UNDER PEER REVIEW

GREEN TECHNOLOGY: A CONTRIBUTION TO SUSTAINABLE DEVELOPMENT IN NIGERIA.

ABSTRACT

In Nigeria, many established and establishing technological industries produce effluents that add to Global warming which have continuously increased during the last decades, bringing many undesired consequences to Earth and human life. Predictions suggest the consequences will continue to worsen over the years to come. One of the solutions to alleviate this problem is the adoption of green technologies. As a result, this paper examines green technology as a contribution to sustainable development in Nigeria. It also examines Policy Requirements for green technology Development in Nigeria. It concludes by proposing some strategies that stimulate effective green technology.

KEY WORDS: *Green Technology, Sustainable Development, Renewable, and Environment.*

INTRODUCTION

Nigeria today faces unprecedented concern over rising energy prices stemming from reliance on traditional sources of energy and their impact on ~~our~~ economic competitiveness and national security in an unstable world. Global environmental concerns such as global warming and climate change have the potential to dramatically alter the world environment. In addition, the relentless pressures of urbanization, manufacturing and population growth demand a renewed commitment to clean energy and environmental solutions.

The challenge of ensuring a sustainable energy development is tremendous, but so are the opportunities. Green technology has emerged as an important trend and development which is believed will lead the way to addressing Nigeria's energy and environmental challenges.

This paper provides an overall perspectives of green technology, strengths from adopting green technology, and categories of green goods and services in line with global effort and trend towards sustainable development. Challenges to green technology adoption and policy requirements for adoption in Nigeria are outlined.

Objectives:

- To expedite the growth of the Green Technology industry and heighten its contribution as a driver for future economic growth, energy security, climate change mitigation and adaptation;
- To guarantee sustainable development and preserve the environment for future generations, and
- To intensify public cognizance and education on green technology and encourage its widespread use.

Research methodology

The data for this paper ~~were~~ was originated from secondary sources: previous research and analysis of scholars, government documents, newspaper/magazines/as well as journals articles that are related to the subject. This study involved an extensive literature review which critically analyzed the present status, prospects of green technology as a driver for future economic growth, energy security, climate change mitigation and adaptation.

How well do you trust data from newspaper and magazine sources?

CONCEPT OF GREEN TECHNOLOGY

Green technology is a general term often used interchangeably with "clean technology." Other terms such as "environmental technologies," (wipo, 2012) "climate related technologies," and "mitigation and adaptation technologies," (Ahmed, et al., 2011) or variations thereof, essentially refer to the same thing. To avoid confusion, the term "green technology" has been adopted in this paper and shall be taken to mean technology which is used, or may be used, to promote sustainability, reduce greenhouse gas emissions, or otherwise assist in the solution to climate change.

Green technology also is the application of environmental monitoring, green chemistry, environmental science, and various technological processes for environmental protection. This term is also used for sustainable energy production technologies such as wind turbines, bioreactors, recycling, photovoltaics, etc. Also, environmental technology may be related to electronic devices and gadgets that promote the sustainable resources management. Green technology includes different technological processes to protect the environment or to revive and repair already damaged ecosystems

It is related to the term "environmentally sound technology", which was adopted under the United Nations Conference on Environment and Development Agenda 21, although it is no longer widely used. Based on Agenda 21, environmentally sound technologies are geared to "protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substituted." (Rio de Janeiro, 1992; UN, 2012). In United States for instance, fifty-seven percent of businesses used green technologies or practices to improve energy efficiency within their establishments in August 2011, and over half used green technologies and practices to reduce or

eliminate the creation of waste materials as a result of operations, (Audrey Watson,2013)

Green technology development must be sustainable, meaning "balancing the fulfilment of human needs with the protection of natural environment and resources so that these needs can be met not only in the present, but in the indefinite future". Other related terms for green technology include: climate-smart, climate-friendly and low-carbon technology.

In general, all green technologies can be divided into two very broad groups: technologies that deal with global warming and sustainable technologies. There are many examples of environmental technology application (in different fields), and some of them are:

- *Recycling*- includes solid waste management, waste incineration technology, different types of wastewater treatments, and other eco-friendly waste recycling technologies.
- *Renewable* **(alternative) energy technology**- energy production from renewable natural resources such as sun, water, wood, and so on.
- *Water purification*- in addition to water purification technologies, various activities and environmental campaigns have been organized to help purify water around the world.
- *Air purification*- it refers to green technologies and cultivation of plants to remove co_2 and keep air fresh.
- *Sewage treatment*- green technology similar to water purification.
- *Environmental remediation*- the removal of contaminants or pollutants for the general environmental protection.
- *Energy conservation*- the utilization of electrical devices that use smaller amounts of energy; this leads to the decrease of electricity consumption which causes less consumption of fossil fuels, (Greentechbox.com, 2015).

How it works

Pollution wise, green technology includes both process and product technologies that generate low or no waste and increase resource- and energy-efficiency. They also cover "end-of-the-pipe" technologies for treating pollution. Green technology does not only mean individual technologies but also systems, including know-how, procedures, goods and services and equipment, as well as organizational and managerial procedures.

GROUPS OF GREEN TECHNOLOGY

Green technology shelters a broad area of production and consumption technologies. The adoption and use of green technologies involves the use of environmental technologies for monitoring and assessment, pollution prevention and control, and remediation and restoration.

Monitoring and assessment technologies are used to measure and track the condition of the environment, including the release of natural or anthropogenic materials of a harmful nature.

Prevention technologies avoid the production of environmentally hazardous substances or alter human activities in ways that minimize damage to the environment; it encompasses product substitution or the redesign of an entire production process rather than using new pieces of equipment.

Control technologies render hazardous substances harmless before they enter the environment.

Remediation and restoration technologies embody methods designed to improve the condition of ecosystems, degraded through naturally induced or anthropogenic effects. (UNEP, 2012; Ghanshyam Das Soni, 2015)

How can Nigeria use these to contribute to green technology for sustainable develop?

STRENGHTS FROM ADOPTING GREEN TECHNOLOGY

Ability to meet strict product specifications in foreign markets: Manufacturers in developing countries typically need to meet stricter environmental requirements and specifications to export their products to industrialized countries than vice versa. The adoption of green technologies can help exporting companies to gain advantage and market share over competitors.

Reduction of input costs: Green technology can improve production efficiency through the reduction of input costs, energy costs and operating and maintenance

are all these written on Nigerian perspective or its just general information? How can Nigeria ~~contri~~ specifically contribute and implement these on their daily activities?

costs, which can improve a company's competitive position.

Environmental image: Adopting green technology can improve a company's environmental reputation, which is crucial if other competitors and consumers are becoming more environmentally conscious.

Ability to meet stricter environmental regulations in the future: Companies that invest in green technology are more likely to be better equipped and ready for stricter environmental regulations as well as product specifications that are expected to be imposed on them in the future, (R. Luken and F. Van Rompaey, 2008).

CATEGORIES OF GREEN TECHNOLOGIES AND PRACTICES.

Green technologies and practices are used to lessen the environmental impact of an establishment. These technologies and practices fall into one or more of four groups:

- ***Energy from renewable sources.*** Examples include electricity, heat, or fuel generated from renewable sources primarily for use within the establishment. These energy sources include wind, biomass, geothermal, solar, ocean, hydropower, and landfill gas and municipal solid waste.

- ***Energy efficiency.*** Technologies and practices are used to improve energy efficiency within the establishment. Included in this group is cogeneration (combined heat and power).
- ***Pollution reduction and removal, greenhouse gas reduction, and recycling and reuse.*** Technologies and practices are used within the establishment to reduce or eliminate the creation or release of pollutants or toxic compounds, or remove pollutants or hazardous waste from the environment; reduce greenhouse gas emissions through methods other than renewable energy generation and energy efficiency; and reduce or eliminate the creation of waste materials; collect, reuse, remanufacture, recycle, or compost waste materials or wastewater.

Natural resources conservation. Technologies and practices are used within the establishment to conserve natural resources. Included in this group are technologies and practices related to organic agriculture and sustainable forestry; land management; soil, water, or wildlife conservation; and storm water management. (Dixie Sommers, 2013)

CATEGORIES OF GREEN GOODS AND SERVICES

Green goods and services are sold to customers and include research and development, installation, and maintenance services. Green goods and services fall into one or more of five groups:

- ***Energy from renewable sources.*** Examples include electricity, heat, or fuel generated from renewable sources. These energy sources include wind, biomass, geothermal, solar, ocean, hydropower, and landfill gas and municipal solid waste.

- ***Energy efficiency.*** Goods and services in this group improve energy efficiency. Included are energy-efficient equipment, appliances, buildings, and vehicles, as well as products and services that improve the energy efficiency of buildings and the efficiency of energy storage and distribution, such as Smart Grid technologies.

- ***Pollution reduction and removal, greenhouse gas reduction, and recycling and reuse.*** These are products and services that:

i. reduce or eliminate the creation or release of pollutants or toxic compounds or remove pollutants or hazardous waste from the environment;
ii. reduce greenhouse gas emissions through methods other than renewable energy generation and energy efficiency, such as electricity generated from nuclear sources; and
iii. reduce or eliminate the creation of waste materials and collect, reuse, remanufacture,

recycle, or compost waste materials or wastewater.

- *Natural resources conservation.* Goods and services in this group conserve natural resources. Included are products and services related to organic agriculture and sustainable forestry; land management; soil, water, or wildlife conservation; and storm water management.
- *Environmental compliance, education and training, and public awareness.* These are goods and services that:
  i. enforce environmental regulations;
  ii. provide education and training related to green technologies and practices;
  iii. increase public awareness of environmental issues, (Dixie Sommers, 2013)

SUSTAINABLE DEVELOPMENT TRAITS OF GREEN TECHNOLOGY

Of the different social challenges in the sustainability revolution, green technology is the tool to make the greatest impact and empowers us to actually reduce greenhouse gas emissions. Such "technological solutions" are well recognized to apply to various dimensions of the climate change problem (ICTSD-CCTTIPR, 2008). Besides providing new solutions, green technology also plays a vital role in enhancing clean technologies that currently exist and lowering the costs of the same, (U.N. Doc FCCC/CP/1997)

The Advantages of green technology to the environment are enormous, but the most important benefits are:

- It uses renewable resources that never depletes in nature. Therefore, future generation can benefit from them too, without harming the planet.
- It uses latest energy generation techniques. For example, green nanotechnology that uses green chemistry and green engineering is one of the newest green technologies.
- Offers environmental solutions for disposal and recycling of waste. It effectively changes waste production in a way that is does not harm our environment.
- Green technology has no adverse effect on our planet and it uses sustainable production of energy.
- This technology uses various innovative methods to create a number of environmentally friendly products.
  (Greentechbox.com/960/ the main features and benefits of green technology, 2015)

CHALLENGES TO GREEN TECHNOLOGY ADOPTION

Do you mean in Nigeria or just in general??

Generally, green technology is more expensive than the technology it aims to replace, because it accounts for the environmental costs that are externalized in many conventional production processes. Because it is relatively new, the associated development and training costs can make it even more costly in comparison with established technologies. The perceived benefits are also dependent on other factors such as supporting infrastructure, technology readiness, human resources capabilities and geographic elements. Adoption and circulation of these technologies can be constrained by a number of other barriers. Some may be institutional, such as the lack of an appropriate regulatory framework; others may be technological, financial, political, cultural or legal in nature. From a company's perspective, the barriers to adopting green technologies are - High implementing costs, Lack of information, No known alternative chemical or raw material inputs, Uncertainty about performance impacts, Lack of human resources and skills, (R. Luken and F. Van Rompaey,2008) . Overcoming these barriers is a complex process. Promoting green technology requires identifying and removing these barriers that hinder the large-scale dissemination of clean technology to developing countries, especially to those countries with special needs, such as least developed countries and Small Island developing states, (Bangkok, 2010; UNESCAP, 2012; Ghanshyam Das Soni Sep 2015)

POLICY REQUIREMENTS FOR ADOPTION OF GREEN TECHNOLOGY IN NIGERIA

Nigeria seeks to promote environmental sustainability through the protection and conservation of its natural resources but with barely recognition of green technology as a driver for future economic growth, energy security, climate change mitigation and adaptation. The national green technology policy will be developed in cooperation with all relevant parties to strengthen the institutional frameworks and policy coherence. The policy will be designed to generate benefits in four areas: energy, environment, economy and social conditions. Strategies to achieve this should predominantly include the development and adoption of policies such as:

Policies to strengthen institutional frameworks include: the formation of a Green Technology Council and a Cabinet Committee on Green Technology for high-level policy coordination among ministries; the establishment of a Nigerian Green Technology Agency to coordinate and oversee initiatives and programmes; a review of legal mechanisms and the creation of new legislation that is in line with national goals; and a revision of institutional clarity so that all agencies are aware of their roles and responsibilities.

Policies to encourage the growth of green technology sectors include: provision for higher-learning and research institutions for R&D; increased foreign and domestic investment; establishment of a Green Technology Fund; feed-in tariffs legislation to support renewable energy in power generation; and the recognition of green products through standards, ratings and labelling programmes. Various industry programmes inform SMEs about new green technologies, strategic green technology hubs throughout the country, and funding mechanisms.

Other fiscal incentives for renewable energy include: "innovator position", which provides exemptions from income tax; investment tax allowances on qualifying capital expenditure incurred within some years of expenditure; and import duty and sales tax exemptions for one or two years on imported machinery, equipment, materials, space parts and consumables that are used for renewable energy by both importers and third-party distributors.

Policies to improve human resource capacity include: establishment of green technology departments in Nigerian universities; presenting financial and fiscal incentives for students pursuing studies in green technology disciplines at both the undergraduate and graduate levels; retraining and apprenticeship schemes for green jobs; a grading and certification mechanism for green technology-related skills; and brain gain programmes to strengthen local expertise.

CONCLUSION

In Nigeria, green technology has been recognized barely as a driver for future economic growth, energy security, climate change mitigation and adaptation. Therefore, there should be commitment to climate change mitigation and energy security by escalating the advancement of green technology through: adhering to the aforementioned policy strategies that stimulate effective green technology adoption and development, and the creation of Green Technology department of Energy Ministry and Water.

REFERENCES

[1] Ahmed Abdel Latif Et Al., Int'l Ctr. For Trade & Sustainable Dev. Overcoming The Impasse On Intellectual Property And Climate Change At The Unfccc: A Call For A Reasonable And Balanced Approach (2011), *available at* http://ictsd.org/downloads/2012/02/overcoming-the-impasse-on-intellectual-property-andclimate- change-at-the-unfccc-a-way-forward.pdf (using the term "mitigation and adaptation technologies" throughout in reference to green technology).

[2] Audrey Watson, "Use of Multiple Green Technologies and Practices in Business Establishments," *Beyond the Numbers: Special Studies and Research*, vol. 2 no. 7 (U.S. Bureau of Labor Statistics, January 2013), www.bls.gov/opub/btn/volume-2/use-of-green-technologies-and-practices-in-business-establishments.pdf.

[3] Dixie Sommers, "BLS green jobs overview" (Monthly Labor Review January 2013) www.bls.gov/ opub/mlr/2013/01/art1 full.pdf

[4] Ghanshyam Das Soni, "Advantages of Green Technology", International Journal of Reseasrch-Granthaalayah [Social Issues and Environmental Problems, Vol.3 (Iss.9: Se): Sep, 2015] Issn- 2350-0530(O) Issn- 2394-3629(P).

[5] (Greentechbox.com /960/ the main features and benefits of green technology, 2015).

[6] Int'l Ctr. For Trade And Sustainable Dev., Climate Change, Technology Transfer And Intellectual Property Rights, (ICTSD-CCTTIPR,) (2008), *Available At* Http://Ictsd.Org/I/Publications/31159/?View=Document [Hereinafter Climate Change, Technology Transfer] ("Technological Solutions Are Imperative In Meeting The Challenges Of Climate Change.").

[7] .Kyoto Protocol To The United Nations Framework Convention On Climate Change, Annex A, Dec. 11, 1997, U.N. Doc FCCC/CP/1997/7/Add.1, 37 I.L.M. 22, *Available At* Http://Unfccc.Int/Resource/Docs/Convkp/Kpeng.Pdf [Hereinafter Kyoto Protocol] (Listing The Six Major Greenhouse Gases: Carbon Dioxide (CO2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (Hfcs), Perfluorocarbons (Pfcs), And Sulphur Hexafluoride (SF6)).
("A Critical Factor In Greenhouse Gas Emissions, Technology Is Also Fundamental To Enhancing Existing Abilities And Lowering The Costs Of Reducing These Emissions.").
Development Goals in Asia and the Pacific (Bangkok, 2010). Available from www.unescap.org/publications/detail.asp?id=1393 (accessed 31 January 2012).

[11] United Nations Environment Programme, *Environmentally Sound Technologies for Sustainable Development*, Revised Draft (Osaka, Division of Technology, Industry and Economics, 2003). Available from www.unep.or.jp/ietc/techtran/focus/sustdev_est_background.pdf (accessed 05 March 2012).

[12] WIPO Green (Pilot) Charter, WORLD INTELL. PROP. ORG., https://www3.wipo.int/green/green-technology/charter (last visited Sept. 16, 2012) (referring interchangeably to "green" and "environmental" technologies) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

[8] R. Luken and F. Van Rompaey, "Drivers for any barriers to environmentally sound technology adoption by manufacturing plants in nine developing countries", *Journal of Cleaner Production* (2008), vol.16, No.1, pp. 67-77.

[9]I United Nations Department of Economic and Social Affairs, *Earth Summit Agenda 21: The United Nations Programme of Action from Rio* (Rio de Janeiro, 1992). Available from www.un.org/esa/dsd/agenda21 (accessed 31 January 2012).

[10] United Nations Economic and Social Commission for Asia and the Pacific, *Financing an Inclusive and Green Future: A Supportive Financial System and Green Growth for Achieving the Millennium*