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IFU INVESTMENT FUND FOR DEVELOPING COUNTRIES

Benpower SA: Dual Fuel HFO/NG power plant, Maria Gleta, Benin

SUMMARY

The project will increase the overall capacity installed in the country of Benin and thus satisfy currently unmet demand for electricity. Electrification provides a viable alternative to highly polluting private generators, running on diesel. Thus, despite the application of rather carbon-intensive fuels, the project can still feasibly provide GHG savings based on detailed analysis. It shall also be noted that the installed electric capacity of Benin has been growing over the past 2 years and has gradually expanded into less carbon intensive generation sources, including hydroelectricity. Two scenarios were analysed – with the power plant operating on heavy fuel oil (HFO) and operating on HFO for 2 years, before transitioning to natural gas.

In the first scenario, materiality of carbon savings is considered '**low'** with an associated net benefit of **24 tCO_2e/DKK million invested**. With social cost of carbon incorporated, this is equivalent to 0.019 DKK/DKK invested.

In the second scenario, should the plant switch to natural gas in the third year of operation, materiality of carbon savings is still considered "**low**" with a higher associated net benefit of **257 tCO_2e/DKK million invested.** With social cost of carbon incorporated this is equivalent to 0.2089 DKK/DKK invested.

DATA AVAILABLE

- The installed capacity will be 144 MW, consisting of 127 MW dual fuel power plants and 17 MW steam turbines. (BWSC Dual Fuel HFO/NG power plant, October 2018).
- The actual working capacity is 91.3% of maximum capacity (BWSC Dual Fuel HFO/NG power plant, October 2018).
- The project life considered for the analysis is 15 years, as per the power purchase agreement (PPA) signed with the primary offtaker for the energy – the national utility Societe Beninoise d'Energie Electrique (SBEE).

ASSUMPTIONS

The following is assumed:

- Marie Gleta, Benin, is a brownfield site. Since the plan entails dismantling some existing capacity and building new one, construction emissions are accounted for.
- The estimation of construction emissions is conservative and leans towards the more carbon-intensive infrastructure for heavy fuel oil.
- The electricity produced by the dual fuel plant will increase the total capacity of the country and will supposedly reduce the use of diesel private generators.
- The plant will utilize heavy fuel oil, with the option of switching over to a less carbon intensive option of natural gas.
- Impacts are determined based on EcoInvent LCA data for construction impacts of conventional oil and natural gas power generation and.
- It is assumed that currently part of unmet demand in the country of Benin is supplied by private generators running on diesel, in accordance with existing practices in other countries in the region of West Africa.
- The baseline scenario considered reflects the 'marginal' emission factor, rather than the grid capacity mix. This considers the likely fuel sources required to generate currently unmet demand, rather than replacing current generation.
- It is assumed that the working hours of a HFO power plant would be 8760 hours per annum.

RATIONALE OF FUNDING THE PROJECT

In Benin, West Africa, there is an increasing demand for electricity, which is currently unsatisfied. Access to power in Benin remains at a low 29% and the unreliability of supply is one of the key constraints faced by economic actors and investors (BWSC Dual Fuel HFO/NG power plant, October 2018).

IFU is considering an investment developing a HFO to help meet this need and increase access to electricity.

The optimal opportunity for carbon reductions relates to renewable energy rather than continued development of fossil fuel based power generation. However, given that the energy demand is increasing at a high rate and it is easier and reliable to expand the energy generation from thermal power plant, HFO electricity generation is investigated as an alternative to current private generator and carbon intensive grid generation.

INTRODUCTION

In 2006, because of structural deficiencies to electricity supply, the Beninese Government decided to build a new power plant by installing eight gas turbines with a combined capacity of 80 MW on the site of Maria Gléta on the outskirts of Cotonou. The power plant was commissioned in 2013. However, because of a chronic shortage of natural gas, the high cost of the alternative fuel Jet A1 as well as design and maintenance problems, the plant could not fulfill its intended role as a steady supplier of electricity to the grid. As a result, the Government of Benin launched an open Request for Proposal (RFP) to invite specialized companies to submit their technical and financial proposals for the rehabilitation, expansion and operation of the plant.

The consortium of IFU-AIIM-BWSC-Enpower has emerged as the final concessionaire for the IPP, after a challenging process. The consortium's Special Purpose Vehicle (SPV) will sign a Concession Agreement (CA) and Power Purchase Agreement (PPA) with the Government of Benin (GoB) to construct a 144 MW combined cycle dual fuel HFO/Natural Gas plant (127 MW thermal duel-fuel power plant and 17 MW steam turbine). The project will provide baseload power during a concession period of 15 years following which the plant will be transferred to GoB. (BWSC Dual Fuel HFO/NG power plant, October 2018).

The CA allows for a 16+4 month construction period followed by a 15 year operation period on a build-own-operate-transfer (BOOT) basis. The power plant (Benpower SA, the project) is to be built on a 20 hectar site in Maria Gleta, 20 km north-west of Cotonou the main commercial city and port of Benin. (BWSC Dual Fuel HFO/NG power plant, October 2018).

Benpower SA will be operational in April 2020. Initially the plant will run on Heavy Fuel Oil (HFO) which will be delivered by truck from storage facilities in the Port of Cotonou close by. SBEE has the responsibility to deliver the HFO. The plant which will the be first Independent Power Producer (IPP) in Benin will be the most fuel efficient and environmentally friendly power plant in the country. Benpower SA, anticipated to add approximately up to 40-50% of Benin's current electricity capacity, will play a critical role in a market with a 7-8% annual increase in demand, which cannot be met due to lack of production capacity. (BWSC Dual Fuel HFO/NG power plant, October 2018).

TABLE 1: DETAILS OF INVESTMENT – BENPOWER SA, DUAL HFO/NG POWER PLANT BENIN

	UNIT	INVESTMENT
Project	-	Benpower SA
City	-	Marie Gleta
Location	-	near Cotonou, Benin
Power Type	-	HFO/NG thermal power plant
Total Investment	DKK	1,392,000,000
IFU investment	DKK	122,500,000
Maximum Capacity	MW	144
Actual working capacity	%	91.3%
Guaranteed output	MWh/annum	1,151,695
Working Hours/day	hours	24
Working Hours/annum	hours	8,760
Total MWH	MWh/annum	1,151,695

METHODOLOGY

The focus of the proposed HFO power plant is to increase the current capacity rather than replace it. In the absence of a HFO power plant, it is assumed an equal amount of electricity would have been provided by thermal power plants (50%) and private generators (50%), based on the current energy mix and assumed near-future generation possibility. It shall be noted that the current energy mix of Benin supposedly has hydroelectricity and some solar capacity installed. However, due to unreliability of the grid, in a more conservative fashion it is assumed that diesel run private generators contribute a higher share than prescribed. IFU should also consider future increase in renewable energy generation could potentially reduce the benefit achieved by a fossil fuel based plant which brings immediate gain. No further consideration of future energy scenarios has been considered in this analysis.

To capture impacts arising from both supply chain and operations of alternative and baseline scenarios, carbon impacts were derived from LCA values from EcoInvent to account for entire upstream activities associated with different electricity producing technologies.

Project life is considered 15 years, in accordance with the signed PPA.

Two main scenarios were analysed: with the plant running on HFO for the entire life of the project and for the plant running on HFO for 2 years, before being transitioned to natural gas.

Benpower SA Project GHG emissions profile

The proposed plant in Benin has a nameplate capacity of 144 MW and an assumed working capacity ratio of 91.3% was applied. While the plant will be constructed to use both HFO and natural gas, the infrastructure required for storing and delivering HFO is more carbon intensive. Thus the construction emissions in both scenarios, consider the initial stage of putting up infrastructure for HFO.

Benin Baseline GHG emissions profile

Benin's grid electricity mainly comes from fuel oil (IEA, 2016), a part of remaining unmet demand is catered through private diesel generators, assumed to be 29% and a small share of capacity of hydro energy is installed (3%). Considering this energy mix (IEA,2016) and using emission factors (Ecoinvent, 2016) a current emission factor of national energy is calculated to be 0.900 $kgCO_2e/kWh$ (Ecoinvent, 2016).

There is currently significant unmet demand in Benin, and this is increasing annually. Therefore, the country energy composition has been adjusted to reflect a higher share of private generators and thus increasing the average emission factor to 0.934 $kgCO_2e/kWh$. Table 4 below presents the total contribution by each power generation type.

TABLE 2: NATIONAL MARGINAL ENERGY SCENARIO, BENIN (IEA,2016, ADJUSTED BY TRUCOST)

COUNTRY	POWER TYPE	FUEL TYPE	ESTIMATED CONTRIBUTION %	GHG/KWh	GRID EMISSION FACTOR (Kg CO2e/KWh)
Benin	Thermal	HFO	50%	0.920	0.460
	Private generators	Diesel	50%	0.948	0.474
				Total	0.934

Here the baseline is electricity generation through thermal power plants and private generators to produce power equivalent to 1,151,695 MWh – total generation of the project.

RESULTS

The total emissions were calculated per typical year and total project life for the project in two fuel scenarios, compared to a baseline case. Using the client provided investment details (in Table 1), the GHG savings or emissions avoided per Million Danish Krone (DKK) invested in the HFO plant were calculated.

SCENARIO 1: The plant operates on HFO for the entire project life

TABLE 3: GHG SAVINGS FROM INVESTMENT MADE IN BENIN HFO POWER PLANT – SCENARIO 1

	TYPICAL YEAR	TOTAL PROJECT LIFE
Project emissions (tCO_2e)	**1,050,342**	**15,755,134**
Baseline emissions (tCO_2e)	**1,075,356**	**16,130,338**
GHG savings (tCO_2e)	**25,014**	**375,204**
GHG savings (tCO_2e per Total DKK mn Investment)	**N/A**	**270**
GHG savings (tCO_2e per IFU DKK mn investment)	**N/A**	**24**
IFU saving (DKK/DKK invested)	**N/A**	**0.019**

For every million DKK IFU is investing in the Benin HFO power plant, 24 tonnes of GHG is being saved. When considering the social cost of carbon, this is equivalent to 0.019 DKK/DKK invested, considered low materiality for carbon saving.

SCENARIO 2: The plant operates on HFO for 2 years and on natural gas for the remaining 13 years

TABLE 4: GHG SAVINGS FROM INVESTMENT MADE IN BENIN HFO POWER PLANT – SCENARIO 2

	TYPICAL YEAR	TOTAL PROJECT LIFE
Project emissions (tCO_2e)	**804,300**	**12,064,500**
Baseline emissions (tCO_2e)	**1,075,356**	**16,130,338**
GHG savings (tCO_2e)	**271,056**	**4,065,839**
GHG savings (tCO_2e per Total DKK mn Investment)	**N/A**	**2,921**
GHG savings (tCO_2e per IFU DKK mn investment)	**N/A**	**257**
IFU saving (DKK/DKK invested)	**N/A**	**0.209**

For every million DKK IFU is investing in the Benin HFO power plant, 257 tonnes of GHG is being saved. When considering the social cost of carbon, this is equivalent to 0.209 DKK/DKK invested, considered low materiality for carbon saving.

The carbon savings in a natural gas scenario are higher, yet it shall be emphasized that in order to achieve absolute carbon savings, the overall direction shall be towards lowering the dependence on fossil fuels and expanding renewables capacity.

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