stage, detailed consultations with key stakeholders namely Bank of Industry (BOI) and Standard Organization of Nigeria (SON) were carried out. To encourage private sector develop the energy sector a credit facility has been put in place by Central Bank of Nigeria (CBN) to be managed by BOI. The modality of accessing the power fund was discussed and training on implementation of SHP project was carried out for the zonal managers of BOI. Consultation on developing and establishing technical standards for locally manufactured SHP turbines and control was carried out with SON. Two potential sites with a cumulative capacity of 3.1MW have been selected as the demonstration sites based on the support from the State Governments. The ongoing power sector reform has successfully privatize the electricity sector in the country and policies are in place to encourage private sector develop the energy sector.

The proposed project will also support the following Government policies and strategies targeted to increase the percentage of RE in overall energy mix and rural electrification in the country.

National Energy Policy (NEP) (2003): It aims at expanding the electricity access to 75% of the total population by 2020. It also aims at developing and promoting the country's RE resources and promoting the decentralized energy supply based on renewable resources, especially, in rural areas. This policy includes the following objectives:

- a) Ensuring the development of the nation's energy resources, with diversified energy resources option,

⁴ For questions A.1 –A.7 in Part II, if there are no changes since PIF and if not specifically requested in the review sheet at PIF stage, then no need to respond, please enter “NA” after the respective question.

- b) Guaranteeing adequate, reliable and sustainable supply of energy at appropriate costs in an environmentally friendly manner to the various sectors and
- c) Promoting the investments for developing the energy sector industries with substantial private sector participation.

One of the major objectives of NEP (2003) is to increase the percentage contribution of hydroelectricity in the total energy mix. It also includes the strategy of ensuring increased indigenous participation in the planning, design and construction of the hydropower plants.

This project is therefore very much aligned with various energy development strategies of Nigeria as well as, National Poverty Eradication Programme (NAPEP) and Millennium Development Goals (MDGs).

Initial National communication to UNFCCC (2003): In the energy sector, the following options for climate change mitigation are identified:

- Efficiency improvement options in the residential, industrial and commercial sectors
- Increased use of renewable resources, consisting of the introduction of small-scale hydro plants and solar-electric options
- Supply-side options, especially rehabilitation of some existing oil refineries and power plants
- Options for increased use of natural gas

Electricity Power Sector Reform Act (EPSR) (2005): The Act resets the target for increasing the electricity access in rural areas from 40% in 2005 to 75% by 2015.

Nigerian Renewable Electricity Policy (2006): It supports the construction of independent renewable electricity systems in areas not covered by the electricity grid to provide power service for local economic activities and sustainable living.

Renewable Energy Master Plan (REMP) (2007): It envisages aggregating the electricity demand of 14,000 MW by 2015, of which, RE will constitute about 5% (700 MW).

National Portfolio Formulation Document (NPF) (2011): It encourages capacity building for legislators and policy makers to sensitize them on the need for the development of policy framework for renewable energy and scaling up small hydro power development in Nigeria.

Renewable Energy Master Plan (REMP) (2011): It seeks to increase the supply of electricity from 13 % of total electricity generation in 2015 to 23 % in 2025 and 36 % by 2030. Electricity from Renewable Energy (RE) sources would then account for 10 % of Nigerian total energy consumption by 2025. The plan also encompasses installed capacity targets for a set of suitable Renewable Energy Technologies (RETs). They are as follows:

- Small-hydro: 600 MW in 2015 and 2,000 MW by 2025;
- Solar PV: 500 MW by 2025;
- Biomass-based power plants: 50 MW in 2015 and 400 MW by 2025;
- Wind: 40 MW by 2025.

The REMP targets higher electrification rates, from 42 % in 2005 to 60 % in 2015 and 75 % by 2025.

A.2. GEF focal area and/or fund(s) strategies, eligibility criteria and priorities

The proposed UNIDO/GEF intervention focuses on creating a favourable environment for promoting both public and private sector investments, thereby scaling up SHP development in Nigeria including enhancing the local capacity for fabrication of electro-mechanical equipment and controls up to 300 kW. Rapid scaling up of SHP has considerable greenhouse gas (GHG) emission reduction potential in Nigeria. This is in line with *GEF-5 Climate change focal area strategic programme CCM-3: Promoting investment in RE technologies*.

A.3. The GEF Agency's comparative advantage:

The project is a technical assistance/capacity development intervention that fits within the climate change focal area objective CCM-3. The GEF Council paper "Comparative Advantages of the GEF Agencies" (GEF/C.31/5rev.1)⁵ recognizes the comparative advantage of UNIDO in meeting these objectives.

UNIDO's previous intervention in the SHP sector has been remarkable and is described in more detail under section A.4 of Part II. UNIDO continues to develop SHP projects around the world and has established a few centres, for instance the International Centre for Small Hydro-Power (ICSHP) in Hangzhou (China), the Regional Centre for Small Hydro Power in Trivandrum (India), and the Regional Centre for Small Hydro Power in Abuja (Nigeria). UNIDO in collaboration with ICSHP has developed a hydropower knowledge platform (accessible under: www.smallhydropowerworld.org) and published a world small hydropower development report in 2013. UNIDO has developed and installed SHP plants ranging from 10 kW to 1.2 MW in seven countries namely:

India:

- 110 kW plant in Mankulam Kerala. Status: in operation
- Demonstration of ultra-low head SHP plant technology from Japan in the State of Uttarakhand. Status: under implementation

Indonesia:

- 30 kW plant in Nias Island. Status: in operation

Kenya:

- 10 kW model pico hydro systems donated by the International Center for Small Hydro Power, Hangzhou, China. Status: under implementation

Rwanda:

- Two 100 kW plants. Status: in operation
- Two 200 kW plants. Status: in operation

Tanzania:

- 10 kW plant in Kinko. Status: in operation

In Nigeria specifically, UNIDO has established a Regional Office for West Africa based in Abuja, as well as four demonstration SHP plants of varying capacities and facilitated the transfer of technology for manufacturing cross-flow turbines up to 125 kW capacity. UNIDO is implementing a large country programme in the country where 'energy' is a major component and has developed a robust GEF portfolio in RE projects.

UNIDO is currently implementing a GEF-4 project in the country entitled "*SPWA-CC Mini-grids based on RE Sources to Augment Rural Electrification*". The main objective of the project is to promote RE (biomass) based on mini-grid to augment rural electrification for domestic and productive uses. The proposed project will support the existing and on-

⁵ <http://www.thegef.org/gef/sites/thegef.org/files/documents/C.31.5%20Comparative%20advantages.pdf>

going GEF projects in increasing Nigeria's efforts in rural electrification and usage of RE to promote Inclusive Sustainable Industrial Development (ISID). Poverty reduction through productive activities is a priority for UNIDO; therefore, UNIDO's substantive branches such as Agro Business Development Branch, Business Investment and Technology Services Branch will be actively involved in developing economic activities in the beneficiary communities.

A.4. The baseline project and the problem that it seeks to address

Energy scenario

In 2010, Nigeria produced 254.78 Mtoe of energy, consumed 21.62 TWh of electricity, and generated 51.91 Mt of CO₂e. In 2011, there was a slight increase, energy production was 256.93 Mtoe, 24.45 TWh of electricity was consumed, and 52.85 Mt of CO₂e was generated.⁶ The energy mix for the total electricity production (27.03 TWh) in 2011 is as follows: large hydro (20.9 %), oil (15.8 %) and gas (63.3 %). The final consumption amounted to 23.68 TWh out of which the residential sector consumed the most 57.3 %, followed by the commercial and public services sector with 26.1 % and the industry sector, which consumed 16.6 % (see figure1).

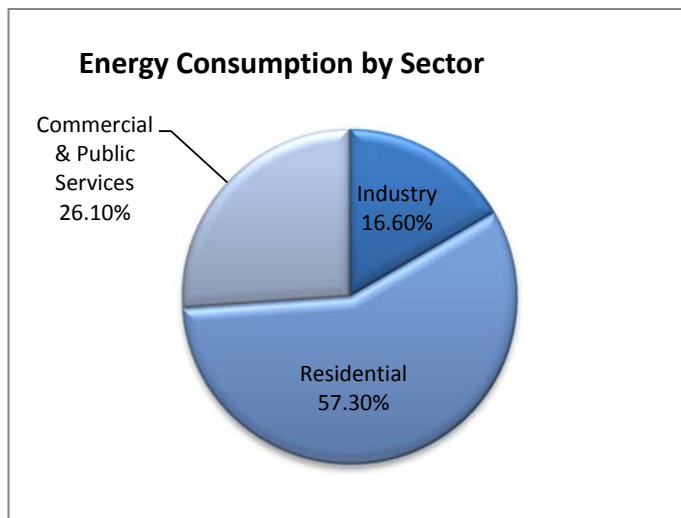


Figure 1: National energy consumption in Nigeria by sector, 2011

The present energy supply cannot meet the energy demand of the country. As a result of this shortfall in demand and supply management, most households and businesses have to resort to private fossil fuel generating sets to supplement power supply. These private fossil fuel generating sets (now an essential part of the Nigerian landscape) are major sources of anthropogenic GHG emissions. Even with drastic reduction of gas flaring in the oil and gas industry, GHG emissions are still increasing. This is attributable to the continuous use of fossil fuel generating sets by the residential, commercial as well as by the public services sector. An estimated 50 % of the electrical energy consumed in the country is currently produced off-grid by fossil fuel generators see images 1 and 2)

⁶ IEA (2013) Key World Energy Statistics [online]. Available from:
http://www.iea.org/publications/freepublications/publication/KeyWorld2013_FINAL_WEB.pdf
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Image 1: Individual generating set



Image 2: Individual generating set

Electricity scenario

Nigeria has an electrification rate of 48 %, with a population of 168.8 million and an annual growth rate of 2.8 %. About 50 % of the Nigerian population lives in rural areas, approximately 20 % of this population has access to electricity⁷. The electricity supply is presently unreliable in the country with frequent shutdowns, load shedding and grid failures. On average, consumers do not have electricity supply from the grid network for 10 hours every day. This has compelled many consumers (both industrial and households) to buy diesel/petrol generating sets to meet their energy needs. The installed generating capacity of the country has increased from about 6,000 MW in 2005 to 10,396 MW through the National Integrated Power Project (NIPP) initiative, with available capacity of 6,056 MW as of 2013 while the energy demand is estimated to be 33 TWh⁸. The NIPP conceived in 2004, is a fast-track government-funded initiative to stabilize Nigeria's electricity supply, while the private-sector led structure of the Electric Power Sector Reform Act (EPSRA) of 2005 took effect. The NIPP was designed around gas-fired power stations in the gas-producing states with a cumulative power capacity of 5,222 MW. Notwithstanding the increment, the peak generation is still about 4,249 MW as of 10 February 2014,⁹ and about 80 % of the rural population still has no access to electricity supply.

Most of the power stations in the country are fossil fuel based, with an installed capacity of 8,457.6 MW (81 % of the total installed generating capacity). The three major large hydropower stations (Kainji, Jebba and Shiroro) account for a cumulative of 1,938 MW (20.9 % of the installed generating capacity). Figure 2 depicts the electricity generation mix in the country. Nigeria has an estimated power potential of 14,750 MW from hydropower, out of which small hydropower (SHP) alone amounts to 3,500 MW.¹⁰ The Government of Nigeria has a target of generating 400 MW of electricity from SHP by 2016 as a short-term goal. The estimated electricity demand in the country is about 15,000 MW; on the supply side, the total installed generating capacity provides around 10,000 MW, but only about 4,000 MW is effectively operating. This is attributable to the current state of the grid network that is characterized by frequent overloading, system collapses and transmission and distribution losses of up to 30 %. Thus, there is a gap of 6,000 MW net supply that still needs to be bridged. This demand-supply gap in the electricity sector is growing day by day and the Government is unable to keep pace with the growing demand. Diesel and petrol generators are presently meeting the wide gap in the current demand-supply scenario. This situation has led to the increased consumption of diesel and petrol, which affects the economy and contributes to GHG emission. As of 2011, Nigeria generated 52.85 Mt of CO₂e.¹¹

⁷ World Data Bank (2012) World Development Indicators [online]. Available from

<http://databank.worldbank.org/data/views/reports/tableview.aspx>

⁸ NIPP (2013) Nigerian Electricity Market [online]. Available from:

<http://www.nipptransactions.com/background/electricity-market/>

⁹ PTFP (2014) Generation Report [online]. Available from: <http://www.nigeriapowerreform.org/>

¹⁰ ICEED (2006) Renewable Electricity Action Program [online]. Available from: <http://www.iceednigeria.org/workspace/uploads/dec.-2006-2.pdf>

¹¹ IEA (2013) Key World Energy Statistics [online]. Available from:

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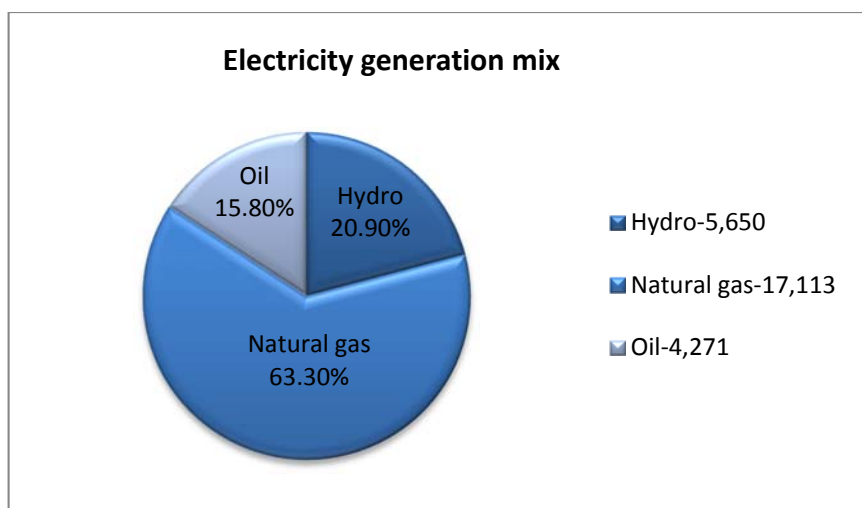


Figure 2: Electricity generation mix in Nigeria (GWh), 2011

Nigeria has a vast amount of water resources, which can be harnessed to generate electricity. Small streams and rivers have the potential of generating electricity with SHP plants. These can be easily installed and managed, when used as a stand-alone or decentralized energy system. There would be no need for high investments in transmission lines since the end-users are close to the source of the electricity generation. The cost of extending the grid is high, compared to the cost of installing off-grid electricity generation plants. Even with the available water resources in almost all rural communities in Nigeria, only very little investment has gone into the development of potential SHP sites.

Impacts of Climate Change on the energy sector

Primary energy generation in Nigeria is mainly through the burning of traditional biomass and fossil fuel, which are increasing GHG emission and affecting the climate. In 2011, the total primary energy consumption mix was dominated by traditional biomass and waste (83 %), fossil fuels (natural gas 5 % and oil 11 %) and hydro (1 %) (See figure 3).

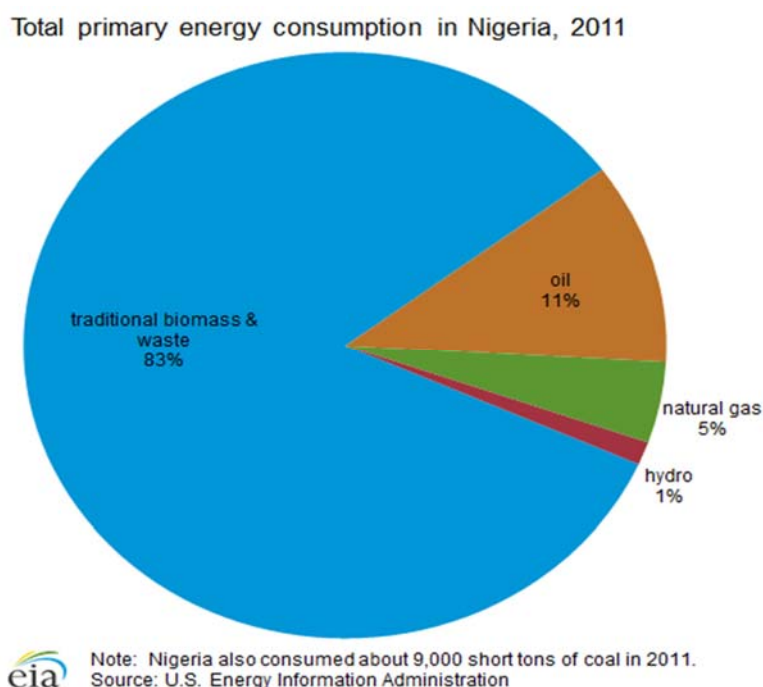


Figure 3: Total primary energy consumption in Nigeria

Climate change has altered the global hydrology cycle with changes in precipitation, its total amount, frequency and intensity. This reduces the generating capacity of large hydropower stations at times, increases the use of private diesel/petrol generators to supplement the supply.

The main climate trends that are relevant to the energy sector are increasing air and water temperatures, decreasing water availability in some regions and increasing intensity and frequency of storm events, flooding and sea level rise. An increase of 2-2.2°C in temperature is projected to occur by 2050 in Nigeria, this will increase the demand for air-conditioning by 3-6 % and electricity by 4 %. Model studies have shown a 3-5°C increase in temperature, a 4-6 % growth in annual electricity energy demand and an increase of 16-23 % in peak national demand attributable to climate change by 2055¹².

A study carried out by Building Nigeria's Response to Climate Change (BNRCC) project shows that Nigeria is vulnerable to climate change and the impacts will be felt differently in the four-eco zones of the country. The demonstration projects will be located in the rainforest zone, which is not prone to drought as shown in table 1 below. Therefore, the sustainability of the project due to drought will not be an issue

Table 1: Projected Key Climate Change parameters by ecological zone

Climate Variables	Mangrove Zone	Rainforest	Tall grass (Savanna)	Short grass (Sahel)
Temperature	↑	↑	↑	↑
Rainfall amount	↑	↑	↓	↓
Rainfall variability	↑	↑	↑	↑
Extreme rainfall events-droughts	Likely	Likely	↑	↑
Extreme rainfall events-storms and floods	↑	↑	Likely	Likely
Sea level rise	↑	NA	NA	NA

Legend: ↑ likely increase or increase; ↓ likely decrease or decrease; NA not applicable.

Source: BNRCC (2011)

The Nigerian Government has been adopting series of policies and measures to mitigate climate change impact, taking into considerations its specific national circumstances. One of the measures under national policy guidance is the development and utilization of SHP potential in the country.

Baseline scenario

The Nigerian Government has been making efforts to address the challenges facing the electricity sector. The Government has reformed the electricity industry, enacted several laws and regulations to exploit the nation's abundant RE deposits, for full contribution to the total energy mix. The reform commenced with the preparation of a National Electric Power Policy (NEPP) in 2001 followed by the preparation and passage of the enabling legislation, referred to as EPSRA into law in March 2005¹³. The NEPP planned a three-stage legal and regulatory reform for the electricity sector comprising:

- (i) A transition stage characterized by private power generation via Independent Power Producers (IPPs) and Emergency Power Producers (EPPs), corporate restructuring, unbundling and privatization of National Electricity Power Authority (NEPA);
- (ii) A medium-term stage characterized by energy trading between generation and distribution companies on the basis of bilateral contracts and

¹²Enete, C. and Alabi, M.(2011)'Potential impacts of global climate change on power and energy generation', Scientific Papers [online], issue 6.

Available from: http://www.scientificpapers.org/wp-content/files/1185_Enete_Ifeanyi_Christian_Potential_Impacts_of_Global_Climate_Change_on_Power.pdf

¹³ Ohunakin, O. et al (2011)'SHP development in Nigeria: An assessment', Science Direct [online], issue 15. Available from : <http://www.sciencedirect.com>

- (iii) A long-term competition structure characterized by the optimal operation of the various power generation, transmission and distribution companies.

The EPSRA provides for the vertical and horizontal unbundling of NEPA into separate and competitive entities, the development of a competitive electricity markets, setting out of a legal and regulatory framework for the sector, a framework for rural electrification, framework for the enforcement of consumer rights and obligations and establishment of performance standards. With the passage of the EPSR Act, NEPA was deregistered and the Power Holding Company of Nigeria (PHCN) was incorporated to manage the unbundling of NEPA. The restructuring broke the monopolistic framework in the power sector thereby allowing:

- (i) Private operators to apply for and obtain a license through the Nigerian Electricity Regulatory Commission (NERC) to build and operate a power plant with aggregate capacity above 1MW and
- (ii) The establishment of the Rural Electrification Agency (REA) together with an independent Rural Electrification Fund (REF) whose major objective is to fully incorporate renewable energy in the energy options.

The EPSRA allows a person to construct, own or operate an off-grid power plant not exceeding 1MW in aggregate at a site without a license. This exemption to holding a license favors energy generation through SHP since some of the identified SHP sites fall within the required range. It is also expected to encourage private sector participation to invest in small/mini/micro hydropower especially for rural development and off-grid generation. The Act paved the way for the unbundling of NEPA into 18 companies: 6 Generating Companies (Gencos), 1 Transmission Company and 11 Distributing Companies (Discos), it also provides the legal and regulatory framework for the Nigerian Electricity Supply Industry (NESI). It empowers NERC to regulate the NESI, comprising of the Gencos, Trancos and Discos/Retail sectors. NERC in 2008 introduce a Multi-Year Tariff Order (MYTO) in its effort to provide a viable and robust tariff policy for the NESI, as well as the framework for determining the industry pricing structure. The MYTO provides a fifteen (15)-year tariff path for the electricity industry with minor and major reviews bi-annually and every five years respectively. There are three separate Tariff Orders; one for each of the sectors in the NESI namely: gencos, tranco and discos/retail.

In a bid to catalyse financing of the power sector, the Government through CBN approved the investment of the sum of N500 billion debenture stock to be issued by BOI. The sum of N300 billion has been set aside for power and airline projects. The objectives of the Fund are to:

- i. Fast-track the development of electric power projects, especially in the identified industrial clusters in the country;
- ii. Improve power supply, generate employment, and enhance the living standard of the citizens through consistent power supply;
- iii. Provide leverage for additional private sector investments in the power and aviation sectors.

UNIDO has focused on creating awareness among relevant stakeholders on the huge SHP potentials available in the country, several workshops have been held to this effect. In November 2002, the Energy Commission of Nigeria (ECN) collaborated with UNIDO and other relevant government parastatal to organise a national stakeholder's forum on RETs specifically based on SHP for rural industrialization. The aim was to formulate strategies to provide access to clean and reliable energy services for ISID. A memorandum of understanding was signed between ECN and UNIDO – IC-SHP, Hangzhou, China, for further cooperation in harnessing the identified SHP potential of 735 MW through technical assistance, training and establishment of demonstration projects. Thus, the framework for training of trainers in SHP was put in place in 2003 in conjunction with IN-SHP and UNIDO. ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) in collaboration with UNIDO has also jointly developed the ECOWAS Small Scale Hydropower Program (2013 – 2018) for the West Africa Region. Prior to UNIDO's intervention in the field of SHP in Nigeria, SHP development in the country has been minimal. Approximately 30 MW of SHP has been developed so far. Nigerian Electricity Supply Corporation Ltd an IPP has developed 70 % (21 MW) of the developed 30 MW over a period of 100 years. Though several policies and regulatory frameworks are in place to promote RE based electricity generation, there is no definite and well-framed pathway that makes these policies successful enough to bring the desired outputs. For example, the Renewable Energy Master Plan launched in 2005 has a 10-year target (2007-2017) for increasing the contribution of RE technologies to the energy mix of the country. The initial targets in MW based on peak supply from

SHP sites were: 40 (2007) for short-term; 100 (2008) for medium-term and 400 (2016) for long-term. The targets were based on the assumption that over 200 identified potential SHP sites (see Annex F) would be developed. However, achieving these targets has been a herculean task and none of the targets have been met. This is attributable to the barriers and challenges affecting SHP development listed below. The major barriers faced by the SHP sector in the current context include the following:

- Need for promoting private sector investments;
- Lack of investment incentives for investors;
- High cost importation of SHP equipment;
- Realization and utilization of initiatives and policies by relevant Ministries.

The major causes for the above problems are as follows:

- Insufficient public awareness and participation;
- Inadequate technology, knowledge and skills available for local fabrication of high quality;
- Need of SHP turbines and control systems of higher capacity;
- Lack of dedicated fund/finance facilities for SHP projects.

Baseline project

The Federal Government of Nigeria through the Federal Ministry of Power is desirous of improving power supply in the country through diversification of sources of electricity supply. The Government has a target of generating about 400 MW of electricity from SHP by 2015 with the abundant water resources in almost all the rural communities in Nigeria, but very little investment has gone to the development of potential SHP sites. Accordingly, the Federal Ministry of Power is conscious of the hydropower potential of several existing dams earlier designed for irrigation and water supply schemes only and is interested in exploiting the power potential of the dams. Contracts have been awarded to carry out feasibility studies and detailed engineering design for SHP integration on all the existing dams in the country. As a result of this, Ondo and Osun State Government in conjunction with the Federal Ministry of Power intend to show the viability of SHP to private investors through the development of the demonstration projects. The proposed project intends to integrate SHP into existing dams that have been sustaining their operational activities on diesel generating set.

The Federal Ministry of Power has a renewed focus on rural electrification using RE sources, as a result of the successful privatization of the power sector. This project aims to create conducive environment for IPPs to invest in SHP plants which is in line with Nigerian Energy Policy, Nigerian Renewable Electricity Policy, as well as the Renewable Energy Master Plan and Vision 2020, which aims to generate 6000 MW of electricity by focusing on renewable and sustainable energy sources.

In spite of the frameworks and reforms put in place to encourage RE investments in the electricity sector, private sector participation has increased only in fossil-based sources rather than in hydropower and other renewable sources. There is still little exploitation of the benefits and opportunities of SHP as a power generation source if we compare the quantity exploited with the identified potentials. So far, private sector participation in RE implementation in the country is in the area of importation and marketing of RE components. Full participation by the private sector in SHP development, especially in the form of investment towards local fabrication of turbines will enhance the exploitation of SHP potential and is expected to contribute about 23 % to estimated energy demand of the country. The reform programme is meant to promote competition in the power industry as well as meet the growing electricity demand. However, since fossil fuels have not been able to resolve the persistent energy challenge of the country, despite the abundance, the need for electricity generation through renewable energy sources has been constantly expressed.

In order to address the precarious electricity situation and to help harness the available SHP potential in the country, UNIDO in collaboration with ECN has been building human and institutional capacity in SHP development. UNIDO's intervention includes establishment of the following pilot plants: Ezioha Mgbowo plant (30 kW), Enugu State, Waya

dam plant (150 kW), Bauchi State and Tunga dam plant (400 kW), Taraba State. Capacity in SHP has been developed in various higher institutions and river basins development in the country. This has led to over 200 potential SHP sites identified, 17 feasibility studies with DPR carried out (see Annex I) and the development of three sites that are under construction which includes a 1,200 kW capacity SHP project with donor support in Benue State. Though 17 sites have bankable documents, private investors are hesitant to develop the SHP sites as the investment costs are high and obtaining finance for these sites is difficult. Table 2 shows UNIDO's achievement with SHP development in Nigeria.

Table 2: UNIDO's achievement with SHP development

S/No	Project Name/ Location	Design Power (kW)	Project Developer	Remarks
1.	Ezioha Mgbowo SHP project (Enugu State)	30	UNIDO	Pilot project, completed and commissioned.
2.	Ikeji-Ile Ijesha SHP project (Osun State)	70	Osun State Government	Penstock installation on-going. Electromechanical equipment on site. Locally manufactured turbine is to be installed at the site.
3.	Waya dam SHP project (Bauchi State)	150	UNIDO	Pilot project, completed and commissioned. Productive activities are springing up around the dam.
4.	Tunga dam SHP project (Taraba State)	400	UNIDO/Highland Tea	UNIDO is assisting Highland Tea in harnessing SHP potential within its premises with electromechanical equipment to eliminate diesel and firewood usage in the factory,
5.	Amoke/ Ugbokpo SHP project (Benue State)	1,225	Federal Ministry of Power	Civil works on-going. Electro-mechanical equipment on site.

UNIDO has facilitated the transfer of technology in manufacturing Micro Hydro Power (MHP) turbines up to a capacity of 125 kW to National Agency for Science and Engineering Infrastructure (NASeni), and Project Development Agency (PRODA), Nigeria. The training took place at Entec's facility in Indonesia from 13th November-11th December 2010 and seven participants from NASeni and PRODA participated in the training. The training was divided into a class session, a field visit with hands on practical experience at the workshop. The class session had two modules, module A focused on introduction to hydropower, the course of planning and implementation of hydropower projects, fundamentals on MHP technology which includes: energy and power, hydraulic engineering, basic components and site configuration. Module B focused on feasibility and initial project planning which includes: field investigation analysis, socio-economic assessment, cost estimating, economic and financial analysis. A field visit was organized after the class session to visit a SHP site. The participants went to the workshop to fabricate a 35 kW cross-flow turbine under the supervision of the trainers to have hands on practical experience.

As a result of the training, 2 no. 35 kW and a 10 kW cross-flow turbines were locally manufactured in Nigeria (see images 3 and 4). The turbines were manufactured at Engineering Materials Development Institute (EMDI), Akure – an institute established by NASeni. The two turbines are to be installed at Ikeji-Ile, Osun State SHP site and the 10 kW cross-flow turbine is to be installed at Ketti community within the federal capital territory.



Image 3: Fabricated runner shaft



Image 4: Assembled completed (2 x 35 kW) cross-flow turbines

The proposed GEF project will be strategic in assisting the Ministry of Power in achieving its goal of rural electrification using RE and as well as building on and sustaining UNIDO's achievements so far. The proposed GEF projects aims to build on the initial transfer of technology and promote local fabrication of turbines and control systems by the private sector. Nigeria still depends on importation of equipment with higher capacity for SHP development. If locally fabricated equipment with higher capacity (at least 300kW) are available, it will have a significant impact on the development cost of SHP plants in Nigeria and Africa. The proposed GEF project aims at upgrading the existing capacity for fabricating SHP turbines and control equipment as well as establishes standards and quality assurance for the fabricated equipment. At present, no standards exist for locally fabricated SHP equipment. However, UNIDO has been holding consultation with Standard Organization of Nigeria (SON) in developing a quality control and standard for the fabricated equipment. The proposed GEF project aims to strengthen the capacity of the RC-SHP to a SHP technology centre with the specific goal of promoting market based exploitation of SHP in Nigeria and then Africa under four broad thematic components: (i) Policy and Quality assurance; (ii) Human and institutional capacity building; (iii) Knowledge sharing and technology transfer and (iv) Investment and market development.

The process of strengthening the RC-SHP will be achieved in two phases namely; a preparatory phase that will run for 6 months and an operational phase that will run for 42 months. The preparatory phase will prepare the centre for its operational phase as a technology centre. It is anticipated that the activities of the SHP-TC will continue beyond these two phases of 48 months by then the SHP-TC will be self-sufficient. Funds mobilization would be a continuous and

cross-cutting activity of the SHP-TC. To implement the two phases, the SHP-TC will actively mobilize financing from different partners and stakeholders. In addition, the SHP-TC will actively develop new programmes and projects and solicit for funds from development partners or respond to calls for proposals. Besides taking advantage of regular meetings and conferences organized by the regional organizations to meet development partners and private sector to mobilize funding, the SHP-TC would organize missions to meet development partners in their countries and at other international forums. It is foreseen that the SHP-TC will, in the long-term, organize regular donors' conferences or briefing sessions etc. In the early period of the operational phase, it is expected that the SHP-TC will develop at least 5 project proposals and submit to development partners to solicit for funding or other forms of support. Consolidation workshops will be organized in the six geopolitical zones of the country to identify and select technical experts, private sector representatives and entrepreneurs interested in manufacturing of SHP equipment locally.

In 2006, the RC-SHP was officially established in Nigeria. An approval for the establishment was granted by the Federal Executive Council of Nigeria. The Director-General of UNIDO officially inaugurated the RC-SHP in Abuja in July 2006. The Federal Government of Nigeria through the Energy Commission of Nigeria funded two phases of the RC-SHP. The host, Federal Capital Territory Administration in Abuja on behalf of FGN allocated an office space to the RC where the preparatory phase of the centre (this project) is planned to operate. All necessary agreements shall be updated. Although the RC-SHP is actually located in Abuja, the Centre will operate with a very minimal number of full time staff. It will however carry out most of the activities under its mandate through linkages with relevant national institutions and private sector. The proposed GEF project aims at building on the activities and achievements made by UNIDO through its RC-SHP in Africa Abuja, Nigeria. The RC-SHP has been receiving requests from private investors to provide technical assistance in carrying out feasibility studies and developing DPRs for potential sites. On this note, the project intends to implement the following activities: strengthen the RC-SHP to a SHP technology centre, increase the capacity of the locally manufactured turbines from 125 kW to 300 kW, develop a national standard for t locally manufactured turbines and create conducive environment for scaling up of SHP projects.

A.5. Incremental /Additional cost reasoning

As stated in A.4, SHP has an estimated power potential of 3,500 MW. If the power potential is developed it would meet about 23 % of the current estimated electricity demand. So far, approximately 1 % of the potential has been developed. For a GEF grant of USD 2,689,680 this project will contribute additional 3.1 MW towards the installed generating capacity with technical assistance in developing two SHP sites and promotion of replication sites with an estimated capacity of 69 MW. The demonstration projects are expected to build investors' confidence in developing SHP projects and are expected to generate a cumulative direct GHG emission savings of 349,424 t CO₂e. As a result of the successful implementation of the project, a replication factor of 10 is projected for developing potential sites by private investors leading to indirect savings of 3,494,240 t CO₂e.

Business-as-usual scenario

In the absence of the project, the water supply scheme dams (Okinni & Awara) will continue to rely on diesel generating sets to carry out their operational activities. Similarly, the deficit in energy demand and supply will continue to be met through petrol/diesel generating engines as stated in A.4 under energy scenario. Also, the 17 techno-economic feasibility studies carried out by the RC-SHP for the SHP potential sites will be left undeveloped.

As the energy demand and supply gap keeps on increasing, due to neglected investment over a long period of time by the State owned electricity utility, the continuous burning of fossil fuel for electricity generation and steady rise of CO₂e will continue. This situation is not going to change in the nearest future; therefore the private sector is encouraged to assist in developing the energy sector. However, investors are wary of developing the potential SHP sites due to the challenges associated with SHP development. Without the assistance of the GEF funding, developing the available SHP potential would be a challenging task due to high cost of electro-mechanical equipment and the awareness created about SHP technology would amount to nothing. Therefore, the basis of incrementality is diesel replacement. The GEF funding will be used for meeting the incremental cost of replacing diesel based systems with equivalent of 3.1 MW SHP systems.

GEF Project scenario

The proposed GEF project aims to establish the following:

- Improved human and institutional capacity for continuous development of SHP projects.
- Upgrade the capacity for local fabrication of SHP turbines and control systems up to 300kW in the country.
- Demonstration of SHP projects for a cumulative 3.1 MW on a Public-Private Partnership (PPP) basis leading to an overall emission reduction of around 349,424 t CO₂e.
- Conducive investment environment leading to replication of at least 32 MW. This would lead to an overall emission reduction of around 3,494,240 t CO₂e.

Two SHP plant will be integrated into existing water supply scheme dams to generate a cumulative power of 3.1 MW, with net power of 2.54 MW to be used by the water works and sold to the national grid. In the baseline scenario, the energy demand would have been generated from diesel generating sets. The investment for the proposed project is USD 8,303,201 which will replace the usage of diesel generators and reduce carbon emission over the plant's life time.

Table 3: Global environmental benefits and incremental cost

	Baseline	Alternative	Increment
Renewable electricity available for usage (MWh)	0	21,839 ¹⁴	21,839
Diesel electricity displaced emission reduction, t CO ₂ e	0	349,424 ¹⁵	349,424
Investment USD	3,800,000	8,303,201	4,503,201
Increment Cost USD/ t CO ₂ e	12.9		

Out of the above alternative investment cost of USD 8,303,201 GEF bears a cost of USD 2,689,680, which is approximately 30% of the total estimated investment cost. The total GEF resources of around 2.7 million is used to mitigate t CO₂ e at the rate of 12.9/ t CO₂ directly and around USD 1.29/ t CO₂ indirectly.

With regards to upgrading the capacity for local fabrication of SHP turbines and control systems, GEF funding will be used mainly for the incremental element in enhancing the existing local fabrication capacity from 125 kW to 300 kW, while co-financing resources will be used for arranging the technology partnership. Hence turbine capacities of up to 300 kW will be locally available. Turbines of such capacity need not be imported anymore; this will reflect on the implementation cost of the replication projects.

It is expected that the GEF's intervention will encourage private investors to act as co-financers and to source for funding at a low interest rate to develop the potential sites. Hence, GEF intervention will be strategic in harnessing the SHP potential in Nigeria.

Successful demonstration of the SHP projects will strengthen confidence, and create sufficient knowledge, technical and institutional capacity in the country. Locally manufactured turbine equipment and controls will reduce the overall investment to a considerable amount which in turn will encourage investors to invest in SHP projects.

All the above activities have created the right environment for scaling up SHP in Nigeria. GEF intervention will be timely and appropriate to achieve the country's goal of harnessing RE sources for rural electrification, removing all remaining barriers; specifically, (i) technology barrier through local manufacturing of turbines, (ii) inadequate institutional capacity through strengthening of institutional capacity and (iii) barriers in accessing financing.

¹⁴ Assuming a plant load factor of 95%, parasitic load of 12% and transmission and distribution losses of 5% and a lifetime of 20 years.

¹⁵ Assuming an emission factor of 0.8 t CO₂/MWh for diesel electricity generation

The project

The proposed project consists of the following 4 project components (PCs):

Project Component 1: Human and Institutional Capacity Building

This project component will mainly strengthen the capacities of the existing SHP Technology Centre for a more effective technical support on SHP project development; facilitate both human and institutional capacity building at various levels. Training will be a major activity in this component, various stakeholders such as: mini-grid experts, policy makers, project developers, private investors, relevant institutions, engineers and financial institutions will be trained in project development and implementation of SHP projects. Efforts will be made to ensure that at least 20 % of the participants at each level are women.

The trainings will be conducted by the SHP- technology centre; training of trainers will first be carried out to strengthen the capacity of the SHP technology centre. Appropriate fee will be charge per participant for the trainings conducted; the trainings will be conducted in the six geo-political zones for wider outreach. Nigeria is grouped into six geo political zones: Northwest, North central, Northeast, South East, South-South and South West. An in-house workshop on SHP development and financing was organized for the zonal managers of Bank of Industry (BOI) staffs during the PPG stage in anticipation for private sector participation in the SHP sector. The zonal managers are expected to transfer the knowledge acquired at the zonal level to their respective level.

Under this component, the project will build on the awareness and capacity created on SHP and strengthens it to achieve the expected outcome of improved awareness, knowledge and capacity on SHP technology. The awareness creation will focus more on the incentives available for private sector involvement and the availability of locally manufactured turbines with prospects of reducing development cost using co-financing resources. Based on the awareness created on SHP technology 5 private investors have shown interest in developing about 20 potential sites and requested technical assistance from the SHP technology centre in conducting feasibility studies on these sites.

Under this component, the project will work with the Ministry of Power, Ministry of Environment, Rural Electrification Agency, Energy Commission of Nigeria, BOI, and private investors, financing institutions, national and international experts to deliver the following output:

1. *Capacity of SHP technology centre in Nigeria strengthened;*
2. *Capacity building of at least 100 policy makers;*
3. *Capacity building of at least 50 project developers, relevant RE institutions and financial institutions.*

Capacity of SHP technology centre in Nigeria strengthened

Based on the awareness created on SHP by the SHP technology centre, requests are being received on a regular basis to provide technical assistance in conducting prefeasibility and feasibility studies on potential SHP sites. In order to sustain the awareness created already, qualified personnel will be engaged to carry out trainings as well as provide technical support in conducting feasibility studies.

The immediate objective is to develop SHP markets in Nigeria and then Africa so as to increase access to electricity for productive use. Also, to improve energy security through regional projects and programmes focusing on SHP market environment and the needs of market enablers and players in four broad areas of policy and quality assurance, human and institutional capacity building, knowledge sharing and technology transfer and investment and market development.

1. *Policy and quality assurance*

This component involves the provision of advisory services for the implementation of SHP policy in Nigeria and Africa so as to support the development of a harmonized policy, regulatory, and institutional framework conducive for scaling-up SHP development.

2. *Human and Institutional Capacity Building*

This component focuses on building capacities of public and private sector to develop and implement small hydro power projects/ programmes in Nigeria and then Africa by linking the RC with centres of excellence both locally and internationally to support knowledge development in SHP. Capacities will also be developed in knowledge sharing and awareness building in areas of SHP engineering, business development, clean development mechanism, support for rural electrification etc. Under this component, the RC would adopt the train-the-trainers approach that is, it will focus on training representatives of institutions or organizations that would in turn be able to train others in their respective institutions, organizations etc. The RC-SHP will offer various training programmes to various stakeholders within the SHP sectors such as policy makers, entrepreneurs, financial institutions and relevant institutions for which it charges fees. Efforts will be taken to encourage relevant Civil Society Organizations (CSOs) and interested individuals to participate in the trainings.

3. *Knowledge Sharing and Technology Transfer*

This component will facilitate portfolios of public/private sector participation in technology acquisition and transfer in the development of SHP. The component supports research and development through demonstrations and dissemination of SHP technologies and services. The component also supports the development of a pool of local expertise in all areas of SHP to promote local manufacturing of SHP equipment. Exchange and training visits between relevant institutions (faculty of engineering, public servants in relevant Government institutions, as well as indigenous technicians) and centres of excellence abroad including private sector manufacturers will be supported under this component.

4. *Investment and market developments*

The component focuses on the development of appropriate business models for SHP project development in Nigeria and other African Countries. Link private-public investors to technologies as well as financing institutions.

Capacity building of at least 100 policy makers

The project will identify at least 100 key policy makers within the Federal and State Governments cabinet and provide adequate training on SHP development. The training will be conducted in order for them to develop and implement policies that will support the implementation of SHP projects.

Study tours will be organized for the policy makers to visit the pilot and demonstration project sites using co-financing resources.

Capacity building of at least 50 project developers, relevant RE institutions and financial institutions

Under this output, training will be conducted for interested private investors, identified relevant RE and financial institutions to develop their capacities in SHP implementation. As described above, a fore sight step has been taking to train BOI ahead of project implementation during the PPG phase to set the ball rolling.

The following activities will be delivered under this project component:

- a) SHP technology centre will be strengthened to provide trainings to various stakeholders mentioned above. The SHP technology centre would be sustained through funds raised from the training activities that will be charged per participant and contributions from the various stakeholders. The centre will disseminate SHP information through various dissemination tools such as flyers, internet, workshops and social networking sites (SNSs). Necessary guide books, training materials and strategies for training recipients on SHP development will be modified and adapted to suite each of the stakeholder group mentioned above. The training materials will be posted on the RC-SHP website and disseminate copies of the training programme on CD ROM to stakeholders in the region. Relevant trainings will be conducted on demand and appropriate fee will be charged per participant.
- b) Appropriate regulatory policy and framework are required to promote and sustain SHP technology. Therefore, it is necessary to build capacity among policy makers; at least 100 relevant policy makers will be trained over the project period. The training will consider the knowledge status of the participants and their requirements. Training programmes targeted at policy and decision makers that cover policy, regulatory and legal issues for promoting SHP projects will be developed. Training to cover issues like, negotiating a Power Purchasing Agreement (PPA), supporting IPPs, setting feed in tariffs, strategies for decentralized power generation, in particular mini-grids for rural electrification will be developed as well.
- c) Project developers and key decision makers from relevant RE /technical institutions will be considered in the training programmes. At least 50 in each group will be trained on SHP development and implementation projects. Develop training programmes targeted at technical experts that cover design, development, manufacturing, and maintenance of SHP technology.
- d) Capacities of financial institutions will be developed for assessment and evaluation of SHP projects to increase their knowledge and capacity in financing these projects. The training programme will include business plan development, investment structuring and mobilization, negotiating PPA.

Impact of the intervention

From the outcome of this project component, it is expected that the barrier listed is removed:

Barriers / Challenges	How it is addressed
Lack of public awareness and participation through experience sharing	<ol style="list-style-type: none"> 1. Strengthening of SHP technology centre; 2. Training activities and information dissemination through various tools mentioned above.
Insufficient skills and experience for developing SHP projects	<p>Training organized for the following stakeholders:</p> <ol style="list-style-type: none"> 1. RE/technical institutions; 2. SHP project developers; 3. Relevant policy makers; 4. Financial institutions.

Project Component 2: Upgrading the Capacity for Local Fabrication of SHP Turbines and Control Systems in Nigeria.

This project envisages increasing the capacity of NASENI, EMDI for fabricating SHP turbines and control equipment up to 300kW. This would lead to further strengthening of local fabrication of SHP turbines and controls. Under this component, suitable technology provider having a proven track record in manufacturing SHP turbines and controls will be selected for transferring the technology on local fabrication of SHP turbines and controls. NASENI has a capacity to

fabricate cross flow turbine of up to 125 kW. So far, a 10 kW and two 35 kW cross flow turbines has been fabricated (see image 4). There is a need to increase the capacity of locally fabricated turbines in order to develop other sites with higher power potential. A business plan will be developed once the locally fabricated SHP equipment passes the performance test is. An investor's forum is then planned and implemented to commence the process of commercializing the product.

The following Research & Development (R&D) institutions/organizations were identified with a potential of fabricating hydro turbines:

1. Project Development Agency, Enugu (PRODA);
2. Hydraulic Equipment Development Institute NASENI (HEDI), Kano;
3. National Agency for Science and Engineering Infrastructure (NASENI), Abuja;
4. Engineering Material Development Institute NASENI (EMDI), Akure and
5. Science Equipment Development Institute NASENI (SEDI), Enugu.

The detailed survey for each R&D institution/organization and selection criteria is shown in Annex K. Under this component, the project will work with NASENI, BOI, Rural Electrification Agency, Standard Organization of Nigeria, national and international experts to deliver the following output:

1. *Enhanced local fabrication capacity for micro hydro turbines and control equipment up to 300 kW;*
2. *National standards developed for SHP electromechanical equipment in Nigeria*

Enhanced local fabrication capacity for micro hydro turbines and control equipment up to 300 kW

NASENI is a Government agency under the Federal Ministry of Science and Technology in Abuja with a vision to create an enabling knowledge driven environment for local mass production of standard parts, goods and services, required for the nation's technological advancement. There are eleven institutes in its organogram structure, one of them being EMDI that serves as the fabricating point for the turbines. EMDI can qualify as an Advanced Manufacturing Centre (AMC), with mini-foundries and mechanical workshops. NASENI's primary target is to empower Small and Medium Enterprises (SMEs) through impartation of technologies, engineering principles and practices for the production of equipment that will meet international standards.

NASENI Initiative in Small Hydro Power Equipment Manufacturing

In the long term, the Agency is working towards the establishment of small hydropower machinery and equipment development institute and a manufacturing industry to go along with it. However, in the short term, the agency is adopting a model, which will lead to a quick harvest of "low-hanging fruits" to show that it is do-able. Knowing that the "heart" of a small hydropower project is the turbine, a domestically made small hydropower turbine will therefore "leap-frog" the process of rural electrification and ultimately bring down the per kilowatt installation cost of small hydro power plants. Hence, NASENI's current focus on the local fabrication of small hydro turbine is to increase the available capacity from 125 kW to at least 300 kW.

Methodology

The agency is adopting the process of reverse engineering for this project in collaboration with identified stakeholders and some higher Nigerian institutions with relevant competencies listed below.

- i. Abubakar Tafawa Balewa University, Bauchi (ATBU);
- ii. Federal University of Technology, Minna (FUTM);
- iii. Federal University of Technology, Owerri (FUTO);
- iv. Federal University of Technology, Akure (FUTA) and

The fabrication unit will be set up for manufacturing SHP turbines and controls. The activities will enable high quality local fabrication of SHP turbines and controls up to 300 kW, which will sustain SHP related activities in the country. The project will complement NASENI's initiative and increase its fabricating capacity through technology transfer from a competent turbine manufacturer. Potential entrepreneurs with competent skills across the six geopolitical zones will be selected based on the experience in fabrication. Interested individuals with relevant fabrication knowledge will be considered during the selection process and encouraged to start fabricating after the training.

GEF resources will be used to procure the license for fabricating higher capacity of turbine locally. Co-financing resources will be used to conduct the technology transfer, competent personnel of NASENI and other relevant RE institutions with experience in SHP will be identified for the training. The training will focus on increasing the capacity of the turbine; therefore the initial recipient of the technology transfer will be given preference during selection of participants.

National standards for developed SHP electromechanical equipment

Standard Organisation of Nigeria (SON) has the sole responsibility for developing national policy on standards, standards specification, quality control and metrology, for manufactured industrial products and equipment. This component intends to collaborate with SON and relevant CSO in developing national standards for locally manufactured SHP electromechanical equipment, in accordance with International Standard Organisation requirement. During the PPG stage, SON was briefed about the prospects of setting a standard for the locally manufactured turbine and SON has agreed to support the project.

The project will develop the capacity of SON with GEF resources using best practices to set standards for testing and quality control of locally manufactured SHP equipment. Co-finance resources will also be used to equip SON's laboratory and train its staff in international standards requirement for small hydro turbines. International experts for small hydro turbine standards will be engaged to carry out the training.

Impact of the intervention

As a result of this component, it is expected that the following barriers will be addressed:

Barriers/Challenges	How it is addressed
Project cost reduction and component barrier	<ol style="list-style-type: none"> 1. Increase in turbine capacity and availability. 2. Availability of locally manufactured turbine.
Inadequate technology, knowledge and skill available for local fabrication of high quality equipment	<ol style="list-style-type: none"> 1. Technology transfer for fabricating turbines with capacity up to 300 kW. 2. Training to R&D institutions/ engineering companies. 3. Standards developed for locally manufactured SHP equipment. 4. Certified SHP equipment available for sale.

Project component 3: Promoting Investments in SHP Sector

This project component aims to promote investments in the SHP sector as widely as possible. The approach is to create a conducive environment to entice private sector involvement since SHP technology has been demonstrated and deemed viable in the country. Private investors and relevant financial institutions will be trained in SHP project implementation, as well as assessment and evaluation of SHP projects to increase their capacity on implementing and financing SHP projects.

Under this component, the project will work with BOI, financing institutions, Rural Electricity Agency, Ministry of Power, national and international experts to deliver the following output:

1. *Incentive systems designed for SHP projects;*
2. *Detailed feasibility studies for the replication SHP plants;*
3. *SHP of 3.1 cumulative capacity established;*
4. *Promotion of replication projects of 69.2 MW cumulative capacity.*

Incentive Scheme for SHP development

Presently, financial institutions lack experience in financing, as well as access to SHP projects and related project risks. This component intends to expose both financial institutions and investors to available financing investing schemes. GEF grant will be used for facilitating the financing scheme; the actual capital investment of the scheme is expected to come from outside of the project resources.

There is an existing incentive scheme for power generation called Power Fund Scheme which was introduced by CBN in March, 2010. Under the scheme, CBN provided NGN 500 Billion investment facility towards financing the real sector of the economy. The sum of N200 billion has been set aside for the refinancing/restructuring of SME/ Manufacturing portfolios while the sum of N300 billion will be applied to power and airline development projects in the country. The fund is administered by BOI, while the African Finance Corporation serves as its adviser. The proposed financial incentive scheme for SHP development is to incorporate SHP projects into the CBN scheme. BOI is acting as a facilitator for rapid industrialization of the country and is already collaborating with some State Governments in accessing the fund for rapid development of industrial clusters.

For an IPP to be eligible to access the fund the following criteria must be met:

- i. Any corporate entity, duly registered in Nigeria, involved in electricity power supply value chain that includes power generation, transmission, distribution, and associated services;
- ii. Eligible projects can be promoted by private or public sector sponsors (or a combination of both) but must be structured either as profit-oriented business or a public service, provided that contracted cash-flows or financing support exist to ensure repayment of principal and interest, as well as long term viability;
- iii. The IPP may also offer appropriate credit enhancement options to support its financial obligations;
- iv. The Project could be already existing and in operation, in design/development, under construction, or existing but operationally inactive;
- v. The refinancing of existing loans for captive power projects for corporate entities that are not power companies will only be eligible if the investments are not older than 2 years from the date of the application. For the avoidance of doubt, this restriction will not be applicable to captive power projects implemented and managed by power companies.

The following types of facilities are available: (i). Long term loans (for new Power Projects) (ii). Refinancing of existing loans (iii.) Refinancing of existing leases. Modalities for accessing long term loans for new power is as follow:

- The Fund facility shall not be more than 70 percent of the total cost of the project;
- The Fund loans shall have a maximum tenor of 15 years as determined by the project's cash flow profile not exceeding 31st July, 2025;
- Working capital facility shall be of one year duration with provision for roll-over but not more than 5 years;

- Repayments under this facility shall be amortised;
- The Fund allows for moratorium in the loan repayment schedule, the moratorium on principal shall depend on the type and nature of the project and shall not exceed either the construction period of the project (which shall not exceed 5 years) or the time required to complete the project;
- Additional moratorium period of [18] months may be added to the moratorium period in order to address the risk of completion delays;
- Protracted completion delays could be addressed through other mechanisms such as adequate sponsor support and contingencies to be determined on a project specific basis;
- The treatment of Interest during Construction (IDC) shall depend on the project. The two options allowed under the funds are: i. Capitalization of Interest - interest shall accrue and be capitalized accordingly during the moratorium period and ii. Pre-funding of Interest - interest shall be funded during construction from a prefunded IDC Account. The amount required for IDC can be added to the total project cost. The IDC payment option adopted shall be expressly stated on the loan documents.

The collaborating States and private investors can access the funds through BOI. This will facilitate funds mobilization and implementation of the projects. This approach is good financial incentives to investors which will in-turn facilitate replication of SHP projects across the country. Efforts will also be taken to collaborate with other stakeholders like Ministry of Power, CBN, ECN, Ministry of Water Resources and commercial banks to create a similar financial facility exclusively for SHP projects.

Part of the GEF grant will be used as an incentive to complement the BOI credit line. The incentive will be based on a pro rata basis; USD 300/kW will be made available for potential investors that have done considerable background work on potential SHP sites to assist in developing the sites. For a potential site to qualify for the grant, the site must have a detailed engineering document and minimum of 50% of the implementation cost sourced.

Similarly, efforts will be taken to consolidate and streamline various support schemes by departments/ministries into a centralized one that will be managed by national experts along with international experts. Low interest rate and long term financing scheme like will be encouraged to be in place to sustain the incentive scheme for private investors. SHP plants of 3.1 MW cumulative capacity will be installed at the identified demonstration sites using GEF resources to demonstrate the economic viability of SHP.

Detailed feasibility studies for the replication SHP plants

During the PPG stage, requests were received from private investors as well as individuals to provide technical assistance in conducting feasibility study and preparing bankable DPR on about 20 potential SHP site. Based on the requests, the feasibility studies to be carried out under this output for the demonstration projects in the original PIF have been replaced with the replication sites. Feasibility studies have been carried out for the demonstration projects already and bankable DPRs designed for the sites. Technical assistance will be provided to the private investors to conduct detailed techno-economic feasibility studies on the potential replication sites and GEF resources will be used for at least 2 sites. After the feasibility studies have been carried out the investors will be introduced to the financing scheme available to develop these sites.

SHP of 3.1 MW cumulative capacity established

This output aims to demonstrate the integration of SHP of 3.1 MW cumulative capacity into existing dam structures. RC-SHP, Abuja has undertaken several assessments and identified potential sites for further development as shown in Annex G. Table 3 lists the intended demonstration sites and their estimated capacities. The GEF funding will be directed towards technical assistance for implementation of the sites such as preparation and launching of tender documents, evaluation of tender, selection of equipment supplier. Co-financing resources will be used to carry out the required civil works and implement the project.

Table 4: Identified SHP sites for development

S/N	Project Name / Location	Investor	Estimated Capacity (kW)	Co-financing (\$)
1.	Okinni Dam SHP project – Erin Ijesha, Oriade LGA, Osun State	Osun State Government	1,900	1,525,403
2.	Awara Dam/ Oyimo River SHP project, Awara Dam, Akoko North East LGA, Ondo State	Ondo State Government	1,200	6,777,799*
Total			3,100	8,303,202

* Ikare Oyimo SHP requires an impounding weir, which entails some high amount of civil works

The sites indicated above were studied and designed by RC-SHP, Abuja. The results were compiled in project reports which comprise techno-economic feasibility study / analysis of each site (please see Annex I). Assisting the State Governments in developing these sites will enhance replication of SHP projects implementation across the country and indeed Africa. Awara/Oyimo site has a high implementation cost attributable to the civil works that is required to be in place. The remaining site is an existing water supply dam with the aim of integrating SHP into it; minimal civil works are required for this site. In accordance with the Environmental Impact Assessments conducted as part of the SHP site feasibility studies, the project is not expected to cause any detrimental environmental and/ or social impacts.

Okinni dam SHP project

The SHP project is proposed to be integrated into Okinni dam built on Erinle River; this is one of the water supply schemes of Ministry of Water Resources and Rural Development, Osun State. The Okinni dam and water supply scheme is located in Egbedore local Government area of Osun State, and the dam has a capacity of 94 million m³. Due to epileptic power supply and increasing cost of diesel powered generation, the operation and maintenance cost of Okinni dam and water works has become one of great concern to the State Government.

A feasibility study was carried out in 2008 by the RC-SHP at the request of the State Government. The site has a power potential of 1,900 kW with a net head of 75.8 m and design flow of 5.41 m³/s. The total minimum load demand of the facilities and community around the dam is 2,137 kW. From the financial analysis it has a payback period of less than 5 years with Multi Year Tariff Order (MYTO) tariff in place. Co-financing resources will be used to implement this project.

Awara dam /Oyimo river SHP project

The Awara dam/ Oyimo River is about 7km off the Ikare-Ado-Ekiti motorway. The immediate communities are residential dwellers as well as Orimolade CAC Community and a lot of agricultural activities are carried out in the immediate environment. Widespread access to electric power is yet to be fully met in the Awara community since the existing 11 KV radial line is not energized. The water treatment plant at the dam is not fully operational as a result of delay in energizing the 11 KV radial network. The dam relies on two diesel generator sets for its energy supply to carry out its operational activities. The Ondo State Government is concerned about the high operating cost of the dam and resolved to source for an alternative, cheaper and reliable source of power.

On this note, the State Government requested the RC-SHP to carry out a feasibility study on Awara dam and Oyimo River. The hydrology report revealed that the power potential for SHP, if built at Awara dam, would not generate adequate power to run the water treatment plants. However, since Oyimo River is about 5 km from Awara dam and with better hydrology analysis, it was selected for the SHP plant. The SHP to be built comprises three units of 400 kW power turbines generating a total of 1.2 MW of electricity. The site has a power potential of 1,200 kW with a net head of 10 m

and design flow of 0.11 m³/s. The total load demand of the water scheme is 236 kW. From the financial analysis it has a payback period of 7 years with MYTO tariff in place.

These intended projects will meet the energy demand for both dams, as well as supply excess electricity to the national grid in the case of Ikare/Oyimo SHP project. The project owners will provide necessary support and cooperation to conduct socio-economic baseline analysis for the community level and an impact assessment study that will be carried out at the end of the project. During this stage, participating State Governments, financing institutions, equipment suppliers, engineering companies and various experts will be involved. The GEF grant will be used for preparation of business models, tender documents for the demonstration plants and partial funding of equipment as well as for carrying out feasibility studies for the potential replication sites.

Micro Hydro Turbine

Micro hydro turbine has the capacity of generating electricity from a few watts up to hundreds of kilowatts from rivers with low head characteristics. Some micro hydro turbine can generate electricity with practically zero head, because it is powered by kinetic energy and not potential energy. As such, penstocks /canals are not required which constitute a large amount of the civil works cost. The use of micro hydro turbine in developing SHP projects will drastically reduce the implementation cost of the project. The turbine is ideal for remote areas that have access to flowing river and lack access to electricity. It offers an alternative to petrol/diesel generators which are commonly used in these areas. The turbine will be used in the replication sites and fabrication of the turbine locally will be encouraged.

Promotion of replication projects of 69.2 MW cumulative capacity

One of the objectives of the project is to promote investments in the SHP sector of the country. During the PPG stage quite a number of requests were received from private investors seeking for technical assistance from the RC SHP to conduct feasibility studies on potential SHP sites. Based on the requests, a new output has been included under this project component.

Under this output, the project will work with BOI, private investors and Rural Electrification Agency. Using co-financing resources, detailed feasibility studies will be carried out for the replication sites. The project will ensure that replication sites with detailed techno-economic feasibility study reports gets access to the power fund scheme to develop and implement the sites. After the implementation of the project it is expected the promotion of replication projects will still be ongoing.

Impact of the intervention

The expected outputs and outcomes of this component will mitigate the following barriers:

Barriers/Challenges	How it is addressed
Inadequate private sector investment in SHP	Increased investments from private sector in developing SHP projects.
Lack of adequate financing scheme	1. Awareness created on the power fund scheme; 2. Investors gaining access to the power fund; 3. More SHP projects being developed.

Project Component 4: Monitoring & Evaluation (M & E)

This project component aims at monitoring and evaluating the project implementation process. M & E plan will be carried out throughout the project implementation; the project will be subjected to a mid-term and final evaluation. The project will be evaluated on the expected outputs and outcomes.

After completion of the project, the project performance monitoring will be conducted to study the technical, financial, environmental and socio-economic performance of the projects. Full scale project demonstration site visits and seminars will be organized and the project experiences will be disseminated to various interested stake holders in order to increase the replication potential of the project. Various dissemination tools such as leaflets, website, etc., will be used for effective distribution.

Under this component, the project will work all project stakeholders, partners and contractors to deliver the following outputs:

- 1. Mid-term evaluation report prepared;*
- 2. Final evaluation report prepared;*
- 3. Lesson learning and information dissemination;*
- 4. Methodologies and tools developed for better planning and decision making.*

Mid-term evaluation report prepared

A mid-term M&E will be conducted at the end of the 2nd year of the project implementation and corrective action will be taken based on the evaluation report. National and International experts on evaluation will be engaged to carry out the evaluation using co-financing resources from UNIDO.

Final evaluation report prepared

An independent final evaluation will take place three months prior to the terminal review meeting. The final evaluation will look at the impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental benefit goals. It will also provide recommendations for follow-up activities to interested stakeholders, in order to increase the development of the potential sites. The end of project report will be made available on UNIDO's website and used for effective dissemination. National and International experts on evaluation will be engaged to carry out the evaluation using co-financing resources from UNIDO.

Lesson learning and information dissemination

An annual report and periodical newsletter on best practices, information on country level projects and key indicators of progress made under the project will be prepared and distributed to the key stakeholders and agencies. Annual reports will be submitted to GEF secretariat in the form of Project Implementation Reviews (PIRs). Project implementation schedule is shown in Annex E.

Methodologies and tools developed for better planning and decision making

Methodologies and tools developed during the project implementation will be documented; the collated information will be used for better planning and decision making. Case studies will be prepared and presented to raise more investment in SHP projects, using the trained capacity and various financing schemes that are created. UNIDO in-kind contribution will be used for this output.

Global environmental benefits

Baseline for all the intended projects:

The project will reduce CO₂ emissions directly, as well as indirectly and will improve the electricity supply situation in Nigeria through the installation of 3.1 MW SHP plants. Direct benefits will be derived from the implementation of the project and indirect benefits will be derived from the replication of similar projects within 10 years from other potential

sites. The overall emission reduction to be derived from the intended projects is estimated based on “Manual for Calculating GHG Benefits of GEF Projects Renewable Energy Projects”¹⁶:

- Diesel electricity¹⁷ is taken as the baseline (emission factor of 0.8 t CO₂/MWh is considered)¹⁸
- Emission reduction potential from the intended projects is presented in table 4.

Table 5: Emission reduction potential in intended projects

S. No.	Name of Project	Demonstration Capacity (kW)	Annual electricity generation (MWh/year)	Annual (t CO ₂ e) reduction
1.	Okinni Dam SHP	1,916	12,379	9,903
2.	Awara Dam/Oyimo River SHP	1,200	9,460	7,568
	Total	3,116	21,839	17,471

Note: Capacity and annual electricity generation figures are taken from the respective feasibility study reports.

Direct emission reduction:

SHP plants with 3.1 MW cumulative capacity will directly result in reduction of GHG emission, through electricity generation that replaces diesel generators usage by the dams. The direct emission reduction is calculated using fuel savings attributable to the investment. Using 3.1 MW as gross capacity and 95% load factor, 12% of parasitic load and 5% transmission and distribution losses, the net 2.47 MW will be the power available for sales. The power plant can operate 8,760 hours in a year.

Cumulative capacity	: 3,116 kW
Load factor	: 95%
Parasitic load	: 12%
Transmission and distribution losses	: 5%
Annual electricity generation	: 3,116 kW x 0.95 = 2,960.2 kW
	: 2,960 kW x 0.12 = 355.2 kW
	: (2,960- 355) kW= 2,605 kW
	: 2,605 kW x 0.05 = 130.3 kW
	: (2,605-130.3) kW = 2,474.7 kW
	: 2,474.7 kW x 8,760 hours= 21,678,372 kWh
	: 21,678 MWh

Box 1: Electricity generation calculation

Hence, the net amount of electricity is 21,678 MWh. The power plants have an average lifespan of 20 years, over the average lifespan the SHP plants will replace diesel) based electricity. The emission factor for baseline scenario is 0.8 tCO₂e/MWh.

¹⁶ https://www.thegef.org/gef/sites/thegef.org/files/documents/C.33.Inf_18%20Climate%20Manual.pdf

¹⁷ Although diesel generators are used to supplement grid electricity, conservatively only diesel electricity is considered for calculating emissions.

¹⁸ <http://www.iges.or.jp/en/cdm/report.html> (IGES)

Amount of electricity generated	(A)	: 21,678 MWh
Emission factor for grid connection	(B)	: 0.8tCO ₂ /MWh
Average lifespan of plant	(C)	: 20 years
Direct Emission Reduction		: A x B x C = 21,678 MWh x 0.8 tCO ₂ /MWh x 20years = 346,848 t CO ₂ e.

Box 2: Direct emission reduction calculation

The direct emission reduction from the generated electricity, which replaces diesel usage in the baseline scenario, is 346,848 t CO₂e.

Indirect emission reduction (Bottom-up Approach):

The approach used to calculate indirect emission reduction is bottom-up approach, which considers only the number of times that the project might be replicated after the project completion. It is expected that after the project completion and the plants running successfully, private investors will invest in similar SHP projects across the country. In this case, the project has long term emission reduction after the project has been completed through the installation of similar projects. It is conservatively assumed that a minimum of 31 MW cumulative capacity of SHP plants would be replicated within a period of ten years. The replication will have a factor of ten, therefore:

Direct emission reduction	(A)	: 346,848 t CO ₂ e
Replication factor	(B)	: 10
Indirect emission reduction		: A x B = 346,848 t CO ₂ e x 10 = 3,468,480 t CO ₂ e.

Box 3: Indirect emission reduction calculation

The overall emission reduction benefits from the proposed project using a replication factor of 10 are summarized in table 5.

Table 6: Overall emission reduction benefits of proposed project

S. No	Type of benefit	Emission reduction (t CO ₂ e)
1.	Direct reduction	346,848
2.	Indirect reduction	3,468,480

The increment of the project:

Under PC 1, the GEF funding would be used for strengthening the SHP technology centre to develop existing human and institutional capacity in SHP technology. Under PC 2, the GEF funding will be used mainly for the incremental element in upgrading the existing local fabrication capacity from 125 kW to 300 kW. This will enable the local availability of turbine capacities up to 300 kW and thereby drastically bring down the cost of SHP projects in the country and facilitate replication. Under PC 3, a part of the incremental cost will be used for creating a conducive environment and capacity based incentive facility for private investors. Under PC 4, the GEF resources will be used for funding the incremental cost of monitoring and independently evaluating the intended projects as well as other project

components to ensure that the global environmental benefit objectives of the project are met. Table 6 summarizes the scenario before and after the project.

Table 7: Baseline and After the Project Scenario

No.	Baseline Scenario	After the Project Scenario
1	Local fabrication of MHP equipment and controls up to 125kW available. Higher capacity equipment to be imported leading to higher investment cost.	Local fabrication of MHP equipment and controls up to 300kW available.
2	Low level of SHP development	Increased level of SHP development.
3	No financing facility to attract investors in SHP.	Enabling environment created to attract investors in SHP.
4	Low human and institutional capacity.	Improved human and institutional capacity.
5	Low rural electrification rate.	3.1 MW added capacity and replication projects to add more capacity for rural electrification.
6	Usage of diesel for electricity needs.	Reduction in diesel usage.

Without the GEF-UNIDO intervention, the baseline scenario will continue to linger for a while as seen with the available engineering design documents not been developed. If at all one or two sites were developed the sustainability and replicability of the sites would not have an impact as high as with the GEF-UNIDO intervention.

Innovation

This project provides an innovative approach to barriers and challenges faced by SHP development and the inadequate electricity generation in the country, through local fabrication of SHP electromechanical equipment. Upgrading the capacity for local fabrication of turbines up to 300 kW will reduce the cost of SHP equipment as well as the implementation cost. This project emphasises market transformation through scaling up and leveraging previous work done in the area of SHP development in Nigeria. This is an innovative approach to take advantage of the 100 MW of SHP potential ready for implementation identified by the UNIDO Regional Centre for SHP projects in Nigeria (see Annex G).

Local fabrication of SHP turbines and controls is entirely new to Sub-Saharan Africa. As of now, local fabrication of SHP turbines and controls up to 125 kW exist only in Nigeria, owing to UNIDO's efforts in developing the SHP sector in the country. This project aims to strengthen the fabrication capacity of up to 300 kW. This is an innovative approach for expediting the SHP scaling up process.

Sustainability

Unless locally manufactured turbines and controls are of standard quality and certified by a Government agency, project developers would be reluctant to buy them. Hence, the project would work along with SON, Federal Ministry of Industry for creating standards for SHP turbines and controls.

If locally fabricated turbines and control for a higher capacity (at least up to 300 kW) are available, it would remove technology barriers significantly in terms of difficulties in importation and related cost and would expedite SHP scaling up. Successful implementation of the demonstration projects will encourage private investors and interested group to develop the available potential sites and generate energy for productive use. The strengthening of the SHP technology centre will lead to capacity development activities at the centre and rendering consultancy services to prospective clients.

A nominal fee would be charged for the consultancy services and development activities to be rendered by SHP technology centre. The funds generated would be used to sustain the activities of the technology centre.

The RC-SHP has been sustaining itself through the consultancy services and assistance from UNIDO would make it more self-sufficient. The demonstration projects will be operated and maintained by the private investor/ State Government and the host community staff. The staff of the demonstration plants will be trained in operation and maintenance of the SHP plants by the technology centre. This approach will ensure the sustainability of the demonstration projects after the project implementation is over.

Scaling up

Upgrading the existing local fabrication of SHP turbines and controls up to 300 kW would ensure reduced project implementation cost and would attract investors to develop the SHP sector. Four private investors have shown interest in developing about 23 of the potential sites; requests have been received to assist them in conducting feasibility studies. Lantarki Energy Ltd has already shown interest in developing three of the potential sites. Six of the remaining 20 sites still require feasibility study to be carried to determine the power potential.

Lantarki Energy Ltd

Lantarki Energy Ltd is an indigenous energy company in Nigeria. It focuses on energy development using renewable energy sources and has a license from NERC to operate as an IPP. Lantarki has shown interest in developing three potential SHP sites with a cumulative capacity of 2,413 kW. Lantarki Energy has sourced for funds to develop these sites on its own. Hence, the start and completion of these sites are wholly Lantarki's decision.

S. No.	Name of Project	Demonstration Capacity (kWe)	Annual electricity generation (MWh/year)	Annual tCO ₂ e reduction
1	Kangimi Dam SHP	1,671	12,096	9,676
2	Doma Dam SHP	450	1,976	1,580
3	Zobe Dam SHP	291	2,300	1,840
	Total	2,412	16,372	13,096

As a result of these activities, it is conservatively assumed that at least 31 MW of SHP plants will be replicated using a replication factor of 10. This will reduce the CO₂ emissions considerably and will also improve the energy supply situation in Nigeria. The project will avoid 349,424 t CO₂e emission directly and 3,494,240 t CO₂e emission indirectly. Table 8 lists 14 potential sites with DPR for replication selected by the Government and private investors for development. However, the assumption is based on development of 50 % of the sites for calculation of indirect emission reduction. Table 9 shows potential sites that require feasibility studies and detailed engineering design to be carried out. Four private investors have requested the RC-SHP to provide technical assistance in carrying out the feasibility studies and developing bankable document. Based on these requests an additional output has been included to PC 3. The aim is to assist the private investors to develop a DPR and get access to funds for implementation.

Table 8: List of potential SHP sites for replication

S/No.	Site name	Power potential (kW)
1.	Unical, SHP Cross River State	6,500
2.	Balanga dam, Gombe State	720
3.	Kabomo SHP, Katsina State	480
4.	Magama dam, Kaduna State	7,035
5.	Asa dam, Kwara State	1,170
6.	Ikpoba dam, Edo State	3,100
7.	Tiga dam, Kano State	7,000
8.	Tede dam, Nasarawa State	20,000
9.	Kogi dam, Kaduna State	14,500
10.	Kangimi dam Kaduna State	1,642
11.	Doma dam, Nasarawa State	450
12.	Zobe dam, Katsina State	291
13.	Ibrede creek SHP, Delta State	400
14.	Ikere gorge, Oyo State	6,000
	Total	69,288

Table 9: List of potential SHP requesting for technical assistance

S/No.	Site name	Power potential (kW)
1.	Malumfashi, Katsina State	-
2.	Itisi dam, Kaduna State	-
3.	Agbokim waterfalls, Cross State	-
4.	Sagbama creek, Bayelsa State	-
5.	Ekeremor creek, Bayelsa State	-
6.	Opuokede creek, Bayelsa State	-

A.6 Risks

Table 10: Risks Associated with the Projects

Component	Risk	Proposed Mitigation Measure	Risk Level
Technical risks	There is no indigenous technology for SHP in Nigeria and the country currently depends upon the importation of components and peripherals from other countries.	<p>Already, UNIDO has transferred technology for fabrication of cross-flow turbines for MHP up to 125 kW. This has reduced the level of dependency on other countries to a certain extent. The training for local fabrication of SHP turbines and controls is planned as a part of the project. With UNIDO's prior experience, the technology can be transferred very effectively to the local manufacturers. Human and institutional capacity will be built effectively. Hence, the acquired knowledge and skills will be used to mitigate against the technical risks</p> <p>Moreover, SHP requires only minimum maintenance and poses lesser problem from the point of view of technical aspect.</p>	Low
Market risks	No off-takers for the generated electricity.	The electricity generated will be supplied to the local communities and industries nearby the power plant. The demand and supply gap is wide and hence will not be any risk for electricity off-take.	Low
	Low market for SHP turbines and components.	The replication potential for SHP is high (82 MW). Enabling environment for investment will be created at the end of the project. Therefore the market for SHP turbines and components will be mitigated.	Moderate
Financing risks	The general perception is that investments in SHP based plants do not provide enough (high) returns and hence investors will not be willing to invest in SHP replication projects.	<p>The project will create awareness about the benefits of SHP projects among the private investors. It will also facilitate fund / financing scheme which would encourage and sustain SHP development. These activities will eliminate the perceptible risks of the project.</p> <p>All the components of the project will bring in improved awareness, knowledge and experiences to the stakeholders involved in SHP plants project.</p>	Moderate

Component	Risk	Proposed Mitigation Measure	Risk Level
		The successful operation of the proposed projects will enhance the stakeholders' participation, especially, the financial institutions. This will ensure successful replication of the project.	
Policy and regulatory framework	No specific policies on SHP to facilitate enhanced scaling up	The project proposes FiT specifically for SHP which, when in place, will significantly improve the development of SHP projects	Low
Government / political risk	Change of RE policies due to change of Government.	Electricity access is the key parameter essential for Nigerian economic growth. Even when the government changes, there is lesser possibility that the existing RE policies will be discontinued, as most of these policies were implemented by Government Ministries.	Moderate
Co-financing risk	Co-financing not being committed by co-financiers.	Enough consultations have been done already with the stakeholders. Letter of commitment will be obtained from the co-financiers to ensure their financing of the project.	Moderate
Climate change risk	Drying of water resources.	Based on the feasibility study report the demonstration projects are not vulnerable to drought.	Very low
	Risk of flooding.	Nigeria is vulnerable to low flooding only. Proper spillways and diversion channels will be constructed to overcome this risk in the flood prone sites.	Very low

A.7. Coordination with other relevant GEF financed initiatives

The project will build on experiences and achievements of the following projects to ensure that it is complimentary to each other.

1. *Local capacity development to design and manufacture MHP at NASENI*: The main objective of the programme was to promote fabrication of turbines and control systems up to 125 kW. The proposed project is complementary to this programme as it aims to increase the local fabrication capacity at least up to 300 kW.
2. *Rural Electrification and Renewable Energy Development*: This is a GEF-World Bank completed project. The objective of the project was to expand and intensify electricity access, pilot projects and support the implementation of the National Renewable Energy Master Plan. The proposed project is complementary to this project as it aims at increasing rural electrification by implementing SHPs for a cumulative capacity of 3.1 MW.
3. *Enabling Activities for the Implementation of United Nations Convention on Climate Change (UNFCCC)*: This is a GEF-UNDP completed project. The objective was to make the initial national communication to UNFCCC. The proposed project is complimentary to the above project as it aims at increasing the use of RE sources for electricity generation by implementing SHP plants.

4. *Small-scale associated gas utilization in Nigeria:* This is a GEF-World Bank ongoing project. The objective of this project is to pursue a low-carbon development path by using associated gas, which otherwise would have been flared. The proposed project is complementary to the above mentioned project as it increases the use of clean forms of energy in rural electrification by using SHP based mini-grids.
5. *SPWA-CC Mini-grids based on RE Sources to Augment Rural Electrification:* This is a GEF-UNIDO ongoing project. The project focuses on biomass based mini-grid, develops the capacity for replicating biomass mini-grid technologies and improves the capacity on biomass power plant operation and maintenance (O & M). The proposed project is complimentary to this project as it promotes SHP based mini-grids for rural electrification and aims at strengthening human and institutional capacity and improving the capacity for SHP plant O&M.
6. *Climate Change Training Phase II - Training Programme to Support the Implementation of the UNFCCC:* This is a completed GEF-UNDP global project. Its objective was to create an informal training network for sharing the training resources developed by other programs and institutions and to enhance the capacity of the participating countries to implement the UNFCCC by facilitating the establishment of a national institution. The proposed project is complimentary to this project as it aims at strengthening the SHP technology centre for effective technology dissemination.
7. *SPWA-CC: GEF Strategic Program for West Africa: Energy Component (PROGRAM):* This is a GEF-UNIDO ongoing global project under GEF 4 cycle. It uses a programmatic approach for ensuring greater coherence in the formulation of RE and EE projects developed under GEF 4 cycle and promotes greater synergies in their implementation. The coordination aspect of this project could be complementary to the proposed project.
8. *SPWA-CC: Promoting Coherence, Integration and Knowledge Management under Energy Component of SPWA:* This is a completed GEF-UNDP global project. The objectives were to develop comprehensive knowledge data base on energy resource endowment, key players, institutions and agencies working in the field of EE and RE and to develop appropriate policy and institutional structures for scaling up RE and EE energy projects. The proposed project is complimentary to this project as it aims at strengthening the SHP technology centre. Also, the knowledge data base derived from the GEF-UNDP project would be used for the proposed project and would be channelled and utilised for SHP technology penetration in Nigeria
9. *Efforts of ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE):* This was established by ECOWAS Commission with the support of the Austrian Development Cooperation (ADC), UNIDO and the Government of Cape Verde. The project will complement the efforts and objectives of ECREEE in the way of popularizing RE through demonstration projects, policy initiatives and technology transferred. The proposed project will complement the above mentioned efforts by popularizing SHP projects through demonstration, technology transfer for equipment fabrication, etc.

B. ADDITIONAL INFORMATION NOT ADDRESSED AT PIF STAGE:

B.1 Stakeholders' engagement

The proposed GEF project implementation arrangement is given below:

Implementing Agency

UNIDO is the only GEF Implementing Agency involved in this project and no specific arrangement with other GEF Agencies is sought.

Executing Agencies

Federal Ministry of Power (FMP) and Energy Commission of Nigeria (ECN) will be the two main executing

agencies coordinating with UNIDO.

Other partners include Rural Electrification Agency (REA), Federal Ministry of Environment FME), Ondo State Governments (ODSG) and Osun State Governments (OSSG).

Project Implementation Arrangement

UNIDO will implement the project and is responsible for the achievement of the expected outcome, in collaboration with FMP, ECN, REA, FME, OSSG, ODSG and related government departments and ministries (see figure 6).

Figure 6: Diagram of project management structure.

Federal Ministry of Environment (FME)

Federal Ministry of Environment (GEF focal point), will guide the execution as chair of the Steering Committee. Federal Ministry of Power, Rural Electrification Agency, River Basin Development Authorities, Energy Commission of Nigeria, State governments, banks/financial institutions are the main stakeholders. Private investors and local fabricators will benefit through capacity building and training activities.

Federal Ministry of Power (FMP)