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Air pollution implications of Nigeria's present strategy on improved electricity generation

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ABSTRACT

One of the strategies being developed in Nigeria to increase the presently installed electricity generation of 6159 MW to the required 30,000 MW is the adoption of electric thermal plants. An emission factor approach is used in this paper to study the emission of uncontrolled air pollutants from all the existing and proposed thermal plants in the country. Calculations are performed to study the distribution of carbon monoxide (CO), oxides of nitrogen (NO_X), particulate matters (PM), sulphur dioxide (SO_2), and volatile organic compounds (VOCs). The estimated emissions ranges are 978–24,607, 1635–41,148, 37–924, 19–472, and 11–286 ton/annum for CO, NO_X, PM, SO_2, and VOCs, respectively. The present locations of these plants across the country are characterized by skewed emission distribution both per capita and across the land. Given the potential environmental and health impacts of these emissions, several measures are suggested to reduce future impacts and assist the country in achieving sustainable development.

1. Introduction

1.1. Purpose of this study

Nigeria is presently developing some strategies that would make electricity available in the country at a sufficient level. Though previous studies showed that generation, transmission, and distribution of electricity need to be overhauled to achieve improved energy supply for all, generation should be given adequate attention. Presently, less than 50% of the 6159 MW hitherto from the various electricity generating units commissioned between 1966 and 1990 (Table 1) are available for consumption. To improve on this, some steps taken include putting in place some power generating units under the National integrated power projects (NIPPs) by the Federal Government (Table 2), encouraging the upstream petroleum operators to build and operate electricity generating plants under the joint venture system (Table 3), and the licensing of independent power producers (IPP) by the Nigerian electricity regulation commission (NERC) under the deregulation programme (Table 4).

Many of the planned electric power generators are thermal power plants that will burn fossil fuels to generate electricity. In thermal plants, gaseous emissions are of great concern. Major components of these emissions are air pollutants, which include carbon monoxide (CO), oxides of nitrogen (NO_X), particulate matter (PM), sulphur dioxide (SO_2), and volatile organic compounds (VOCs), the focus of this study. This paper focuses on the quantity and location of pollutant emissions and points out the localized and uneven geographic distribution of electric power plants and their emissions in Nigeria.

The impetus for this study is a desire to inform both the policy makers and investors in the sector to the environmental implications of these air pollutants, due to the preference for thermal plants in the current drive towards improved electricity generation (Fig. 1) and their concentration in two airsheds (the south-west and south–south) of Nigeria's air basin (Fig. 2). Secondly, it is to raise the need for conscientious efforts by all players in the sectors to control emissions of air pollutants from the proposed power plants.

1.2. Electric generation technologies

Electric power generating units require the use of prime movers, which may be internal-combustion engines or turbines, for electricity generation. In the internal-combustion engines, there are one or more cylinders in which combustion of fuel takes place. The mechanical energy produced in the engine, which is connected to the shaft of the generator, drives the generator to produce electricity. Generally, turbines have a series of blades mounted on a shaft against which fluids are forced, thus rotating the shaft connected to the generator. They may be steam turbines, gas turbines, or hydroelectric.

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Table 1
PHCN[a] successor power plants.

S/No	Power station	Capacity (MW)	Year commissioned	Location/State	Region
1	Lagos thermal	1320	1985	Egbin/Lagos	Southwest
2	Afam thermal	971	1965	Afam/Rivers	Southsouth
3	Kainji hydro	760	1968	Kainji/Niger	Northcentral
4	Shiroro hydro	600	1990	Shiroro/Niger	Northcentral
5	Jebba hydro	576	1986	Jebba/Niger	Northcentral
6	Delta thermal	912	1966	Ughelli/Delta	Southsouth
7	Sapele thermal	1020	1978	Ogorode/Delta	Southsouth

[a] PHCN- Power Holding Company Nigeria Plc., Nigeria's electricity national grid owner.

Table 2
National integrated power plants (NIPPs) in Nigeria.

S/No	Power plant	Capacity (MW)	Status	Location/State	Region
1.	Papalanto	335	Commissioned	Papalanto/Ogun	Southwest
2.	Omotoso	335	Commissioned	Omotoso/Ondo	Southwest
3.	Geregu	424	Commissioned	Geregu/Kogi	Northcentral
4.	Eyaen	451	Construction	Eyaen/Edo	Southsouth
5.	Sapele	450	Construction	Sapele/Delta	Southsouth
6.	Egbema	338	Construction	Egbema/Imo	Southeast
7.	Gbarain/Ubie	225	Construction	Gbaran/Bayelsa	Southsouth
8.	Omoku	230	Construction	Omoku/Rivers	Southsouth
9.	Alaoji	504	Construction	Alaoji/Abia	Southeast
10.	Calabar	561	Construction	Calabar/Cross Rivers	Southsouth
11.	Ibom Power	188	Commissioned	Akot Abasi/Akwa Ibom	Southsouth
12.	Ikot Abasi	300	Construction	Ikot Abasi/Akwa Ibom	Southsouth
13.	Mambilla Hydro	2600	Construction	Mambilla/Taraba	Northeast

Table 3
Joint-ventures integrated power plants (JV-IPPs) in Nigeria.

S/No	Partner	Capacity (MW)	Status	Location/State	Region
1.	NNPC/Agip	480	Operation	Okpai/Delta	Southsouth
2.	NNPC/Shell	642	Operation	Afam/Rivers	Southsouth
3.	NNPC/Total	450	Construction	Obite/Rivers	Southsouth
4.	NNPC/Chevron Texaco	780	Construction	Ijede/Lagos	Southwest
5.	NNPC/Exxon Mobil	350	Planning	Bonny/Rivers	Southsouth

Table 4
Licensed independent power plants in Nigeria[a].

S/No	Power plant	Capacity (MW)	Status	Location/State	Region
1.	AES	300	In operation	Egbin/Lagos	Southwest
2.	Anita Energy	90	Planning	Agbara/Ogun	Southwest
3.	Dangote Obajana	350	In operation	Obajana/Kogi	Northcentral
4.	Eleme Power Plant	95	In operation	Eleme/Rivers	Southsouth
5.	Ethiope Energy	2800	Planning	Ogorode/Delta	Southsouth
6.	Ewekoro Power	12.5	In operation	Ewekoro/Ogun	Southwest
7.	Farm Electric	150	Planning	Ota/Ogun	Southwest
8.	Geometric	140	Planning	Aba/Abia	Southeast
9.	Hudson Power	150	Planning	Warewara/Ogun	Southwest
10.	Ibafo Power	200	Planning	Ibafo/Ogun	Southwest
11.	ICS Power	624	Planning	Alaoji/Abia	Southeast
12.	Ikorodu Ind. Power	39	Completed	Ikorodu/Lagos	Southwest
13.	Lotus and Bresson	60	Planning	Magboro/Ogun	Southwest
14.	Mabon Ltd	39	Under Const.	Dadinkowa/Gombe	North
15.	Omoku Power	150	In Operation	Omoku/Rivers	Southsouth
16.	Supertek	1000	Planning	Akwete/Abia	Southeast
17.	Trans Amadi Power	136	In Operation	Trans Amadi/Rivers	Southsouth
18.	Westcom Energies	1000	Planning	Sagamu/Ogun	Southwest
19.	Westcom Energies	50	Planning	Lekki/Lagos	Southwest

[a] *Source*: NERC (2008) www.nercng.org.