

## Green Energy Solutions in Nigeria: Merits, Challenges and Way forward

<sup>1</sup>Theoma M. Adekunle, Eneni .M.I. Roberts<sup>2</sup>, Marcellina U. Offoha<sup>3</sup>, Taye T. Alawode<sup>1</sup>, Adebola A. Adekunle<sup>4</sup>, Babtunde Ilesanmi<sup>2</sup>, Joseph A Adeleke<sup>1</sup>, Isaac I Udo<sup>1</sup>, Jonathan Iworiso<sup>5</sup>

<sup>1</sup>Department of Chemical Sciences, <sup>2</sup>Department of Biological Sciences, <sup>3</sup>Department of Social Sciences, Federal University Otuoke Bayelsa State (FUO), <sup>4</sup>Department of civil Engineering, Federal University of Agriculture, Abeokuta, <sup>5</sup>Department of Mathematical, Computer and Physical Sciences, FUO

\*Corresponding author; [imkunle@yahoo.com](mailto:imkunle@yahoo.com)

Biofuel technology appears to be a viable alternative to non-renewable energy sources. Nigeria, though reputed for immense petroleum resources, has potential for the development of biofuel technology, given the abundance of renewable energy resources in the country. Due to the merits of biofuel technology, Nigerian researchers are exploring ways to provide feasible and sustainable biofuel technology in the country. The objective of this paper is to provide an overview of the benefits, challenges and possible way forward. As a result, a field survey on the population perception on green energy as an alternative to petroleum dependence in Nigeria was conducted using structured questionnaire administered to 1000 respondents. Information elicited from the questionnaire include (i) potential resources (ii) limiting factors (iii) sustainability and (iv) public acceptance among other burning questions. Results showed that all the respondents were educated adults between ages 18 and 60 years; with a satisfactory approximate gender mix ratio of 1:1. Seventy-one percent (71%) opined that food security would not be adversely affected by biofuel technology. Respondents stated that the involvement of women will bring more awareness on green energy solutions in the country and lack of legislative platform for enhanced women participation in biofuel technology was perceived by 83% of the respondents as a strong deterrent. Despite the perceived challenges regarding biofuel technology in Nigeria, if given the appropriate awareness, the technology stands to have up to 90% public acceptance, alleviate poverty through job creation and provide a more friendly environment for sustainable development and diversification of economy.

**Keywords:** Biofuel technology, renewable energy, environment, Nigeria

### 1. Introduction

Nigeria is a West African country whose developing economy is largely dependent on petroleum, which is a non-renewable energy resource. Bearing in mind that non-renewable energy resource does not last forever, it is high time alternatives were sourced. Furthermore, recognizing the attendant adverse environmental impacts associated with petroleum exploration, production and distribution, a proactive gesture would be to explore a more environmentally friendly replacement or supplement such as green energy. Developed countries have bought the idea of green energy as a substitute to non-renewable energy sources and have expended immense resources (both human and material) for target actualization (Dufey, 2006). In contrast, developing countries are yet to optimally take advantage of the benefits offered by green energy technologies. Only a few isolated reports of intensive research works on green energy resources (with emphasis on biofuel technology) in developing countries are found in literature (Alamu et al., 2008; Olusegun and Adekoya, 2012). Biofuel technology appears to be a viable alternative to non-renewable energy sources.

In Nigeria, given the abundance of renewable energy resources, green energy technologies have the potential to thrive. The knowledge of the merits of biofuel technology has motivated Nigerian scientists to explore ways of providing feasible and sustainable biofuel technology in the country (Alamu et al., 2008; Alamu et al., 2010; Oparaku, 2010; Olusegun and Adekoya, 2012). The objective of this study is to provide an overview of the benefits and challenges facing the exploration of green energy solutions in Nigeria. Consequently, a field survey on the population perception on green energy as an alternative to petroleum dependence in Nigeria was conducted using structured questionnaire administered to 1000 respondents. Views sought on burning issues affecting the exploration and utilization of biofuel technology in the country included (i) potential resources (ii) limiting factors (iii) sustainability and (iv) public acceptance. Finally, way forward in the provision and implementation of biofuel technology as contribution to green energy solution in Nigeria was proffered.

## **2. Materials and Methods**

### **2.1 Administration of research questionnaire and data processing**

Research methodology for this work was conducted via the administration of 1000 copies of a structured questionnaire to willing respondents spread across south-west, south-south, and south-east geopolitical regions of Nigeria. Information solicited for were grouped into nine categories namely: (i) socio-demographic characteristics of respondents (ii) socio-economic characteristics of respondents, (iii) petroleum resources and environment in Nigeria, (iv) greenhouse gas emissions and the environment, (v) green energy, (vi) biofuel technology in Nigeria, (vii) public acceptance of biofuel technology in Nigeria, (viii) renewable energy, biofuel technology and gender issues and (ix) general issues. Each category was made up of different questions pertaining to the subject matter. Altogether, fifty- six (56) questions were asked in the research questionnaire. In order to ensure that no respondent completed more than one copy of the questionnaire, copies were distributed systematically to individuals by one on one interaction. In some parastatals, the administrator/director collected bulk copies and distributed to known members of staff. Information procured from the questionnaire was transformed to graphical forms, tabular presentations and percentages. In some cases, data were segregated according to gender.

### 3. Results and Discussion

#### 3.1 Socio-demographic characteristics of respondents

Socio-demographic characteristics of respondents are shown in Fig.1. Ninety-nine (99%) of respondents were between the ages of 18 and 60 years and generally constituted of 49% females and 51% males. Thirty-four percent (34%) of them were married, 64% were single and 2% belonged to other marital affiliations such as never married, divorced or widowed. Ninety-five percent (95%) of the respondents were Christians, 4% were Moslems and 1% belonged to other religion groups.

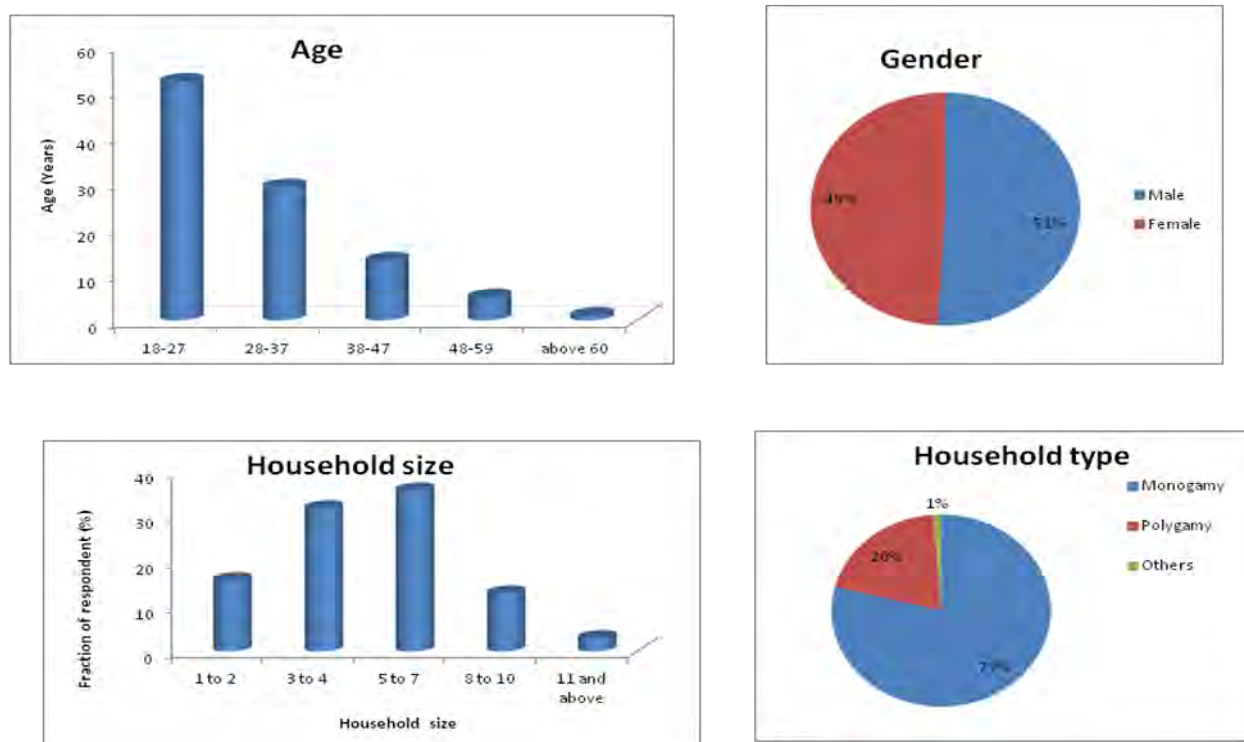


Fig. 1: Representative socio-demographic characteristics of respondents

The common household size fell between 5 and 7. Interestingly, household size of 11 and above constituted only 3% of the total respondents. Polygamy (21%) was found not to be popular in comparison to monogamy (79%). Respondents were largely Christians and of monogamous households. A reasonable gender mix of an approximate ratio 1:1 was obtained for the respondents.

#### 3.2 Socio-economic characteristics of respondents

Socio-economic characteristics of respondents are represented in Fig.2. On Educational background, 74% of respondents were Masters Degree and above, Higher National Diploma (HND) or a University first degree and Ordinary National Diploma (OND) holders. The remaining fraction had either Modern/Secondary school or standard 6/primary 6 certificate. Results showed that majority (42%) of the respondents were civil servants, 5% belonged to the

Academia (Lecturers and Teachers), 14% were public servants, 24% were students at the University level (undergraduates), 7% were self employed and only 8% were unemployed. The participants claimed to be either of medium income (61%) or low income (22%) status and 12% seemed not to have any means of livelihood. However, only 5% perceived themselves as high income earners. Regarding housing tenure; respondents comprised of 74% tenants and 26% landlords (house owners); living in residential (68%), institutional (22%) and commercial (10%) accommodation. In these houses, some had lived between 1 and 10 years (49%), 11 and 20 years (7%) and maximum of 1 year (44%). By deduction, large population of respondents was civil servants and university undergraduates.

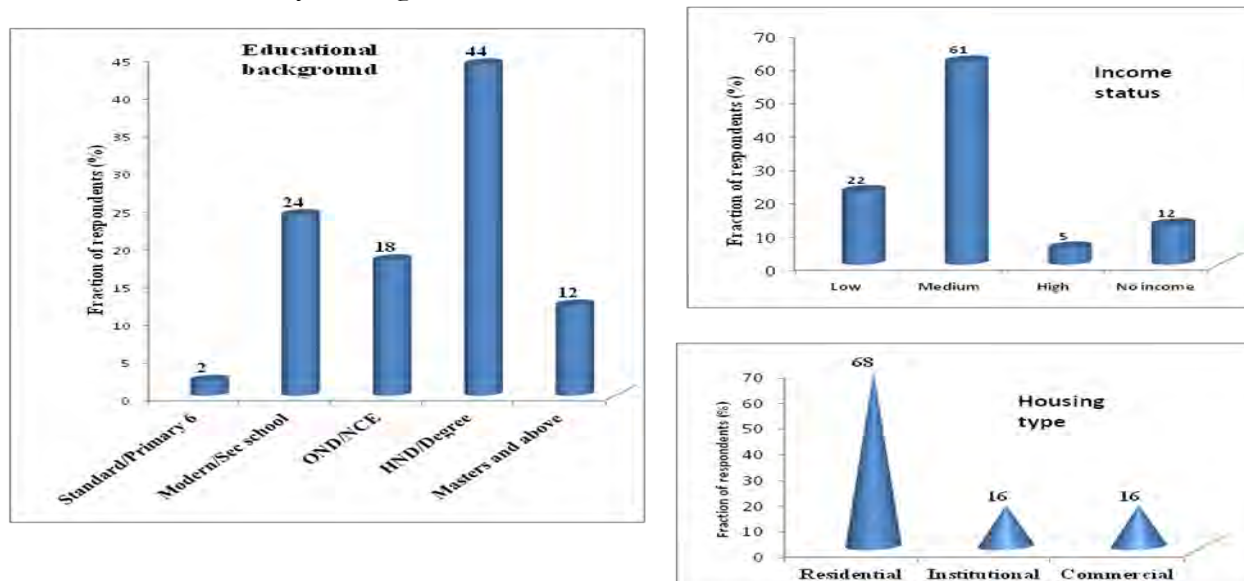


Fig.2: Educational background, income status and housing types of respondents

Eighty-eight percent (88%) of them had sustainable means of livelihood. In all, literate respondents were involved in the study and 100% of them were accommodated in houses, showing that none was homeless.

### 3.3 Knowledge of respondents on petroleum resources in Nigeria

Data on knowledge of respondents on petroleum resources in Nigeria and perception of women participation in the oil sector are presented in Figs. 3 and 4. Data showed that 59% of respondents were of the opinion that crude oil reserves are predominantly in the Niger Delta region, 37% claimed south-south region, 2% for North central region, 1% for south-east region and the remaining 1% claimed north-west, south-west and north-east regions. This implies that the majority of the respondents were aware that petroleum resources are predominant in the Niger Delta region of the country, which comprises Bayelsa, Rivers, Cross River, Akwa Ibom, Edo and Delta states (south-south); Imo and Abia states (south east) and Ondo state (south-west). Regarding the origin of petroleum, 58% went for organic residues (plant and animal remains), 5% for industrial wastes, 2% for glass and 1% for plastic wastes. Interestingly, 34% opined that petroleum resources were a gift from God. History and formation of petroleum is traceable to diagenesis and catagenesis processes associated with plant and animal residues (Sarkar, 2000). On oil exploration and mining activities, 74% of the respondents were of the

opinion that oil is extracted from beneath the ground, 7% went for ocean, 10% claimed onshore, 8% gave offshore and 1% believed that petroleum is mined from the air.

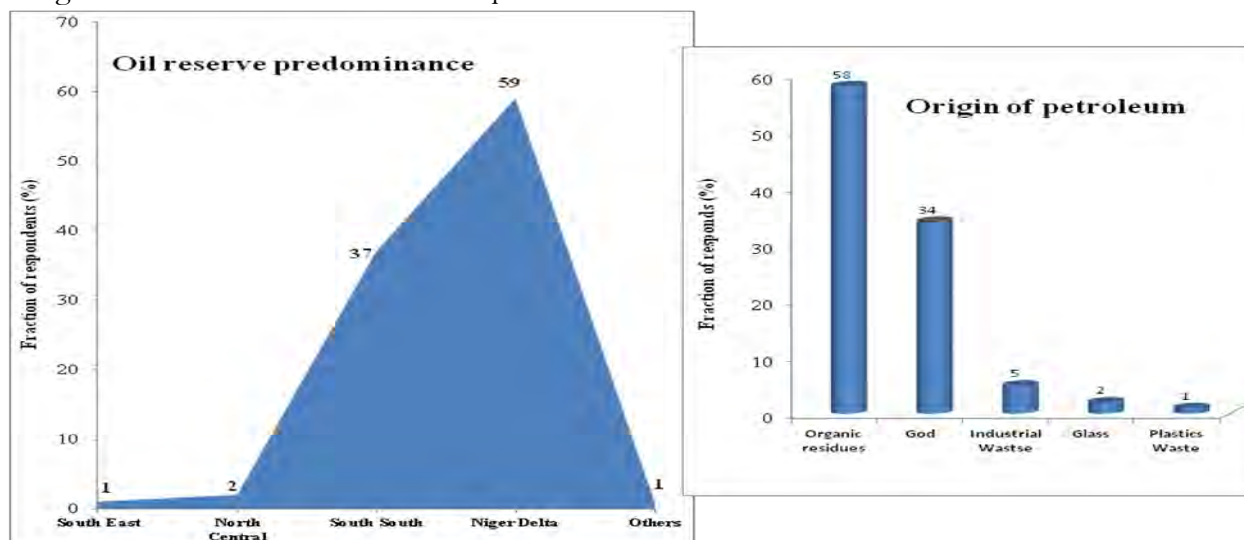


Fig.3: Respondents' perception on location of oil reserve and origin of petroleum in Nigeria

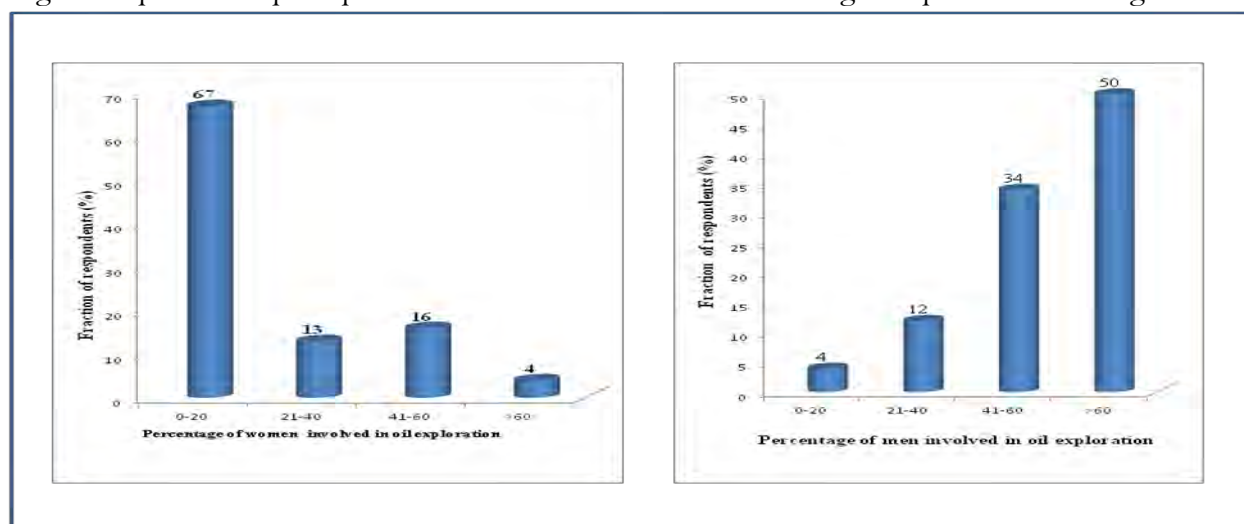


Fig.4: Respondents' perception on gender participation in petroleum sector in the country

Results revealed that respondents have a poor knowledge on the technicalities of petroleum exploration such as onshore/offshore concepts and women participation in the oil sector is very low. As to whether petroleum is a blessing in Nigeria (Fig.5), 48% opined that it is a blessing but 46% believed it is both a blessing and a curse. This conflict of opinion was attributed to petroleum based environmental issues and socio-economic problems encountered in the country (UNEP, 2011). However, 6% had a shaky view. On Nigeria's future and petroleum, 61% of the populace was very certain that Nigeria can survive without petroleum, 35% believed otherwise while 4% had no definite standpoint.

### 3.3.1 Petroleum Resources in Nigeria and Environment

On environmental issues, ninety-four (94%) to ninety-seven percent (97%) of the participants were in accord that petroleum activities are causative factors to air and water pollution (Fig.5).

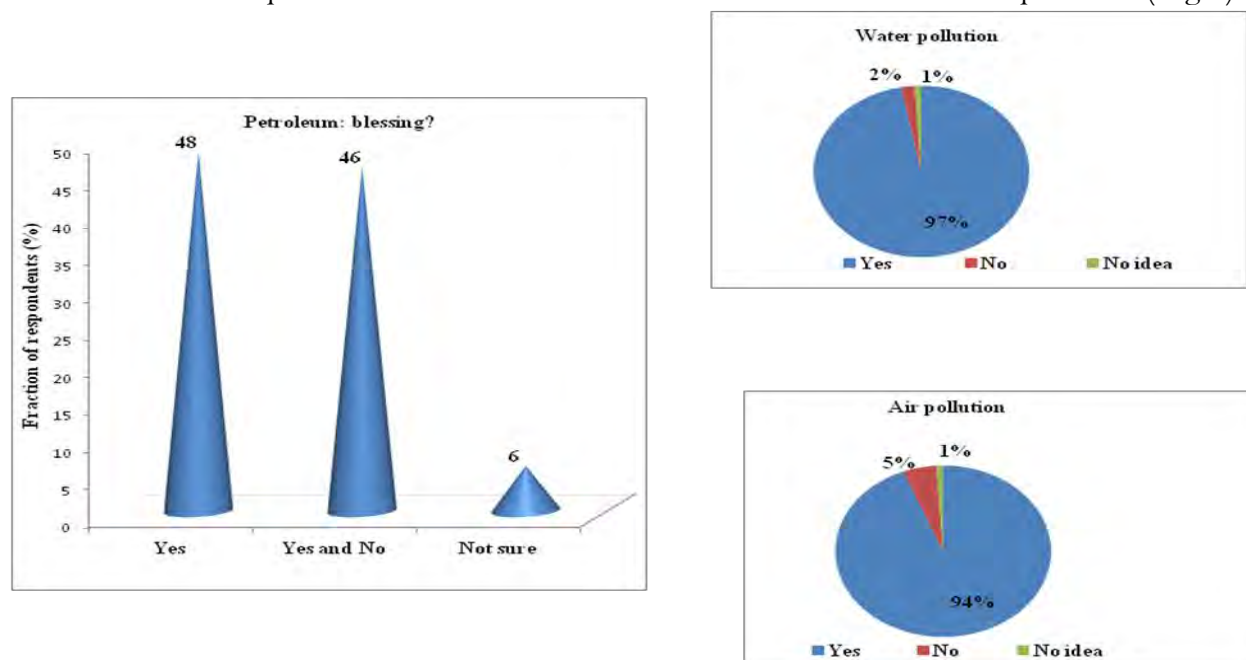


Fig.5: Respondents' perception on environmental issues associated with petroleum resources

Regarding the relationship between petroleum, ozone layer depletion, greenhouse gas (GHG) emissions, global warming and climate change, it was discovered that 36% of respondents were not familiar with the concept of GHG emissions. Nonetheless, 64% were conversant with the phenomenon of GHG emissions and 59% could differentiate between ozone layer depletion and global warming. Sixty-two percent (62%) of them claimed to have a good understanding of the relationship between ozone layer depletion, global warming and climate change. Eighty-eight percent (88%) were aware that GHG emissions are strongly related to climate change issues. Their knowledge was traceable to social media (21%), electronic media (26%), school (30%), friends (7%), print media (9%), neighbours (1%) and literature (6%). On the effect of petroleum activities in the environment, 76% of respondents related these activities in Nigeria to global warming and 66% affirmed that the activities have bearing to climate change issues. Seventy-one percent (71%) opined that biofuel technology would not have negative impact on food security while 29% had a different view. Data showed that large percentage of respondents has good understanding of contemporary environmental concerns such as GHG emissions, ozone layer depletion and climate change issues. By deduction, information source was highest from schools. Nonetheless, the results point to the fact that awareness from all the sources was generally poor (1 to 30%).

### 3.4 Green energy prospects in Nigeria

Majority (88%) of respondents was of the viewpoint that it is high time Nigeria explored alternative energy sources as shown in Fig.6. The concepts of green energy and biofuel technology were known to 55 to 64% of the respondents with knowledge obtained from social

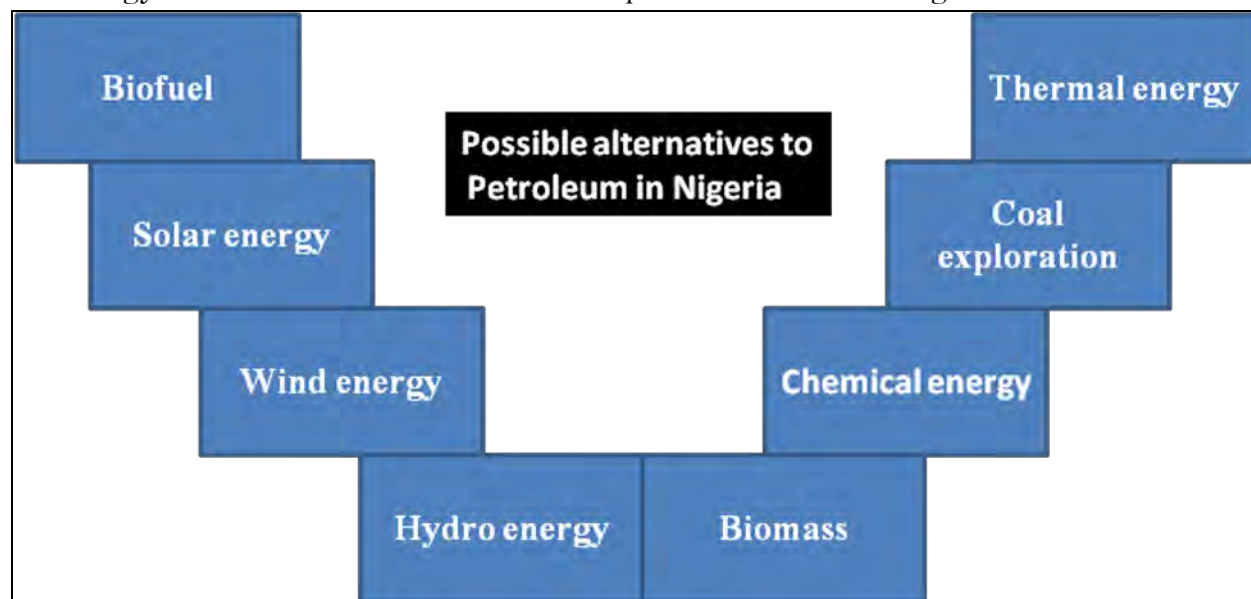


Fig.6: Respondents' suggestion on potential alternatives to petroleum resources in Nigeria

media (20 to 21%), electronic media (28 to 30%), school (25 to 26%), friends (8 to 9%), print media (1 to 9%), neighbours (2 to 7%) and literature (7%). As to whether Nigeria has keyed into biofuel prospecting, only 24% of the participants were positive. Limiting factors to the feasibility of biofuel technology were put as ignorance (33%), data scarcity (15%), land ownership system (7%), capital (14%), technical know-how (27%), culture (3%) and religion (1%). Possible implications of the technology in the country, according to the respondents were social factors (22%), economic implication (5%), food security (9%), food safety (6%), conflicts (3%), enhanced national image (85%), environmental implication (16%), job creation (18%) and sustainable development (13%). The values in parenthesis represent the percentage of the respondents for a given factor. Results showed that on a scale of 100%, awareness on Nigeria's involvement on green energy by the Nigerian people is less than 30%.

Public acceptance is a critical factor to any technology. Generally, 67% of respondents were willing to invest in biofuel technology and cook using gas generated from animal wastes with only 33% unwilling to do so. Interestingly, 90% of the respondents would gladly work in a biofuel related establishment. The use of agricultural produce was advocated by 84% of respondents. Public acceptance indices and gender based response are presented in Table 1. By deduction, biofuel technology stands to have up to 90% public acceptance in Nigeria.

Table 1: Response to public acceptance indices to biofuel technology in Nigeria

S/N	Question	Male Gender (%)		Female Gender (%)	
		Yes	No	Yes	No
1.	Knowledge of green energy concept?	68	32	47	53
2.	Willing to invest in biofuel technology?	73	27	50	50
3.	Willing to utilize biogas	63	37	49	51
4.	Willing to cook with only gas of petroleum origin?	44	56	48	52
5.	Willing to work in biofuel industry?	81	19	73	27
6.	Willing to encourage the use of agricultural produce in biofuel technology?	83	17	69	31
Willingness to work in biofuel establishment: Irrespective of gender = 90% of respondents					

### 3.5 Gender issues on green energy solutions in Nigeria

**General view on women participation in biofuel technology:** Seventy-six percent (76%) of the respondents strongly believed that women should be encouraged to participate fully in biofuel technology, 13% opposed and 11% was indifferent. Opinion poll showed that 43% of the participants concurred to the possibility of adverse health effects on women, if allowed to get involved in the technology. It is however worrisome that 73% opined that women will not excel over men in biofuel production. Nonetheless, 75% had the view that involvement of women will bring more awareness on green energy solutions with emphasis on biofuel technology. Regarding factors that would enhance women participation in biofuel technology, 17% of the respondents went for access to credit facilities, 6% for land and 15% for capacity building. Lack of legislative platform for enhanced women participation in biofuel technology was perceived by 83% of the respondents as a strong deterrent.

### 3.6 Challenges, implications and way forward for biofuel technology in Nigeria

Data on challenges, implications and way forward for biofuel technology in Nigeria were segregated according to male and female gender. Values in parenthesis signify percentage of respondents for a given factor for male and female (male –female). Single values in parenthesis denote same percentage for both genders.

**Challenges:** Based on information obtained in this study, major identified challenges against effective exploration of biofuel technology in Nigeria were ignorance (33%), capital (10 -18%),



religion (2-1%), scientific/technical data scarcity (14 -17%), technical know-how (32-18%), land (5-11%), culture (4 - 2%). Other miscellaneous limiting factors include over dependence on crude oil, non-diversification of economy, lack of zeal/interest/motivation, militancy/insurgency, lack of research infrastructure and facilities, non-availability of market for products, attitudinal problem (resistance to change), corruption, and budgetary priority. In support of these view points, it is difficult for an average Nigerian to procure credit facilities from financial institutions. This hinders intending small-scale investors. There is also acute data scarcity on biofuel raw material inventory in the country. Nigeria has abundant natural resources, suitable for different types of biofuel production but it is quite a task locating them in the absence of proper documentation. Lack of awareness and public enlightenment pose a strong obstacle to viable investment in biofuel technology and its public acceptance.

**Implications:** Potential implications of biofuel technology in Nigeria as listed by respondents were: economic implications (19-26%), social implications (6 - 4%), food security (8 -10%), food safety (6-7%), conflict (4%), improved national image (10-4%), environmental implication (13 - 15%), job creation (20-18%), sustainable development (14-12%): Biofuels have the potential to create rural employment and contribute to rural development by providing decentralized small-scale sources of energy. Biofuel technology offers an excellent value added waste management option, creates job opportunities, enhances economic and social growth, revitalizes small and medium scale enterprises, encourages national and international investors and saves foreign exchange. On the contrary, if not well managed the consequences include: deforestation and attendant environmental problems, reduced food security, hunger, threat to public health and conflicts. These are in concordance with the views of Peskett et al., (2007).

**Way forward:** Factors that would enhance implementation of biofuel technology in Nigeria as put by respondents were: awareness (41-46%), legislation (16-13%), fund availability (22 – 24%), data availability (6-3%), raw material inventory (15 -14%). On a practical note, suggestions on the way forward for biofuel technology in Nigeria include (i) mechanized agriculture, (ii) creation of reward systems for outstanding biotechnology feedstock producers, (iii) provision of subsidy to farmers for crop production expansion, (iv) enhanced publicity on the technology via social, print and electronic media (v) sensitization and mobilization of the rural population: grass root campaign, (vi) encouragement of maximum women participation, (vii) access to loan schemes at reduced interest rate for small and medium scale enterprises to boost entrepreneurship drive, (viii) viable legal framework and conducive political platform.

## Conclusions and recommendations

Despite the perceived challenges regarding biofuel technology in Nigeria, if given the appropriate awareness, the technology stands to have up to 90% public acceptance, alleviate poverty through job creation and provide a more friendly environment for sustainable development and diversification of economy. It is recommended that the Federal Government creates an enabling environment for the development and growth of biofuel technology in the country.

## Acknowledgements

Authors acknowledge the immense assistance rendered by the Directors and Staff of different Establishments, Corporate organizations and Institutions that made the survey a huge success.

## References

- Alamu, O. J., Dehinbo, O., Suleiman, A, M (2010). Production and Testing of Coconut Oil Biodiesel Fuel and its Blend. Leonardo Journal of Sciences, 16: 95-104
- Alamu, O. J., Akintola, T. A., Enweremadu, C. C. Adeleke, A. E (2008). Characterization of palm-kernel oil biodiesel produced through NaOH-catalysed transesterification process. Scientific Research and Essay 13 (7): 308-311.
- Amigun, B., Sigamoney, R., H. von Blottnitz, H (2009). Commercialization of biofuel industry in Africa: A review. Renewable and Sustainable Energy Reviews 12 (2008) 690-711
- Dufey, A. (2006). Biofuels production, trade and sustainable development: emerging issues. Environment report, International Institute for Environment and Development (IIED). London, UK. [www.iied.org/pubs](http://www.iied.org/pubs).
- Olusegun, D. S. and Adekomaya S. O. (2012). Challenges confronting sustainability of biodiesel in Nigeria. Energy and Environmental Engineering Journal, 1(1); 41- 44.
- Oparaku N. F. (2010). Alcohol fuel from biomass: challenges of implementation in Nigeria Continental J. Biological Sciences 3: 1 – 7.
- Peskett, L., Slater, R., Stevens, C. and Dufey, A. (2007). Biofuels, agriculture and poverty. Reduction. Natural Resource Perspectives, June, Overseas Development Institute, Swedish International Development Cooperation Agency, Sida.107.
- Sarkar, G. N. (2000). Advanced petroleum refining. Romesh Chander Khanna, Delhi, India