LOW-CARBON AFRICA: NIGERIA

POVERTY

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1. COUNTRY CONTEXT

Nigeria experiences a tremendous paradox – the abundance of energy resources and widespread poverty. The country is home to 102 million extreme poor – one-in-four of Sub-Sahara Africa's total. It is also the region's largest exporter of crude oil. Today, low access to energy services accounts, in part, for the slow progress against poverty in the country.

Only about 40 per cent of the Nigerian population have access to the country's broken electricity grid. About 95 million rely on traditional use of wood energy for cooking. According to the World Health Organisation, 79,000 Nigerians die each year as a result of smoke from three stone fires. After malaria and HIV/AIDS, this is the largest killer in the country.

The singular most important source of greenhouse gas emissions in the African continent is from gas flaring in the Niger Delta. This not only contributes to the build up of these harmful gases; it represents a huge waste of opportunities to address widespread energy poverty. The amount of flared gas in the Niger Delta would meet all of Nigeria's energy needs, including that of the rest of West Africa. This opportunity for growth, poverty and emission reduction continues to be untapped.

In almost all cases in Nigeria, strategies required for growth and poverty reduction are consistent with low carbon development. From gas flare out programmes to the development of the abundant hydropower, bioenergy and solar energy potentials – projects required to implement low emission reduction policies are consistent with the country's Vision 2020, a blueprint for economic growth and development. However, progress is stymied by weak policies, vested interests and poor financing.

The scale of financial requirements for low carbon emission reduction implementation in Nigeria is significant. It is estimated that Nigeria requires US$200 billion to close the existing infrastructure gap, mostly power but also transport and water. According to an International Centre for Energy, Environment

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and Development research, in the next 10 years, Nigeria requires about US$32 billion to meet the cost of power generation from hydropower and gas alone. The cost of transmission and distribution infrastructure will almost require as much. Today, the flow of domestic private sector finance as well as international investment is unable to close this gap. International climate financing has a key role to play in de-risking investments, meeting potential incremental costs, supporting market expansion measures, funding small scale community based low carbon projects and building capacity. However, the scale of current international climate finance does not match these needs, and existing financial resources often bypassed the poor.

This analysis presents a broad overview of the challenges and opportunities of low carbon policy and implementation in Nigeria. It mobilises the power of examples, by identifying case studies that can inspire ambitious transformation programmes. Finally, it provides some thoughts on the potentials of a leapfrog fund, the gaps it can fill, policies that will enable it, and partnerships that can make the fund transformative.

1.1 Review of Nigeria's current energy situation

Nigeria is blessed with abundant sources of energy, including oil and gas, hydro, biomass and solar energy. The following is an overview of Nigeria's energy resources, supply and demand.

Fossil fuels: Nigeria is Africa's largest oil-producing country and accounts for nearly a third of the continent's crude oil reserves. It ranks second in natural gas, after Algeria. The country has large reserves of bitumen and lignite. Petroleum export is the mainstay of the Nigerian economy.

Renewable energy: Nigeria has abundant renewable energy resources especially solar, hydro and biomass (as shown in Table 1). However apart from biomass, which constitutes over 70 per cent of total energy consumption and large hydropower, the share of renewable energy in the nation's overall energy supply mix is small.

The table below summarizes the nation's energy reserves.

Nigeria's current crude oil reserve is 35.5 billion barrels. In energy terms, Nigeria's surpasses the crude oil reserve. It is currently estimated at 187.44 trillion standard cubic feet discovered in the course of oil prospecting. The country has significant tar sand, coal and lignite, bitumen and uranium deposits.

According to the National Energy Master Plan of 2006, current exploitable large hydropower resource is 11,250MW and small hydropower is 3,500MW. However, only a fraction of these potentials have been exploited for several reasons including weak government policies, unsupportive regulatory framework and generally low investments in infrastructure by both government and the private sector.

Located along the tropics, Nigeria receives significant solar radiation. Solar radiation for the country is estimated 3.5-7.0KWh/m2 – day. In energy terms, this is several times the current energy demand of the country. However, the exploitation of solar energy has been considerably modest. High prices, weak government support, poor technical standards within the industry and lack of innovative consumer financing all contribute to the low usage of solar energy in the country.

Nigeria has a low wind regime. For that reason, the country has not developed the market for wind energy. Despite present efforts by the government to enhance the quality of wind maps and promote pilot projects, the future outlook for this market is not very promising.

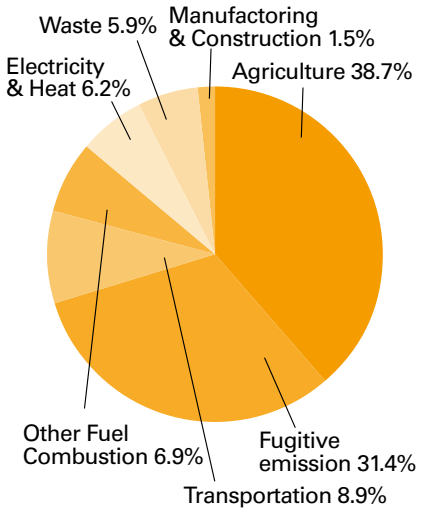
In 2010 electricity production from all sources was 23.4 gigawatt hours (GWh) while per capita electricity consumption was 129 kilowatt hours (KWh). In the same year, only 40 per cent of the population had access to grid electricity.[3]

Table 1: Indigenous energy resources of Ethiopia

Source	Capacity
Fossil fuels (including nuclear)	
Crude oil	35.5 billion barrels
Natural gas	187.44 trillion standard cubic feet
Tar sand	30 billion barrels of oil equivalent
Coal and lignite	639 million tonnes
Bitumen	42 billion tonnes[1]
Uranium	Discovered in six states[2]
Renewables	
Large Hydropower	11,250MW
Small Hydropower	3,500MW
Fuelwood	13,071,464 hectares
Animal waste	61 million tonnes/year
Crop residue	83 million tonnes/year
Solar radiation	3.5–7.0 KWh/m2 – day
Wind	2–4ms-1 at 10m height

Source: Draft National Energy Master Plan – 2006

Figure 1: GHG Emission for Nigeria by Sector in 2005 (excludes land use change)



Source: Nigeria's Climate Change Mitigation Position Paper (Dayo, Gilau & Samec, 2009)

Agriculture and gas flaring from the Niger Delta are the principal sources of greenhouse gas emission in Nigeria. Reducing gas flaring is therefore central in low carbon energy development in Nigeria.

1.1.1 Energy deficit

Oil: By the end of 2010, the state owned refineries operated at between 60-70 per cent refining capacity processing a maximum 311,500 bpd leaving a local production deficit of 218,500 bpd. This is the highest achieved in more than ten years. Poor maintenance records and several governance issues have affected the operations of local refineries and reduced operational effectiveness. To augment this deficit, NNPC imported about 8.1 million metric tonnes of petroleum products in 2010[4] representing a huge loss to the nation's treasury. Currently, availability of cooking kerosene at retail outlets is very limited. Supply of the product has dropped by 66.6 per cent since April 2011[5] from 10 million litres per day to 3.34 million litres, causing a deficit of 6.66 million litres. Kerosene scarcity hits poor people the most.

Electricity: Present average electricity capacity requirement in Nigeria is estimated to be more than 12,000MW[6] while current supply stands at about 3,800MW. This leaves a deficit of more than 6,000MW, mostly filled by private generators. In 2009, it was estimated that about 6,000MW of electricity was self generated from petrol and diesel power generating sets.[7]

Biomass: Biomass is becoming a scarce and expensive energy source especially in the urban centres. The burning of fuelwood is contributing to the already heavy deforestation of Nigeria. Due to the growing scarcity of wood, a person in the village on average has to spend 4-6 hours collecting enough wood for a single day's meal. According to estimates, approximately 350,000 hectares of natural vegetation and forest are destroyed annually, and the deforestation rate is expected to increase alongside the increasing demand for energy.

1.1.2 Energy poverty

In a country of more than 150 million people with the majority living on less than a dollar a day, the implications of the current energy crisis are severe. Over 90 million people, representing 60 per cent of the population, have no access to electricity services. Many more depend on traditional biomass sources for cooking.[8] Energy poverty in Nigeria could take the form of inadequate quantity, poor quality and low access, despite the abundant endowment of energy resources. For instance, although Nigeria is blessed with large amounts of energy sources (both renewable and non-renewable), widespread substitution of poor electricity supply from the utility company with highly-polluting private generating sets prevail. Scarcity of kerosene in most parts of the country combined with its rising cost has induced greater use of fuelwood among low and middle income groups. Shortages and high prices of diesel have also crippled industrial activities, creating more unemployment.

1.1.3 Energy and industrialisation/growth

Industries contribute only 4 per cent of Nigeria's GDP.[9] Industrial growth in Nigeria has been largely hindered by inadequate energy supply, especially electricity. According to the Manufacturers Association of Nigeria (MAN), between 2000 and 2009 about 857 major firms either closed shop or suspended operations due to poor energy supply.[10] Nearly all major companies in Nigeria provide their own electricity through diesel generators. The high cost of energy supply has been a key factor in limiting the competitiveness of Nigerian industrial production, and the growth of unemployment.

1.2 Current low-carbon strategy

There is no clear-cut national policy or strategies for low carbon energy development in Nigeria. However, the Federal Government has developed a number of policy documents and strategies aimed at growing Nigeria's energy sector along a low carbon pathway.

The National Electric Power Policy of 2001 provided for electricity supply for the rural areas (off-grid and mini-grid systems) from renewables. It proposed joint electricity and natural gas capacity expansion in order to utilize flared gas for electricity generation. It listed a number of strategies for achieving these objectives, among which are fiscal and tax incentives, and capacity expansion for domestic production of low carbon energy.

The National Energy Policy of 2001 provided for optimum utilization of the nation's renewable energy resources. The policy emphasised the need for adequate energy supply for domestic, commercial and industrial utilization and provided for intensive development of joint electric power and gas supply to at least 75 per cent of the population by 2020. Among the strategies listed for achieving these objectives include ensuring increased indigenous participation

in planning, design and construction of low carbon systems; encouraging the establishment of necessary infrastructure for the effective gathering, transmission and distribution of gas nationwide, etc. However, this policy has over the years not guided government action on the energy sector.

The Renewable Energy Master Plan (REMP) of 2005 articulates Nigeria's vision, targets and road map for addressing key development challenges facing Nigeria through the accelerated development and exploitation of renewable energy. It proposes programmes for developing renewable energy to ensure that the visions and targets are realized. Some of the strategies for achieving these objectives include adoption of a renewable portfolio standard; creation of innovative fiscal and market incentives to grow renewable energy industries; and preferential customs duty exemptions for imported renewable energy technology components – among others. Like the energy policy, the government has not implemented the master plan to a reasonable level.

The main policy thrust of the National Policy and Guidelines on Renewable Electricity of 2006 is to expand the market for renewable electricity to at least 5 per cent of total electricity generation by 2016 and a minimum of 5TWh of electric power production, excluding large hydropower. Some of the strategies listed for achieving this include encouraging local manufacture and assembly of renewable energy components, provision of subsidies, establishment of technical standards for renewable energy equipments, introducing feed-in tariffs, etc. Since the publication of this document, there are no legal instruments to back its implementation.

The National Bio-fuels Policy of 2007 aims at firmly establishing a thriving bio-fuel industry utilizing agricultural products as a means of improving the quality of automotive fossil-based fuels in Nigeria. The policy stipulated a 10 per cent blending of fuel ethanol with gasoline to achieve a blend to be known as E-10, and 20 per cent of biodiesel with conventional diesel by 2020. Like most of the government's policy documents on the energy sector, there has been little commitment to implement the biofuels policy.

1.3 Barriers to low-carbon development and energy access in Nigeria

A number of factors are hindering low carbon development and energy access in Nigeria, including the following:

Policy implementation barriers – Policies to encourage, promote and incentivise low carbon projects are poorly implemented. Many never receive approvals from legislature or the Federal Executive Council. Lack of political will and constant changes in government often account for the inability to implement these policies. However, it is clear that that vested interests often ensure that sound policies are not implemented fully. This could be the case for the several missed targets for ending gas flaring.

Financing and investment barriers – Low carbon energy technologies often have high initial costs and this affects the overall cost of energy produced per KWh. Without adequate financial incentives, market expansion will be difficult. Further, financial institutions are not always willing to provide credits to low carbon projects as these are perceived to have higher degrees of risk than conventional energy projects. These projects usually have long gestation periods. The Nigerian financial sector is a short-term lender, making access to long-term investment finance daunting.

Weak institutional frameworks – There is no nationally endorsed framework for low carbon development in Nigeria. A number of agencies and institutions are involved in one form of low carbon development or another. Lack of inter-agency coordination often stymies implementation of policies and projects.

Inadequate information and interest – Knowledge of low carbon technologies is often inadequate. Moreover, the government's attention is overwhelmingly focused on crude oil production because of its high revenue. The only lower carbon energy source that arouses both government and public interest is natural gas, because of its use in power generation and the opportunities for income generation through the export of Liquefied Natural Gas.

Lack of local manufacturing base – There is no significant manufacturing capacity for components of low carbon technologies in the country. The existing capacity in solar PV, small hydro, gas and other plants is very limited. As a result, almost all the low carbon energy technologies are imported.

1.4 Links between energy and climate resilience

Nigeria hopes to generate about 35,000MW of electricity by 2020, raising the per capita electricity consumption to about 2000kwh per capita. Many of the most critical economic, social, and environmental issues impacting the future development of Nigeria as a result of climate change have an energy underpinning.

The hydrology of Nigeria's hydroelectric dams has suffered low water levels, even during the rainy seasons. Increased temperature and desertification in the northern parts of the country account for this. Should climate change result in even high temperatures, the future of hydroelectric power production will be in jeopardy.

Approximately half of Nigeria's oil production is offshore while the rest is located along the coast of the Niger Delta. Rising sea level and severe climatic events will pose significant danger to these investments.

As wood dominates energy demand, especially among poor families, human activities accentuated by climate change will result in wood loses. Already, wood scarcity has been recorded in most parts of the country, especially along the Sahelian North. Clean cookstoves may help address increasing scarcity and cost of wood. By expanding access to clean cookstoves for poor families, the poor may become part of the climate solution.

1.5 Potential benefits of low carbon development

Low carbon development has a number of benefits including the following:

Energy access: Low carbon technologies can contribute to socio-economic development and enhance energy security. Vision 2020 seeks to expand access to electricity services to about 75 per cent of the population from 40 per cent today. Investing in low carbon energy sources will significantly promote energy access by utilising decentralised energy options to reach remote communities.

Health: Human health could also benefit from low carbon technologies. In household energy, for instance, it is estimated that 79,000 deaths occur annually as a result of smoke from traditional three-stone woodstoves.[11] Expanding the use of clean cookstoves can help address this health problem.

Carbon finance: The pursuit of low carbon development also has the potential to place Nigeria strategically in the carbon market. This will attract the needed climate mitigation and adaptation funds to tackle both poverty and emission reduction.

Environment: Low carbon development will be beneficial to Nigeria's environment. The nation's forest cover especially in the north is fast diminishing as a result of the quest for fuelwood and agriculture. Oil spillage and gas flaring in the Niger Delta region is threatening the ecosystem and livelihoods of the communities. Adopting low carbon growth will drastically reduce the incidence of these occurrences.

Transportation: According to the Vision 2020, Nigeria plans to develop transportations infrastructure that is consistent with international standards. The Bus Rapid Transit (BRT) System in Lagos state is a typical example of what the nation seeks to achieve. The introduction of the BRT system has promoted a cleaner environment with a huge reduction of about 13 per cent in CO2 and 20 per cent in GHG emissions.[12] Improvements in the nation's transport system and a shift towards lower carbon fuels such as compressed natural gas enhances, sustainable biofuels, and electric transport systems will be of immense benefits to the nation's economy.

Green jobs: Investing in low carbon technologies can lead to significant job creation. A study by ICEED (2010) on 'Low Carbon Jobs in an Interconnected World' shows that more than 600,000 jobs can be created from investments in gas and small hydropower technologies. The job-creating potentials of these technologies will increase should other technologies such as solar, wind, biomass and sustainable bio-fuels receive adequate attention. This will ameliorate the growing unemployment among Nigeria's youths

2. CASE STUDIES

A number of low carbon projects have been executed by the Nigerian government, private companies, NGOs, finance institutions and international organizations. Some of these projects have been registered by the CDM Executive Board.

This study examines three low carbon projects in Nigeria, namely: Pan Ocean Gas Utilisation Project; Save 80 efficient woodstove project; and the Nigerian Electricity Supply Company (NESCO) small hydropower project. The first two are registered at the CDM Executive Board and are currently earning carbon credits. All three case studies promote energy access and the reduction of greenhouse gases.

2.1 Pan Ocean Gas Utilization Project

This project has the objective of eliminating gas flaring at the Ovade-Ogharefe oil field operated by Pan Ocean Oil Corporation in a Joint Venture Partnership with Nigerian National Petroleum Corporation (NNPC). The plant will process about 130 million standard cubic feet of associated gas per day. This will save about 7,280 tonnes of CO2 equivalent per day.[13] In addition to the reduction of methane emissions, the project seeks to discourage the prevailing practice of using diesel generators by homes and industries in Nigeria by replacing them with cleaner natural gas. In addition to replacing the more potent methane with the less potent CO2, the gas can deliver approximately 520MW of electricity per day.[14]

The project activity will capture and process associated natural gas that is currently flared and would be flared in the future. It will reduce the GHG concentration, promote sustainable development and contribute to environmental sustainability.

2.1.1 Technologies used – type, size, technology source, manufacturing

The project consists of a gas processing facility designed to process approximately 130 million standard cubic feet of associated gas per day products are dry sales residue gas with stabilized liquid hydrocarbons as crude feedstock. The design of the facility is optimized to maximize the methane, ethane and propane-plus recoveries and minimize utilities usage while ensuring trouble-free, low maintenance operations.

The project was executed by the following firms: Lemna Energy Resources, a Nigerian subsidiary of Lemna International, Incorporated,[15] Audubon-Linkso Engineering Company Limited,[16] and others. The technologies are from different countries, notably the United Kingdom and the United States of America, among others.

2.1.2 Development benefits and impact

The project has contributed to environmental sustainability in the project region through gas flare reductions. Local air pollution and other environmental impacts and respiratory problems associated with the combustion of natural gas such as asthma and bronchitis[17] may be reduced.

According to the project design document, the installation is expected to employ 35 to 45 skilled staff and about 150 unskilled positions when fully operational. These jobs are expected to continue over the estimated 20 years of the project.

This project serves as an important step in using CDM to address this crucial environment issue. It also shows the ability of local Nigerian companies and the society to participate in CDM and sustainable development.

Under this project activity, the treated gas will be infused into an existing gas transmission line for sale to Independent Power Producers (IPPs). At full capacity, it would provide 135 million standard cubic feet of gas per day for electricity generation,[18] thus supporting economic sustainability and growth of the country.

2.1.3 Opportunities/risks of this development

A major advantage of this project is the reduction of gas flaring. It presents an opportunity for eco-friendly habitation for both aquatic and human inhabitants. Over the ten years of crediting this project, the net GHG emissions will be reduced by approximately 26.27 million tons CO2 equivalents. Air quality within the project area will be relatively free from pollutants and the frequency of acid rains will be significantly reduced. This may lead to increased yields in agriculture and other agro-allied businesses.

Employment within the project community will be enhanced and there may be corporate social benefits to the host communities. If a survey is to be carried out, it will possibly show that supply chain jobs could be created.

The project will serve as a template for replication in other gas flaring fields around the Niger Delta. As previously stated, the technologies are in the open domain, though the main barrier is finance. With adequate mobilization of funds, the technologies can be deployed in other gas flaring sites.

Additionally, this type of project comes with added infrastructure development like roads, housing for staff, provision of pipe-borne water and electricity to both members of staff and the host community, among others. The Niger Delta region is in dire need of infrastructural development,

and with more than 100 gas flaring sites in the region,[19] installing gas processing facilities with their associated infrastructure development will go a long way in providing basic amenities to the host communities.

However, despite these opportunities, the political and economic situation of the Niger Delta region poses a great risk to the overall success of the project and its potential for expansion to other areas in the region.

Disruption of operations due to violent conflicts overtime has negatively affected normal oil and gas operations in the region. Presently the region enjoys relative peace as a result of the Amnesty Programme. If this peace is not sustained, the region may return to another round of conflicts.

Another factor that may pose a risk to expansion in gas processing facilities in the region is the lack of political will to end gas flaring. Government overtime has set gas flare out dates that were not met. Strong political will is needed to enforce gas flare-out policies in the region.

Finally, there is a clear risk that the benefits of investments in gas infrastructure may bypass the poor. In many instances, centralised energy systems have left the poor behind.[20]

2.1.4 Types of investment needed

Significant financial commitments from both the government and private companies are needed to expand gas processing facilities in the Niger Delta. Recent government initiatives aim to revitalize state owned oil and gas processing installations, as well as establish new ones. In all, the government together with the multinational oil companies plan to spend about US$5.3 billion in the next three to four years on the establishment of three green field refineries, a petrochemical plant, fertilizer plants, methanol plants, gas-processing facilities, as well as other gas related infrastructure.[21] This comes in addition to tens of billions of dollars investment plans for gas power plants, transmission and distribution infrastructure.

2.1.5 Other types of support needed for the project

Capacity building: There is need for capacity building for the national gas regulatory body in Nigeria – the Nigeria National Gas Company (NGC) and other relevant institutions. This capacity is necessary because the issue of gas flaring need to be tackled from all fronts.

Security: It is always difficult doing business in the Niger Delta region due to the incessant disruptions on oil facilities. In fact, this project was suspended for about two years as a result of militancy and disruptions in the area. An expansion of this type of projects depends on the peaceful resolution of outstanding conflicts in the region.

Market development: Efficient LPG distribution and marketing is also vital to the success of this project and prospects for expansion. Such barriers like shipping, transportation, cylinder bottling and most especially, pricing need to be addressed. It requires a robust gas pricing policy that will activate investment in this sector. The current gas regime is not favourable to project developers since reasonable return on investment is not guaranteed except in the long term.

2.2 The SAVE 80 efficient fuel wood stoves

The purpose of the project activity is the dissemination of up to 12,500 efficient fuel wood stoves (SAVE 80) and heat-retaining polypropylene boxes (called Wonder Boxes) in different states located in the Guinea Savannah Zone of Nigeria, at subsidized prices. This stove saves over 80 per cent of wood use, and therefore is attractive in areas where wood scarcity is particularly severe. Today, the SAVE 80 is the most efficient household wood stove available in Nigeria, despite its high cost.

The project is implemented by the Nigerian Developmental Association for Renewable Energies (DARE), the German Non-Governmental Organisation Lernen-Helfen-Leben e.V. and the German carbon offset organisation Atmosfair gGmbH.

2.2.1 Technologies used – type, size, technology source, manufacturing

The stove was developed and prefabricated by a German manufacturer and assembled in Nigeria. It has a nominal effective thermal power size equivalent to 1.5KW. It is made of stainless steel and weighs about 4kg with a lifetime of at least 13 years. The interior parts of stove are also made of stainless steel to ensure a life span of many years, high efficiency and burning at high temperatures for complete combustion with low emission of smoke. On one side near the upper rim there is a port for feeding fuel into the burning chamber. After lighting, air is sucked in and enters the burning chamber from below. The design ensures preheating of the air and a complete combustion with no visible smoke and only small amounts of ash. Exhaust air outlets are on the side opposite the feeding port.

2.2.2 Development benefits and impact

As specified by the manufacturer, the stove needs only about 250g of small brittle sticks of wood to bring 6 litres of water to the boil: 80 per cent less than traditional fire places. By bringing wood consumption drastically down, it will slow down deforestation in the Guinea savannah region and allow for natural recovery of forests and/or reforestation to take place.

Each of the 12,500 stoves saves about 2.7 tonnes of CO2 annually, creating about 31,000 tonnes of offset credits annually in the carbon market. This has the potential to generate US$310,000 annually at the price of US$10 per tonne of CO2.

For the 10 years that the project is expected to bring in CDM earnings, expected income is about US$3.1 million. This foreign revenue will go a long way in financing and expanding other sustainable energy projects, thus creating foreign income potentials for the country.

Additionally, the stoves contribute to poverty reduction and achieving the Millennium Development Goals (MDGs). The following MDGs are expected to be achieved in the project area: MDG 1 (less time spent on wood collection, more time for other productive uses) as well as co-benefits for health; and MDGs 4, 5 and 6 (less black soot, less indoor pollution and fewer respiratory diseases). It will also contribute to the preservation of wood resources so as to avoid inter-communal and/or inter-religious conflict over resources.

2.2.3 Opportunities/risks of this development

The main opportunity created by this project is the ability to generate awareness about clean cookstoves in Nigeria. Before the project, little was known of the modern use of wood energy. Despite the high costs, several governments, foundations and NGOs have used it as a template for disseminating information about clean cooking. Today, the launching of the Nigerian Alliance for Clean Cookstoves benefits from the awareness generated by this project, and in particular the opportunity to use the carbon market for other types of stoves that may be more affordable to the poor.

The project offers opportunity for replication in other parts of the country. Since woodstove technologies are rarely weighed down by intellectual property rights,[22] it is possible to copy these stoves or even venture into other stove models using the principles of the SAVE 80 as a basis. This way, R & D will be enhanced and the industry for efficient woodstoves expanded.

This project helps create employment opportunities for people working in the Nigerian assembly plants, wholesalers and retailers of these stoves, thus promoting economic expansion in these areas.

However, despite the benefits and opportunities presented by the project, some risks can hinder its success.

The high cost of the stoves coupled with their pot-specific usage may pose a risk to their adoption by some households, especially those who usually cook with large bottomed pots. Unless different sizes of the stoves are in the market and sold at affordable costs, widespread national adoption may be difficult.

Market expansion for efficient woodstoves depends on enabling policy, legal and regulatory frameworks. The government needs to enact the appropriate laws to support its growth. However, government policy has focused on promoting the switch from fuelwood to kerosene, LPG and electricity. The reality on the ground is a stark contrast to the intention of the government. Until the necessary policies are implemented, the market for efficient woodstoves will not be expanded.

2.2.4 Types of investment needed

The SAVE 80 stove models may stimulate interest in more appropriately priced models of clean cookstoves in Nigeria. Access to investment finance for companies and NGOs seeking to establish stove producing facilities will be required. The lack of such facilities has led entrepreneurs to often produce stoves with poor technical standards and an inability to market them. This has impeded the plans to scale up markets for clean cooking.

Innovative finance will also be needed in providing consumer credits so poor people can buys stoves and pay in instalments. Microfinance is therefore important in creating access to clean cooking.

2.2.5 Other types of support to the project

Technology: The SAVE 80 stove is a German product. Market expansion might require the domestication of the technology. This will also create jobs and may help to bring down the cost of the stoves.

Capacity Building: Capacity building for project developers, metal works SMEs and microfinance institutions needs to be carried out if the hope of expanding market access for efficient woodstoves is to be achieved.

Strong Institutional Framework: Presently there is no national institutional framework in place to support the dissemination of efficient woodstoves. No government institution is charged with the mandate of ensuring access to clean household energy. A strong institutional framework is needed if this vision is to be realized.

2.3 Case Study 3: NESCO hydropower

The Nigeria Electricity Supply Company (NESCO) commenced operations as an electric utility company in Nigeria in 1929 with the construction of a hydroelectric power station in Kurra near Jos.[23] As a private company, its main aim was to make profit out of the investment and also ensure increased generation and distribution of electricity efficiently in Jos to the satisfaction of its customers.[24] The NESCO system operates as an independent network serving a number of industrial customers and communities, and also sells to the national grid. NESCO provides the main source of power for the city of Jos, with a population of about 900,000 people.

2.3.1 Technologies used – type, size, technology source, manufacturing

The NESCO hydropower system has a total installed capacity of 21MW, comprising of five interconnected

hydroelectric power stations, three of which have synchronous generators driven by Pelton and Francis turbines respectively and the remaining two use induction generators driven by Francis turbines. These last two stations located at Ankwil Falls are arranged for unattached operation and are remotely controlled through two separate simple supervisory control systems. The Kurra Falls scheme uses three large storages and four smaller head pond reservoirs. These receive their water from Tenti and Gnar Rivers, Kurra Dam, and the confluence of the two rivers from where the Sanga River is formed. There are three major storages or reservoirs with a total capacity of some 57 million cubic meters. Construction of the dams were done in such a way that the spill-offs from one dam are utilized in the next dam and so on, to the final dam. Each of the dams has a main reservoir and an auxiliary reservoir. The entire system is completed by 66KV transmission grid system comprising a total of 274km of double circuit lines, and seven main transmission sub-stations with a total capacity of 57.5MVA, supplying 33KV distribution networks comprising 58 distribution sub-stations of some 70MVA total capacity and supplying a total of 340 km of distribution lines at 33kV, 11kV and 3.3kV and low tension reticulation networks.

The first set of Pelton turbine was manufactured by James Gordon, a UK based company. The second set of Francis turbines was made by Borings, a Swedish owned company, while the third set of Francis turbines was made by a UK based company now owned by General Electric Company (GEC). The generators used by NESCO were made by Metropolitan Victors, a UK based company now owned by GEC.[25]

2.3.2 Development benefits and impact

Electricity supply from the NESCO hydropower installation has contributed to the industrialization of Jos and its environs. Almost all the industries in Plateau State rely on NESCO for electricity supply. Some of them include Makeri Smelting Company in Jos and the Fiber Product Factory (an arm of NASCO Group factory).

Employment generated in the project area is significant. In an interview with the Managing Director of the company, he revealed that the company currently employs 260 persons directly. Indirect and supply chain jobs created amount to about 2,800 and this, according to him, is a conservative estimate since the survey was conducted a long time ago. Overall, it is estimated that a total of 20,000 or 30,000 jobs might have been created from their operations in the Jos, Plateau region since they came into existence more than 80 years ago.

NESCO invests over N300 million in its Nigerian operations annually and carries out development and training scheme for its Nigerian technicians and engineers who manage the plant's operations without expatriates. These have boosted local capacity as well as domesticating investments in Nigeria.

The beauty of NESCO dams also attracts tourists, thereby increasing the eco-tourist potential of the area.[26] Other benefits include reducing rural-urban migration and also reducing or replacing the use of firewood for cooking, hence reducing environmental degradation.

2.3.3 Opportunities/risks of this development

It is estimated that Nigeria has approximately 3,500MW of exploitable small hydropower capacity.[27] Assuming this capacity is built and produces at about 90 per cent capacity, and that power to families is provided at 10 times current national per capita electricity consumption, this capacity will supply 21.9 million Nigerians with electricity.[28]

Job creation potentials for small hydropower can be significant. In a study by International Centre for Environment and Development on low carbon jobs in Nigeria, over 95,000 direct, indirect and supply chain jobs will be created if 734MW of this capacity is harnessed.[29]

Installation of small hydropower facilities will bring along other infrastructures like roads and bridges, especially in the rural areas where many of the rivers that have small hydropower potential are located.

However, despite the opportunities outlined above, small hydropower development is fraught with a number of risks, including policy and investment risks, as well as the fact that the availability of hydropower can be intermittent as a result of fluctuations in rainfall. Climate change can exacerbate this fluctuation in rainfall patterns.

2.3.4 Types of investment needed

As a result of the scale of financial requirements for building clean energy infrastructure in Nigeria, Nigeria's domestic financial market presents the most important potential source of finance. This investment will primarily go to clean energy generation, transmission and distribution, including the expansion of decentralised energy in community mini-grids and stand-alone clean energy systems. Investments are also required in expanding collective transportation in an efficient and sustainable manner.

The carbon market will potentially be important in meeting the cost of additionality in the implementation of these projects. To date, no hydropower project has attracted carbon financing in Nigeria.

Foreign direct investments will also be required, especially in large clean energy schemes. However, for clean energy systems targeting poor communities, there should be a role for donor support, especially in de-risking these investments and developing the market.

2.3.5 Other types of support to the project

Institutional framework: There is no institution specifically saddled with the responsibility of hydropower development in the country. Various government agencies like the Energy Commission of Nigeria and Federal Ministry of Power have developed isolated projects, but there are no comprehensive and binding commitments by government.

Tariffs: Electricity tariffs in Nigeria do not guarantee reasonable return on investment. The Multi Year Tariff Order (MYTO), Nigeria's present electricity tariff structure, is in the process of being reviewed by the Nigeria Electricity Regulatory Commission. Feed-in tariffs for renewable electricity will be incorporated in the new MYTO, which is expected to be effective in 2012.[30] It is hoped that these moves will stimulate investments in small hydropower development in the country.

Human resources: The development and management of hydropower requires various types of skill and expertise to study, plan, design, construct, operate and maintain the physical and natural resources utilized in hydropower production. Training facilities are therefore needed.

Resource assessment: Nigeria lacks adequate data on hydropower resources. A good overview of existing potentials will be a starting point for expanding the market for SHP.

3. LEAPFROG FUND POTENTIAL

The transition to low carbon development will require massive mobilization of financial resources. Today, there is no clear overview of the scale of financial requirements to implement the transformation to low carbon technologies and adaptation measures. Making this happen in Nigeria will require investments of billions of dollars annually in low carbon energy infrastructure, dams and transportation.

3.1 The role of the fund

Given the weak recovery in the international financial market and the fiscal crisis in important donor countries, international financial transfer will only fill a limited gap in financing a low carbon transformative agenda and in protecting the poor. Other sources of finance will be important. The challenge is to find innovative roles for international funding, especially in catalysing private sector and government sources of funds. The following are possible gaps where the leapfrog funds can make a difference:

De-risking low carbon energy investments. Local banks and international investors often withhold investment decisions on low carbon projects as a result of perceived policy, technology and market risks. The leapfrog funds can play a catalytic role in mobilising local and international investments by providing various forms of investment guarantees, including: policy insurance, loan guarantees, foreign exchange liquidity funds, pledge funds, etc. The leapfrog fund's aim will be to de-risk lending to projects that reduce emissions and stimulate growth and/or are compatible with building resilience in vulnerable communities.

Meeting incremental costs. Several technologies that will make the poor people part of the climate solution often have higher costs than their brown technology counterparts. Small hydro, solar energy and efficient cookstoves, in many circumstances, tend to be costlier than their conventional alternatives. The leapfrog fund may bridge these costs by providing funding to close the gaps in the costs of these technologies.

Supporting market expansion measures. In most cases, low carbon development projects in Nigeria have negative incremental costs. However, weak policies, inadequate funding, poor capacity and information gaps often constitute market expansion challenges. The leapfrog fund can help to cover the costs of opening up markets for low carbon technologies. In particular, it could help facilitate innovative financial solutions to address the needs of the poor through micro-lending and climate based micro-insurance schemes.

Closing skill gaps. Capacity building is required in a number of critical areas of low carbon and climate resilient development. Training of project developers, bank officials and national regulators, as well as intermediaries such as national consultants is important in bridging existing skill gaps. The leapfrog funds can assume a niche role in building the capacities of these critical actors in expanding the pipeline of projects and in implementing sectoral programmes.

Expanding technology cooperation and promoting research and development. The leapfrog fund can help stimulate innovation and technology sharing. Many technologies that are not necessarily protected by intellectual property are often costly and have minimal local contents in their production. A fund that helps local research, development and production will be essential. Such a fund can also support south-south and north-south cooperation.

Funding small-scale community based low carbon projects. Often development projects tend to bypass the poor in rural areas. The leapfrog fund can address the specific situation of vulnerable groups, particularly women. It can finance community based schemes that promote adaptation and mitigation while growing the economies of the poor. One powerful example of how funding can target the poor, especially women, is the market transformation for clean cookstoves. These efficient stoves save lives from indoor air pollution, mostly women, and conserve incomes and forests.

3.2 Grants or loan?

Developed countries have accumulated climate debts by their disproportionate use of the greenhouse gas storage capacity of the atmosphere. Consistent with the UNFCCC, rich countries should meet the full costs of adjustments in the development trajectory of countries like Nigeria in meeting the challenges of low carbon and resilient growth. Such grants are crucial in closing the existing gaps in funding. Grants will be particularly important for community based projects targeting the poor, especially vulnerable groups such as women, children and the disabled.

However, the global financial crisis and political reality in developed economies demand that a variety of funding mechanisms should be encouraged. While grants will remain central in the demand for financial transfers under the leapfrog fund, other forms of financing, including loans and guarantee schemes, will also be needed. This will help to expand opportunities for scaling up energy access and climate-friendly technologies and adaptation mechanisms.

3.3 Beyond climate finance

The transition to low carbon resilient development in Nigeria is held back by several factors that go beyond

the existing financing constraints. These include a non-supportive policy framework, vested interests, low level of awareness and weak implementing capacity among key actors.

Clear government commitments matter. Nigeria has no clear-cut policy to promote the transition to low carbon economy. Even when low carbon development in infrastructure, especially in the energy sector, is consistent with industrialisation and growth objectives of government, policies that are supportive of these objectives are yet to emerge. For instance, most Nigerian industries are dependent on diesel generators for meeting their power needs. Lack of clean government commitment to expand the gas grid or stimulate hydropower development where these resources are available has maintained the high emission profile of Nigerian industries and has reduced the prospects for growth and job creation.

Vested interests. Often when policies such as the Renewable Energy Master Plan or the National Gas Master Plan are developed, they end up not being implemented. In many instances, vested interests benefitting from the current brown economy ensure that little progress is made. There are no strong coalitions within or outside government to counter these forces, or ensure that vested interests discover potential gains from green technologies.

Creating awareness and building capacity. There is widespread lack of knowledge of the promise of green technologies and how these can change the condition of the poor. Expanding low emission development policy implementation therefore requires an appropriate narrative. Beyond spreading the knowledge, building required skills in technology, policies and project development are all important in delivering a green transformative agenda for the poor.

Partnership with the private sector. Accelerating the transformation to pro-poor low carbon development creates an impetus for partnership between the government and the private sector. According to Nicholas Stern, achieving the goals of low carbon development is nothing short of a new industrial revolution. For countries like Nigeria, this is an unmarked terrain, and there are no clear examples of countries that provide good templates for bringing about this change.

When perceived investment risks and the required scale of financing are high, a partnership between government and the private sector becomes an imperative. To incentivise the private sector, the government must provide a clear and predictable policy framework, promote information sharing and technology development, and help close existing skill gaps.

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