Evironmental, Health and Social Hazards of Fossil Fuel Electricity Generators: A Users' Assessment in Kaduna, Nigeria

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Abstract

Users of fossil fuel generators for electric power supply to buildings in Kaduna metropolis of Nigeria, were engaged in the assessment of the associated environmental, health and social hazards. The study was effected mainly by field survey in which Kaduna metropolis was divided into twelve clusters and well structured questionnaire administered on a purposive sampling basis. The results show that: there is a massive use (89.9% of households) of the generators; users are aware and "agree" that there are associated environmental hazards (noise and air pollution, heat generation, threat to living organisms and defects to buildings); there are also health hazards (such as impaired hearing with 67.2% frequency of observation, sleeplessness 60.5%, choking sensation 55.4%, deafness 35.5%, dizziness 31.9% and impaired visibility 13.4%); and social hazards (mainly disturbance to neighbours for which 30% of users confirmed receipts of complaints). Conclusion was reached that these hazards are great concerns to both the generator users and their neighbours. Government was called upon to redouble efforts at providing adequate and uninterrupted electricity across the country and in the interim, put in place appropriate policies and implementation framework for regulating use of fossil fuel generators; as well as promote use of less hazardous alternatives such as the solar home systems.

Key Words: Environmental Harzad; Fossil Fuel; Electricity Generator; Fossil Fuel Electrcity Generator; Kaduna- Nigeria

1.0 Introduction

Provision of adequate infrastructure for sustainable development has remained a major challenge of government in Nigeria. The supply of adequate and uninterrupted electricity for example which has been a recurring item on the priority project lists of the three successive democratic regimes in the country since 1999, has remained a dream to date. Of the estimated population of 150 million people in Nigeria, less than 40% have access to electric power supply from the national grid (Hall 2006, FRN 2009).

The Power Holding Company of Nigeria (PHCN) which is solely responsible for generation and supply of electricity have not fared too well in the discharge of its mandate. With an installed generating capacity of only 6,000MW (against the 30,000MW estimated national peak demand), the PHCN could only provide a maximum of 3,000MW with 30 – 35% losses during transmission (Hall, 2006). It follows therefore that less than 10% of the national electricity demand only, could be met through the national grid. This mounts pressure on individuals, institutions, corporate bodies and businesses in the country; for private provision of electricity, with fossil fuel generators being the option most frequently adopted (Offiong, 2003, Akande and Owoyemi, 2008). The reason for this option has been attributed to the relatively low initial capital cost, convenience and availability of the fuel to power the generators (EIA, 2007).

1.1 Fossil Fuel Generator Use Hazard

Combustion of fossil fuel in generators is however associated with environmental pollution which in turn impact adversely on the physiological and mental health of the associated human lives (Offiong, 2003; Dimari, Abdulraham, Akan and Ogugbuaja, 2007). Apart from the heat, vibration and noise accompanying generator operations, carbon dioxide (CO_2), nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO), and particulate matter are also released (IPCC, 1996). Carbon dioxide is a greenhouse gas whose presence in the atmosphere has a warming effect on the earth's climate. Nitrogen oxides (NOx) deplete the ozone layer and from Dimari et.al (2007), an exposure in the range of 150 – 200ppm results in bronchiolitis, a dangerous disease which occurs within 3 to 5 weeks after exposure. In Rao (2007), SO_2 was associated with impaired visibility, damage to vegetation and materials, harm to human health and production of acid rain.

In Smith, Mehta and Maeusezahl-Fenz (2003); indoor air pollution from fossil fuel combustion was observed to have claimed more than 1.6 million lives and left over 38.5 million disabled worldwide in the year 2000. In Osuntogun and Koku (2007), noise levels beyond the World Health Organization's limit of 70 to 75dB were associated with high blood pressure, abnormal foetal development, extreme emotions and behaviour. Such noise levels have also been reported to cause instantaneous hearing impairment as well as complaints and friction among neighbours (Minja, 2003; Boateng and Amedofu 2004, cited in Akande and Owoyemi, 2008).

Stanley (2011) used the digital sound level meter and the IMR 1400 combustion gas analyzer to measure the noise and air pollution levels respectively from fossil fuel generators' operations in Kaduna, Nigeria. It was found that both the indoor and outdoor noise levels were most of the times very much above the WHO limits of 30dB and 70dB respectively. Also the indoor and outdoor concentrations of the gaseous pollutants (CO_2, CO, NOx and SO_2), exceeded their respective WHO limits.

1.2 Purpose of the Study

This paper investigates generator users' and their neighbours' perceptions on the environmental, health and social hazards of fossil fuel generators used for electric power supply to buildings in Kaduna, Nigeria. It was effected mainly by field surveys through the instrumentality of a well structured questionnaire. A hazard for our purpose here may be defined as a situation that poses a level of threat to life, health, property or environment (Wikipedia, 2010).

1.3 The Study Area (Kaduna)

Kaduna the study area is an important administrative city (headquarters of the defunct Northern Region and capital of the present Kaduna State of Nigeria). It is also an industrial city, accommodating a considerable volume of commercial activities. The Kaduna metropolis is characterized among other things, by: high population density; erratic water and electricity supply; and high use of fossil fuel generators. It has a population of about 1.6 million people and an estimated household number of 314,066 (FRN 2009, NPC 1998). The household constitute the target population of this study.

2.0 Methodology

The city was divided into twelve (12) clusters for the purpose of this study and six households were sampled (purposively) for investigation from each cluster. The basis of selection was mainly accessibility and readiness to participate in the exercise. For each selected household, two of the questionnaire were administered, one to an able member of the household and the other to a close and willing neighbour. A total of 144 questionnaires were administered in all, out of which 119 were completed and returned, making a response rate of 83% approximately.

The questionnaire mainly addressed the following:

a). Frequency of possession of generators and the operation characteristics.
b). Environmental issues in fossil fuel generators operation.
c). Health and social issues associated with generator operation.
d). Users' awareness of generator use related hazards.
e). Generator users' attitude to neighbours' complaints.
f). Ways of minimizing generator use hazards.

2.1 Data Analysis Technique

Data from the questionnaire were analyzed using simple percentages (for questions involving yes or no answers), and computation of means (for questions involving assessing some aspect of generator use issue on a scale of 1 to 5). The weighted average formula (Equation 1) was used for this computation.

$$\bar{x} = \frac{\Sigma fx}{\Sigma f} \quad \text{- - - - - -} \quad \text{Equation 1}$$

where: $\bar{x}$ = mean

x = points on the Likert's scale (1, 2, 3, 4 and 5)

f = frequency of respondents' choice of each point on the scale

3.0 Results

Data from the field survey are presented in Tables 1 to 9 and Figure 1, together with the analysis results.

Table 1 Respondents' Profile

S/N	Variables	Options	Frequency of Occurrence	
			(No)	(%)
1	Age (Year)	a) ≤ 20	13	10.9
		b) 21 –30	61	51.3
		c) > 30	45	37.8
		Total	119	100
2	Sex	a) Male	96	80.7
		b) Female	23	19.3
		Total	119	100
3	Marital Status	a) Married	42	35.3
		b) Single	77	64.7
		Total	119	100
4	Highest Educational Level Attained	a) Tertiary	99	83.2
		b) Secondary	19	16
		c) Primary	0	0
		d) None	1	0.8
		Total	119	100
5	Occupation	a) Business	28	23.5
		b) Civil Service	29	24.4
		c) Others	62	52.1
		Total	119	100

Table 2 Household Generator Possession Frequency and Type

S/N	Variables	Options	Frequency	
			(No)	(%)
1	Possesses and uses generator	a) Yes	107	89.9
		b) No	12	10.1
		Total	119	100
2	Generator Type	a) Petrol	97	90.7
		b) Diesel	10	9.3
		Total	107	100

Table 3 Generator Operation and Related Characteristics

S/N	Variables	Mean	SD	N
1	Years of operation	4.75	3.10	107
2	Capacity (KVA)	2.00	1.56	107
3	Daily quantity of fuel used (litre)	5.83	3.02	107
4	Daily amount spent on fuel (Naira)	468.22	227.85	107
5	Daily hours in operation	6.60	3.33	107
6	Distance away from building (m)	6.81	4.45	107

SD – Standard deviation, N – Total number of generators

Table 4 Perceptions on Environmental Hazards of Generator Operations

S/N	Hazard	Weight/Frequency					Σf	Mean
		1	2	3	4	5		
1	Noise pollution	60	41	9	6	2	119	1.71
2	Air pollution	38	51	16	13	1	119	2.06
3	Heat generation	32	52	22	12	1	119	2.14
4	Threat to living organisms	21	48	35	11	4	119	2.40
5	Cause defects in buildings	26	50	30	9	4	119	2.29
					Grand Mean			2.12

1 = strongly agree, 2 = agree, 3 = undecided, 4 = disagree, 5 = strongly disagree

Table 5 Details of Generator Use Effects on Building

S/N	Problems	Total no of respondents	Frequency of observation (No)	(%)
1	Discoloration of wall finishes	107	57	53.3
2	Littering of floor with engine oil	107	69	64.5
3	Noticeable vibration	107	43	40.2

Table 6 Health Hazards Associated with Generator Use

S/N	Hazard	Total respondents	Frequency of observation (No)	(%)
1	Impaired hearing	119	80	67.2
2	Impaired visibility	119	16	13.4
3	Deafness	119	42	35.3
4	Sleeplessness	119	72	60.5
5	Choking sensation	119	66	55.4
6	Dizziness	119	38	31.9

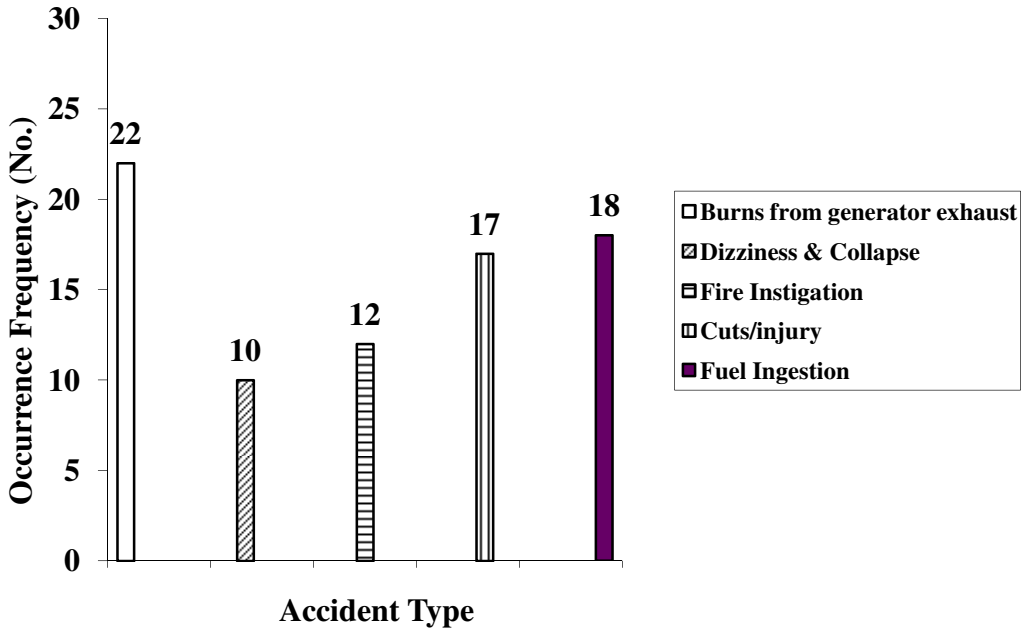

Fig 1 Generator Accidents

Table 7 Social Issues Associated with Generator Use

S/N	Issues		Options	Occurrence frequency (No)	(%)
1	Neighbours Awareness of Exposure to Hazards	a)	Quite Aware	99	92.5
		b)	Not Aware	8	7.5
			Total	107	100
2	Complaints from Neighbours	a)	Received	32	29.9
		b)	Never Received	75	70.1
			Total	107	100
3	Owner's Attempts at Nuisance reduction	a)	Made Efforts	87	81.3
		b)	Made No Efforts	20	18.7
			Total	107	100

Table 8 Generator Users' Attitudes to Neighbours' Complaints

S/N	Attitude	Total no of complaints	Occurrence frequency (No)	(%)
1	Feel unnecessarily challenged	32	1	3.1
2	Neighbour has right to complain	32	25	78.1
3	Sympathetic to the complaint	32	20	62.5
4	Wish something could be done	32	27	84.4

Table 9 Perceptions on Ways of Reducing Generator Use Related Hazards

S/N	Factor	Weight/Frequency (f)					Σf	Mean
		1	2	3	4	5		
1	Improve supply from national grid	65	25	20	5	4	119	1.81
2	Regulate sale of generator	12	23	25	40	19	119	3.20
3	Regulate use of generators	11	20	23	35	30	119	2.06
4	Restrict generator importation	11	25	27	36	20	119	3.24
5	Provide less hazardous alternatives (e.g. solar home systems)	72	35	1	2	9	119	1.66

1 = strongly agree, 2 = agree, 3 = undecided, 4 = disagree, 5 = strongly disagree

4.0 Discussion of Results

4.1 Possession Characteristics and Environmental Hazards

Table 1 shows that use of fossil fuel generators is a common feature (89.9%) of households in Kaduna. The more common type is the petrol engine with mean capacity of 2.00KVA and average fuel consumption of 5.83 litres per household per (6.60 hr) day (Tables 2 and 3). The generator users are aware and agree that noise pollution, air pollution, heat generation, threat to living organisms and defects on buildings are some of the environmental hazards associated with generator use (Table 4). Further investigation of the nature of defects on buildings shows that discolouration of walls and littering of floors with engine oil have the highest frequency of occurrence, 53.3% and 64.5% respectively; while noticeable vibration has 40.2 % frequency of occurrence (Table 5).

4.2 Health Hazards

The associated health hazards in descending order of agreement to their occurrence are: impaired hearing (67.2%), sleeplessness (60.5%) and chocking sensation (55.4%). Others are deafness, dizziness and impaired visibility with 35.5%, 31.9% and 13.4% potential of occurrence respectively (Table 6). On accidents from use of generators; burns from the exhaust has the highest count of (22); followed by fuel ingestion (18); cuts/injury (17); fire initiation (12) and dizziness/collapse (10) (Figure 1).

4.3 Social Hazards

Disturbance to neighbours is the major social issue associated with use of fossil fuel generators. This study shows that the neighbours are quite aware of their exposure to hazards, some (about 30%) have actually complained to the users and majority of the users have either made some efforts (81.3%) or wished (84.4%) something could be done to reduce the associated hazards (Table 7 and 8).

4.4 Tackling Generator Use Hazards

Finally, on how to reduce generator use related hazards, users agree on such measures as: use of less hazardous alternatives such as solar home systems, improving the supply from the national grid and regulating the use of the generators. They are however undecided on the other two options namely; regulating the sale of generators and restricting the importation (Table 9).

5.0 Conclusion and Recommendation

5.1 Conclusion

There is a prevalent use of fossil fuel generators for electric power supply to buildings in Kaduna, Nigeria. The associated environmental, health and social hazards are major concerns to both the users and their neighbours. There is a willingness to embrace measures (such as regulation of the use, provision of better alternatives and improvement of the supply from the national grid) which would reduce the hazards.

5.2 Recommendation

As mentioned in the background, the Nigerian government have been making considerable efforts at providing adequate and uninterrupted electric power supply across the country. This should be continued and if possible redoubled. In the interim, government should put in place appropriate policy and implementation framework for the regulation of the use of fossil fuel electric generators in the country. Government should also take appropriate measures to promote use of cleaner and less hazardous alternatives, such as the solar home systems. Users of fossil fuel generators should as much as possible mount the generators with due consideration to reduction of noise and air pollution. They should also ensure adequate ventilation of all rooms in the building.

6.0 References

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Appendix 1: Research Questionnaire

Topic: Environmental, Health and Social Hazards of Fossil Fuel Electricity Generators: A Users' Assessment in Kaduna, Nigeria.

In line with current global pursuit of sustainability in all spheres of human activity, this research is being carried out to assess the hazards associated with fossil fuel generators used for electricity supply to buildings. Please kindly give your most sincere answers to the questions below.

A. RESPONDENTS' PROFILE

1. Age Group (please mark 'X' as appropriate in box provided).
   a). ≤ 20 years [ ] b). 21 to 30 years [ ] c). ≥ 30 years [ ].

2. Sex
   a). Male [ ] b). Female [ ]

3. Marital Status
   a). Married [ ] b). Female [ ]

4. Highest Educational Level Attained
a). Tertiary [ ] b). Secondary [ ] c). Primary [ ] d). None [ ]

5. Occupation
a). Business [ ] b). Civil Servant [ ] c). Others [ ]

B. GENERATOR POSSESSION FREQUENCY AND OPERATIONAL CHARACTERISTICS

1. Do you own an electric power generator?
a). Yes [ ] b). No [ ]

2. If yes, please kindly indicate the type
a). Diesel [ ] b). Petrol [ ] c). Others (please specify) _____

3. What is the capacity of the generator?
a). ≤ 0.9KVA [ ] b). 1.0 – 1.9KVA c). 2.0 – 4.9KVA [ ]
d). 5.0 – 9.0KVA [ ] e). 10.0 – 19.0KVA [ ] f). 20KVA and above [ ]

4. How long a day do you use the generator?
a). ≤ 5hrs [ ] b). 6 – 10hrs [ ] c). 11 – 15hrs [ ] d). 16hrs and above [ ]

5. How many litres of fuel do you use daily for the generator?
a). 0 – 2litres [ ] b). 2.1 – 4litres [ ] c). 4.1 – 6litres [ ] d). 6.1 – 8litres [ ]
e). > 8litres [ ]

6. How much in Naira do you spend daily on fuel for the generator?
a). 0 – 150 Naira [ ] b). 151 – 300 Naira [ ] c). 301 – 450 Naira [ ]
d). 450 – 600 Naira [ ] e). > 600 Naira [ ]

7. What is the distance of the generator away from the building
a). ≤ 5.0m [ ] b). 5.1 – 10.0m [ ] c). 10.1 to 15.0m [ ] d). > 15.0m [ ]

C. HAZARDS ASSOCIATED WITH GENERATOR USE

1. Are you aware that the operation of electric power generators is associated with some environmental, health and social hazards?
a). Yes [ ] b). No [ ]

2. How would you rank your agreement with the following (on a scale of 1 – 5) as hazards associated with electricity generator operations? (Where 1 = strongly agree, 2 = agree, 3 = undecided, 4 = disagree and 5 = strongly disagree).

S/No	Hazard	Ranking				
		1	2	3	4	5
i.	Noise pollution					
ii.	Air Pollution					
iii.	Heat generation					
iv.	Threat to living organisms					
v.	Causing defects in buildings					

3. Which of the following defects have you actually observed in your building as a result of generator use? (Please tick as appropriate)
i). Discoloration of finishes [ ]
ii). Litering of floor with engine oil [ ]
iii). Noticeable vibration [ ]
iv). Others (please specify) ……

4. Which of the following health hazards have you observed in connection with generator use? (Kindly tick as appropriate)
   i). Impaired hearing [ ]
   ii). Impaired visibility [ ]
   iii). Deafness [ ]
   iv). Sleeplessness [ ]
   v). Chocking sensation [ ]
   vi). Dizziness [ ]

5. Which of the following types of accident have you observed or experienced in connection with generator use?
   i). Burns from the exhaust [ ]
   ii). Dizziness or collapse [ ]
   iii). Fire instigation [ ]
   iv). Cuts/injury [ ]
   v). Fuel ingestion [ ]

6. As an electricity generator user, are you aware that your neighbours are exposed to hazards?
   a). Yes [ ] b). No [ ]

7. Have your neighbours ever complained to you about any disturbance arising from your generator use?
   a). Yes [ ] b). No [ ]

8. Have ever attempted to reduce the disturbance your generator is causing your neighbour?
   a). Yes [ ] b). No [ ]

9. As a generator user, how do you feel when neighbours complain to you of disturbance? (Please tick as appropriate)
   i). Feel unnecessarily challenged [ ]
   ii). Neighbour has right to complain [ ]
   iii). Sympathetic to the complaint [ ]
   iv). Wish something could be done to mitigate the disturbance [ ]

D. GENERATOR USE HAZARD REDUCTION

1. How would you rank your agreement with the following (on a scale of 1 – 5) as ways of reducing generator use related hazards? (Where 1 = strongly agree, 2 = agree, 3 = undecided, 4 = disagree and 5 = strongly disagree).

S/No	Factor	Ranking				
		1	2	3	4	5
i.	Improve supply from national grid					
ii.	Regulate sale of generator					
iii.	Regulate use of generator					
iv.	Restrict generator importation					
v.	Provide less hazardous alternatives (e.g. solar home systems)					

Thank you,