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Evaluating the potential of sustainable energy in small and medium-sized enterprises: Accelerating the energy transition in communities in Global South

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Session 3: Energy Interventions and the SDGs

Chaired by Dr. Rupert Gammon, IESD

Evaluating Sustainable Energy Potential through Carbon Emissions Assessment of Small and Medium-sized Enterprises in the Global South: a case in Wula Community in CRS Nigeria

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Abstract

About, 40% of the world's population, mostly in low and middle-income countries, do not have access to sustainable energy amidst an increasing demand for sustainable energy in the global south as part of low carbon economy transition. In Nigeria, this is further exacerbated by the ravaging impact of gross energy poverty. Against this backdrop, Small and Medium-sized Enterprises (SMEs) which plays significant role in achieving the United Nations (UN) Sustainable Development Goals (SDGs) are adversely affected; with cascading impact on local economic growth and ecological systems. In Nigeria, inaccessibility and regular outages of power from the national grid has compelled SMEs to rely on fossil-based energy sources which aggravates environmental pollution, increasing mean carbon footprint, and further expand social and economic consequences. This paper implemented observatory investigation and conducted semi-structured interviews to obtain data on the cost, quantity consumed and sources of energy in Wula in Boki forest area of CRS, Nigeria. Using standard emission factors, we estimate carbon footprint and identify sustainable energy potentials of the community.

The study found a significant sustainable energy potential in the local community and opportunities for co-creating sustainable interventions that could jointly address energy needs for SMEs and proffer solutions for environmental and social impacts. The analysis further indicates that SMEs spent about $13,563 USD annually on fossil fuel-based energy and consumed 33,215 litres of petrol and diesel/annum; an estimated 76,891.0642 $KgCO_2e$ (76.89106 tCO_2e) per annum of CO_2 emission. Having scaled the problem, we plan to demonstrate a hybridised sustainable energy system aimed at reducing

CO_2 emissions, sustain SMEs viability and contribute towards the achievement of the UN SDGs. Potentially, this could establish new business frontiers for the rural poor, lift families out of poverty and transform rural lives in line with the SDGs requirements.

Keywords: Sustainable energy, Carbon footprint, Small and Medium-sized Enterprises, Global South

1.0 Introduction

Recently, the public policies promoting the transition to sustainable energy have given its attention to the promotion of energy efficiency and the adoption of new sources of energy such as renewable or sustainable energy (green energy) in order to minimise increasing carbon emissions (Segarra-Blasco and Jove-Llopis, 2019a). The implementation of sustainable energy technologies has faced a range of barriers that have affected their rate of adoption globally (Luthra *et al.,* 2015). One key strategy for transitioning to a low-carbon and sustainable energy model is to enhance the share of renewable energy, mainly for electricity generation (Pfeiffer and Mulder, 2013). Energy poverty and absence of sustainable energy is hindering the growth of small and medium-sized enterprises (SMEs) in the Global South with severe impacts on the society. In the Nigerian context, inaccessibility and regular outages of power from the national grid compels SMEs to rely on fossil-fuel based energy systems which exacerbate pollution and carbon footprint with severe environmental, social and economic consequences. Nigeria is also facing electricity crisis resulting the threatening of most business sectors. It is estimated that around 40% of people in Nigeria are connected to the national grid but the connected population/communities are exposed to frequent power outages causing disruption (A. S. Aliyu, Dada and Adam, 2015). Furthermore, electricity is conventionally generated by employing the natural resources such as oil, coal and gas and the fossil-based electricity contributes to increase in carbon footprints (Balsalobre-Lorente *et al.,* 2018). Growing energy demand and increasing concerns about environmental and economic costs call for sustainable energy interventions in Nigeria. Therefore, this project aims to evaluate the potential of sustainable energy in SMEs for minimizing the carbon footprint and accelerating the energy transition in a local community of Wula in Nigeria. The project has adopted a novel approach of co-creating sustainable energy solutions and bottom up approach to capture the perspective of the local community. It is argued that energy availability is crucial for the economic growth of the local community in Wula. Also, access to clean, affordable and reliable sustainable energy is key in achieving sustainable development (namely SDG 7: Affordable and Clean Energy) (Emodi and Boo, 2015). The paper first presents the literature review to develop theoretical background around the topic area. Research Methodology is presented followed by the analysis of data and findings. Then, key findings are discussed, and conclusions are drawn with direction for future project work.

2.0 Literature Review

The reality that the earth is heading for an unprecedented environmental crisis has never been more imminent than in the last decade (Burgess, Bowring and Shen, 2014; Redclift, 2010). With increasing production and consumption patterns among super-rich nations driven mostly by profits, coupled with

the unwillingness to honour carbon emissions treaties, there is no doubt of the earths continued environmental crisis. Whereas increasing production activities in the global north has meant greater prosperity for the citizens and businesses, the situation in the south is not just gloomy, but near bleak (Werther Jr and Chandler, 2010; Lin, Omoju and Okonkwo, 2015; Xu and Lin, 2015).

Occasioned by weak economies, weak fiscal policies and near absent social safety nets, and public infrastructure, nations in the global south tend to thrive solely on micro-economies, mostly micro, small and medium-sized enterprises (MSMEs/SMEs), whose productive capacity is equally limited by these preceding factors (Yacob, Wong and Khor, 2019; Segarra-Blasco and Jove-Llopis, 2019b). Despite the obvious lack of critical public infrastructure, specifically power supply, MSMEs/SMEs have consistently contributed to the sustenance of African economies but from conventional fossil dependent energy systems; hence making them outstanding culprits for carbon emissions. In Nigeria for instance, MSMEs/SMEs has in addition to high emissions, continued to struggle with the cost of fossil, imported goods and services and production with an increasing attendant cost and damage to the environment (Akuru and Okoro, 2009; Amrinder, 2016; Oyedepo, 2012; Pursiainen, 2018).

Several experts commentaries and the UN sustainable development drive for responsible consumption and production are making it imperative for governments at all levels, the private sectors and responsible communities to explore and pursue alternative sources of energy with the view to decarbonise the atmosphere (Braun, 2020; A. K. Aliyu, Modu and Tan, 2018; Munro, van der Horst and Healy, 2017; Hodge, 2017; Bello, 2015). Braun further argued that if nations must contribute substantially to curbing carbon emissions, there must be a deliberate drive towards even "demonopolisation" of energy generation because monopoly plays a central role that shield small and medium-sized enterprise from making sustainable progress.

In the Nigerian context, it is intriguing to reveal that the regulatory framework for the production and transmission of energy on a large scale outlaws the participation of individuals, hence the resort to the use of fossil-based systems by small and medium-sized enterprises and households. The scale of the population adapting to lack of sustainable energy in Nigeria is huge yet, the carbon footprint from this sector has been ignored and given less attention globally. Hence, innovative approaches to analyse the carbon footprint of SMEs and proffer solutions for local communities could portray a ray of hope for the global climate system, responsible consumption and production, and chart the way for affordable and clean energy systems. (Oyedepo, 2012) further illuminate the benefits of sustainable energy to include reduced cost of production; leading to higher returns on investment, improved spending capacity, hence the possibility of improved access to quality health care, education and nutrition; reduced carbon footprints, among other things.

To achieve some of these UN SDG targets, suggested a "full exploration and promotion of renewable energy sources (including hydro, solar and wind), energy efficiency practices, as well as the application of energy conservation measures in various sectors" (Hampton and Fawcett, 2017; Kalantzis and Revoltella, 2019; Rahil *et al.*, 2019). This position is in line with some empirical studies conducted by the (Kumar, Fujii and Managi, 2015) on linking renewable energy to rural development. It reveals that renewable energy sector grew by 26% between 2005 and 2010 globally, and at the time provides about 20% of the world's total power, with substantial supply in the rural areas. The reports overarching summary agrees with the argument of Oyedepo (2012) that the impact of this thrust brought about an

improvement in local revenue, local jobs, innovations in products, processes and policies, capacity building and empowerment, affordable and reliable energy.

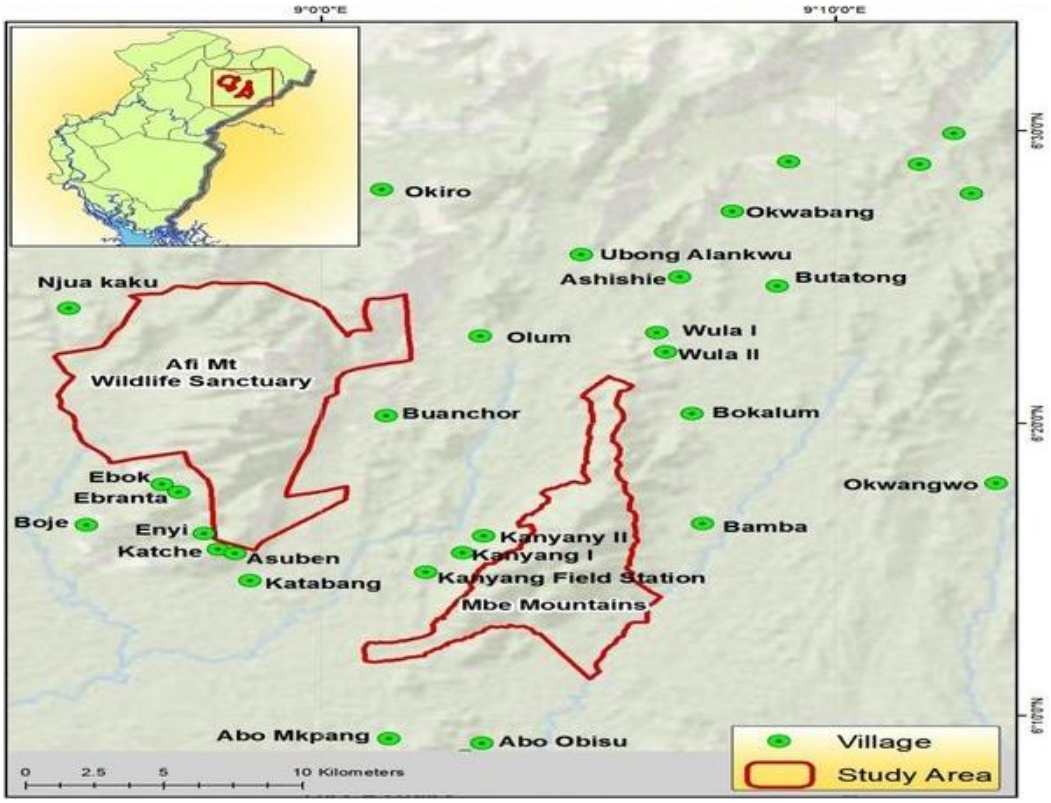
The implication of these arguments is that properly deployed sustainable energy in local communities targeted at MSMEs/SMEs sector benefits a wider population, the environment and stimulates a bottom-up economic growth which is central to this study. Though other theoretical assumptions tend to ignore the cost implications of energy transition for SMEs, they recommend that regional and local governments must adopt a pragmatic integrated rural sustainable energy development programme. This pilot study examines the cost and cost implications of fossil energy consumption to complement the gap in literature and suggest possible approaches of energy transition for Wula (I) of Boki LGA of CRS, Nigeria (Balsalobre-Lorente *et al.*, 2018; Bello, 2015; Chappells and Shove, 2005). An integration of policy formulation to guide investments in renewable energy in local communities has been advanced as peculiarity boosting economies while factoring in strategies for achieving the UN Sustainable Development Goals, (SDGs) and the aims of New Partnership for African Development (NEPAD) (Ahmed-Hameed and Wapmuk, 2017; Edkins, Marquard and Winkler, 2010).

In alignment with this objective, this study proposed a further modelling of an integrated modular hydro-electric power (MHEP) systems for Wula community with an attempt to suggest community collaboration n co-creating local energy management policies. This is because it has been contended that active engagement with relevant stakeholders at the community, local, state and national levels are essential for establishment of new systems in the global south (Ferdig, 2007; van der Jagt, Alexander PN *et al.*, 2019). This study adopts gatekeeper's engagement strategy and snowballed into a wider community engagement to ensure effective dialogue to scope the readiness of MSMEs/SMEs owners to transit from fossil to renewable energy, reduce their carbon footprints and impact of CO_2 on the environment.

3.0 Methodology

The study implemented and exploratory investigation through application of semi-structured interviews to conduct a pilot study and obtained data on energy type, quantity consumed and annual cost. Standard emission factors were applied to estimate individual and gross carbon footprints of the SMEs and evaluation of sustainable energy potential of Wula (I) community in Boki, Cross River State Nigeria. See figure 1 below

Figure 1; Topographycal Map of Wula I & II in Boki LGA of Cross River State, Nigeria. Source: (Shomkegh, Adaje and Verinumbe,)



Wula (I) is about 20 km from protected forest areas of Boki with endangered species of plants and animals of global importance. We delineated an area with a population of about 10,000 people, 16 energy users SMEs and the rest of the population survive rom peasant arming and dependence on forest wealth. The study focused on SMEs which are the ubiquitous businesses in the community which activities have direct and cumulative impact on the environment and socio-economic life of the people. As indicated on Kalantzis and Revoltella, (2019), examples of the businesses in the community includes barbering shops, restaurants, and medicine stores.

To collect data for this study, we invested embarked on a 48 hours exploratory pilot survey in September 2019; conducted both one-to-one and focus group interviews with relevant stakeholders in the community to collect data and formed arguments for cocreating effective and sustainable energy solutions. Owners of small and medium-size enterprises were mostly engaged in a one-to-one interview while the focus group sessions involved youth and elderly community leaders. Participants were randomly selected and interviewed to assess community energy sources, quantity consumed and

acceptance threshold of alternative energy (Devine-Wright and Wiersma, 2020; Bartolini *et al.,* 2020; Zhang *et al.,* 2020). We interviewed 46 households to evaluate community acceptance of alternative renewable energy plan (analysis is outside the scope of this paper) and 16 SMEs which data formed the bases of this paper (see (Yacob *et al.,* 2019; Ugwu and Haupt, 2007). One-to-one interview with each SME owner lasted for about 25 minutes including observatory investigations where applicable.

Consistent with the objective of our study, we collected energy data according to sources, rate of consumption, and cost implications, for each SME per day and estimated annual consumption from extrapolatory calculations (Bolton, 2017; Cheung and Wang, 2018; Faghani, Ashrafi and Sedaghat, 2018). From observatory investigation, we collected photographic evidence of petrol generating sets per business and the corresponding quantity of petrol or diesel fuel consumed daily for data verification. However, the study does not include analysis of the running cost (maintenance/servicing) of the generating set which could be considered in subsequent exploration.

Nonetheless, the direct cost of fuel was calculated using the local retail price of N150.00/litre and N300.00/litre for petrol and diesel respectively. Emissions and carbon footprint were estimated by multiplying the standard emission factor (section 4) by quantity of petrol and or diesel consumed per SME (Lingl and Carlson, 2010).

4.0 Results and Analysis

Detail analysis of energy (fuel) type, daily and annual consumption by SMEs in Wula, Boki area of Cross River State Nigeria, is presented. Further estimation of financial cost and carbon footprints resulting from gross consumption is calculated and analyse in this section. We implemented *Petrol (100% mineral petrol) gross calorific value (CV – 0.24099)* and *diesel (100% mineral diesel) gross calorific value (CV – 0.25267)* emission factors to determine in kilowatt (kWh) of petrol and diesel fuel consumed per kilogram of carbon equivalent (Liu *et al.,* 2015; Lingl and Carlson, 2010).

$$\textit{Carbon footprint } (KgCO_2e) = \textit{emission factor (CV (kWh)) X quantity of fuel consumed}$$

$$\textit{Tons of } CO_2 \textit{ equivalent } (tCO_2e) = KgCO_2e/1000$$

We implement the obtained prevailing retail cost of three hundred naira (N300.00/litre) in estimating the cost of diesel in the data while oanda exchange rate was implemented in determining USD equivalent of local currency. Accordingly, fuels *100% minerals* factors were adopted because both fuel sources were unblended with biofuels sources.

4.1. Energy Source, Consumption and Impact

Results of SMEs activity, fuel type, daily and annual fuel consumption (in litres) is shown in Table 1. The result shows that 100% of energy used by SMEs in the local community is from fossil sources (mostly petrol and diesel). Each SME consumes an average of 4.44 litres for a maximum of 5 hrs/day between 6 pm and 11 pm, a combined daily total of 71 litres from 16 SMEs. This implies that electric energy dependent commerce is closed after 11 pm with the entire SMEs and households' resorting to alternatives mostly firewood and kerosene lantern which has exponential negative health implications. It can cause degradation of air quality in homes while producing toxic and carcinogenic gases. The direct exposure to kerosene have various consequences such as unintentional poisoning, dermatitis, chemical depression and headaches, loss of memory and affects respiratory, kidney and blood functions (Epstein

et al., 2013). The combine impact of inaccessible sustainable energy and community adaptation strategies is subjecting both businesses and communities to several health dangers and avoidable environmental impact. From the data analysis, it is found that a total of 25,950 litres of fossil petrol/diesel is consumed per annum and the health implications in the community remained under reported and ignored by the concerned authorities. This is in contradiction to 'SDG 3: Good Health and Well-being' which aims to ensure healthy lives and promote well-being for all at all ages in communities across the world. It is believed that investment in alternative sustainable energy solutions could help reduce these health and environmental impacts and vulnerability and enshrine new livelihoods and save the climate in line with the UN SDGs.

Table 1; Estimated SMEs annual fuel usage and carbon footprints

SME TYPE	FUEL TYPE	DAILY USAGE (LITRES)	ANNUAL USAGE (LITRES)	ANNUAL EMISSION (KgCO2e)
Provision store for one-stop shopping	Petrol	4	1460	351.8454
Commercial Foodstuffs vendor	Petrol	6	2190	527.7681
Hair Dressing Shop	Petrol	5	1825	439.80675
Tailoring Shop (Making and mending cloths)	Petrol	5	1825	439.80675
Provision Store and Onestop shopping	Petrol	4	1460	351.8454
Commercial Mobile Phones Charging Shop	Petrol	8	2920	703.6908
Sports viewing Centre and Sale of cool drinks	Petrol	3	1095	263.88405
Sale drinks, Provisional items and Fast Food	Petrol	5	1825	439.80675
Provision Store for Onestop shopping	Petrol	10	3650	879.6135
Commercial Food vendor	Petrol	2	730	175.9227
Medicine Store (Chemist)	Petrol	3	1095	263.88405
Provision Store one-stop shopping	Petrol	6	2190	527.7681
Fast food and Food items	Petrol	3	1095	263.88405
Patent Medicine Store	Petrol	3	1095	263.88405
Medical Diagnostic Laboratory	Petrol	4	1460	351.8454
Iron fabrication and Welding	Diesel	20	7300	1844.491
TOTAL Consumptions and Footprints		71	25,950	8089.74685

4.2 Estimating Carbon footprint of SMEs

The combine carbon footprint of selected SMEs stands at 8, 089.747 $kgCO_2^e$ (equivalent of 8.089 tCO_2e) per annum; implying an emission of 505.609 $KgCO_2e$/SME/annum. With each SME emitting at least

half a ton of Carbon dioxide, the implications for climate change and widespread severity on the society could exacerbate physical and socioeconomic consequences (Yao, Huang and Song, 2019). If sustainable energy measures are continuously ignored, there is a high tendency of aggravated global warming potential SMEs and direct impact on the preserved forest, biodiversity and ecological systems (Amrinder, 2016; Midgley and Bond, 2015). The carbon footprint of the local business community in Wula needs attention and sustainable energy interventions can minimise this whilst ensuing the economic and human health & well-being. Therefore, the local interventions can help align with the SDGs such as SDG 7: Affordable and Clear Energy, SDG 9: Industry, Innovation, and Infrastructure, SDG 11: Sustainable Cities & Communities and SDG 13: Climate Action

4.3 Estimating Financial Cost of Energy (COE) on SMEs

SMEs in the Wula community have significant financial Cost of Energy (COE) as a result of regular fuel consumption. The data indicates that SMEs spent an equivalent of $15,432.81 USD annually by consuming 25, 950 litres of fossil energy (petrol and diesel). This is equivalent of 0.6 cents/litre (see Table 2). This excludes the cost of generator's monthly maintenance and parts replacement which according to an SMEs operator, *"has high impacts on her business turnover"* and impact on livelihoods in a typical rural community. On the contrary, a $15, 400 USD investment on renewable alternatives such as solar PVs and mini-wind systems could serve the energy need of SMEs, reduce reliance on fossil sources and provide return on investment. More so, such investment could save SMEs energy cost and increase turn over, reduce carbon footprint and improve quality of life in rural communities.

Table 2; Estimated annual fuel usage and financial cost

SME TYPE	FUEL TYPE	ANNUAL USAGE (LTRS)	FUEL COST/ANNUM (=N=)
Provision store for one-stop shopping	Petrol	1460	219,000
Commercial Foodstuffs vendor	Petrol	2190	328,500
Hair Dressing Shop	Petrol	1825	273,750
Tailoring Shop (Making and mending cloths)	Petrol	1825	273,750
Provision Store and One-stop shopping	Petrol	1460	219,000
Commercial Mobile Phones Charging Shop	Petrol	2920	438,000
Sports viewing Centre and Sale of cool drinks	Petrol	1095	164,250
Sale drinks, Provisional items and Fast Food	Petrol	1825	273,750
Provision Store for One-stop shopping	Petrol	3650	547,500
Commercial Food vendor	Petrol	730	109,500
Medicine Store (Chemist)	Petrol	1095	164,250
Provision Store one-stop shopping	Petrol	2190	273,750

Fast food and Food items	Petrol	1095	164,250
Patent Medicine Store	Petrol	1095	164,250
Medical Diagnostic Laboratory	Petrol	1460	219,000
Iron fabrication and Welding	Diesel	7300	2,190,000
Totals		25,950	6,022,500

The financial and environmental cost (carbon footprint) of SMEs in Wula indicate the scale of the problem suggesting investigating solutions which are feasible for a sustainable community. Nonetheless, the next phase of this study will explore sustainable interventions to reduce estimated CO_2 emissions and further explore sustainable strategies for improving return on investment for SMEs. This is with the view to contributing towards the achievements of relevant SDGs such as SDG 3: Good Health and Well-being, SDG 7: Affordable and Clean Energy, SDG 11: Sustainable Cities and Communities and SDG 13: Climate Action. Continual energy audit and investment decisions driven by the need to obtain constant energy supply, expand business and economic well-being and protect the environment is critical. This is consistent with the opinion that understanding energy demand, cost and carbon emission scenarios is a strategic tool for investment in sustainable efficient measures for small and medium-sized enterprises (Özbuğday *et al.,* 2020; Wu *et al.,* 2019; Kalantzis and Revoltella, 2019). Potentially, this study could further open new markets and business opportunities for the poor in the rural area, hence lifting families out of poverty and transform lives as a contribution towards wider achievement of SDGs.

5.0 Discussion and Conclusion

The study has offered evaluation of the potential of sustainable and renewable energy in SMEs in the Wula community in Nigeria by measuring their carbon footprint and gaining empirical insights from SMEs owners/managers in the local area. This research is first of its kind in attempting to help SMEs in Wula to transition towards a model for low carbon sustainable energy and address social, economic and environmental challenges. The study has adopted co-creation and bottom-up approach to include SMEs owners and managers to understand the problems and have their perspective on the demand side of sustainable energy which has been underdeveloped in the context of SMEs energy strategy (Hampton and Fawcett, 2017). The study found that SMEs in the Global South have significant potential to accelerate towards energy transition in communities. By adopting sustainable energy technologies, SMEs cannot only minimise their carbon footprint (Segarra-Blasco and Jove-Llopis, 2019a), but also reduce cost of fossil fuel energy consumption. However, the main issue is the country's inability to make use of these sustainable resources (Emodi and Boo, 2015).

The study found that 100% of the energy consumption in SMEs in Wula is from fossil fuels which has severe environmental and social impacts. This may suggest that the energy supply in SMEs may not be able to meet the demand as there could be interruption due to lack of fuel supply and financial reasons, as stated by Aliyu et al. (2015). There appears to be demand for more sustainable or renewable energy and this comes against a backdrop of area being deprived and no grid availability by the national government (Aliyu et al., 2015). Large scale renewable energy is an option however, there has been no local or national policy mechanism to support the interventions. Therefore, the paper recommends for policymakers that Nigeria needs to design an energy policy for the SMEs that pursues both energy

efficiency and renewable/sustainable energy. It needs to be noted that the country is blessed with abundant renewable energy resources that have not been fully exploited yet (Aliyu et al., 2015), offering an opportunity for environmental sustainability, carbon management and economic growth.

The project suggests that the potential of sustainable energy in SMEs can help accelerate the energy transition in communities in the Global South whilst meeting the SDGs. This evaluation can inform the development of national and local policies for energy transition to meet climate change mitigation targets and contribute towards the SDGs, mainly SDG 7: Affordable and Clear Energy, SDGs 11: Sustainable Cities and Communities and SDG 13: Climate Action. Sustainable energy interventions do not only help address environmental challenges such as carbon emissions and pollution but can help save financial cost for economic sustainability and social prosperity including health in developing countries (Ahuja and Tatsutani, 2009). This means that the SDGs are interconnected and intersect. In contrast, there might be some trade-offs which need to be made in decisions by practitioners and policymakers. It is recommended that responsible government agencies could tap into sustainable energy potentials to better support SMEs and community livelihoods by reducing their emissions and carbon footprint in alignment with the UN SDGs. This study is expected to help both policymakers and practitioners in terms of SMEs who are serious toward sustainable energy and carbon management implementation and are looking for appropriate insights into the state of the problem.

It is paramount to highlight limitations of the paper. The analysis allows to measure carbon footprint of SMEs and identify scale of the problem in the local area in Nigeria as well as direction for transitioning to sustainable energy adoption. However, it does not provide pathway of which renewable energy technologies would be feasible in this particular context and only the need/application of such actions is discussed. Future research can conduct feasibility study of a selection of sustainable energy technology options. In alignment with the strategic energy objective, this study proposes a further modelling of an integrated modular hydro-electric power (MHEP) systems for Wula community with an attempt to suggest community collaboration n co-creating local energy management policies. This is because it has been contended that active engagement with relevant stakeholders at the community, local, state and national levels are essential for establishment of new systems in the global south (Ferdig, 2007; van der Jagt, Alexander et al., 2019). It needs to be noted that this project is a work in progress and future work package also aims to carry out need assessment of SMEs and local communities based on Multi Criteria Decision-Making analysis. This will help understand how sustainable energy is prioritised which may inform some local and political action regionally and nationally. The project aims to co-create sustainable energy solutions with local SMEs and communities not only to minimise carbon footprint of SMEs (and reduce environmental impact of the community) but also help contribute to economic prosperity of local residence and transform their lives.

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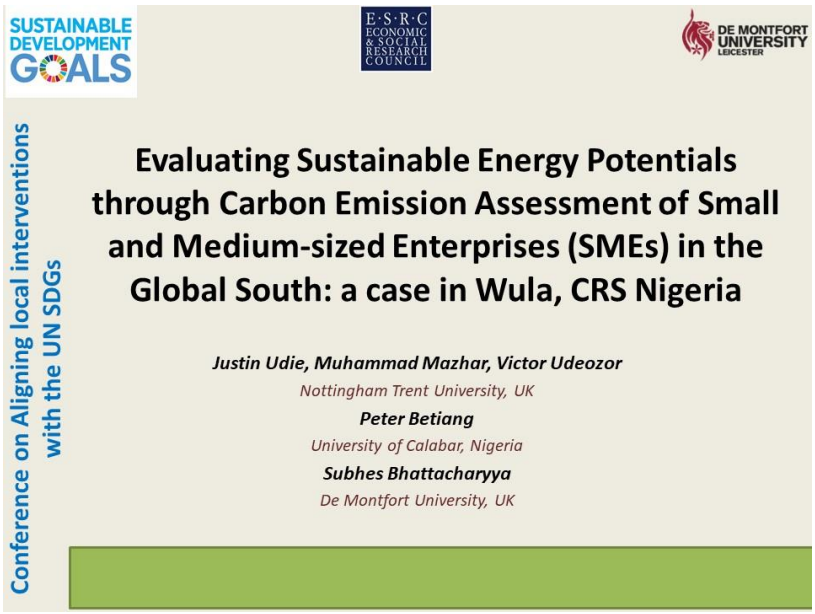
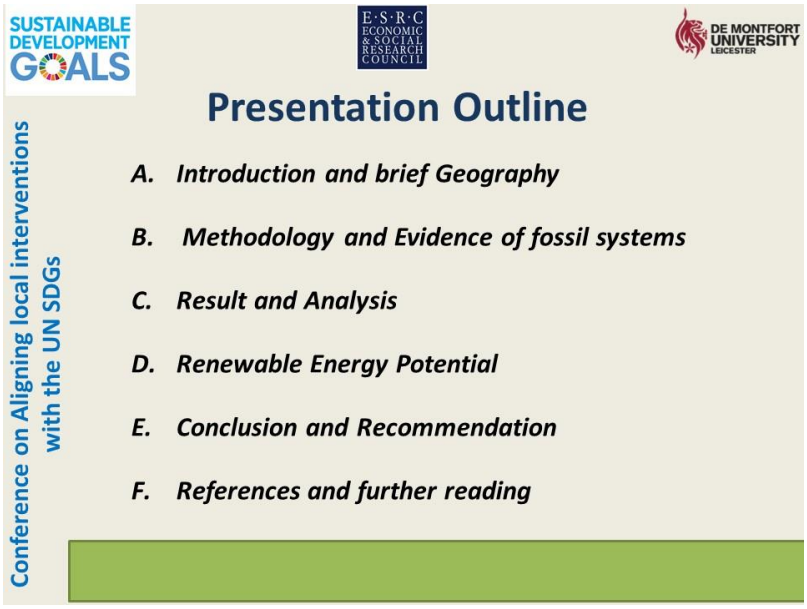
Evaluating the potential of sustainable energy in small and medium-sized enterprises: Accelerating the energy transition in communities in Global South,

by Dr. Justin Udie, Nottingham Trent University (on behalf of Justin Udie, Muhammad Usman Mazhar, Victor Udeozor, Peter Betiang, Subhes Bhattacharyya)

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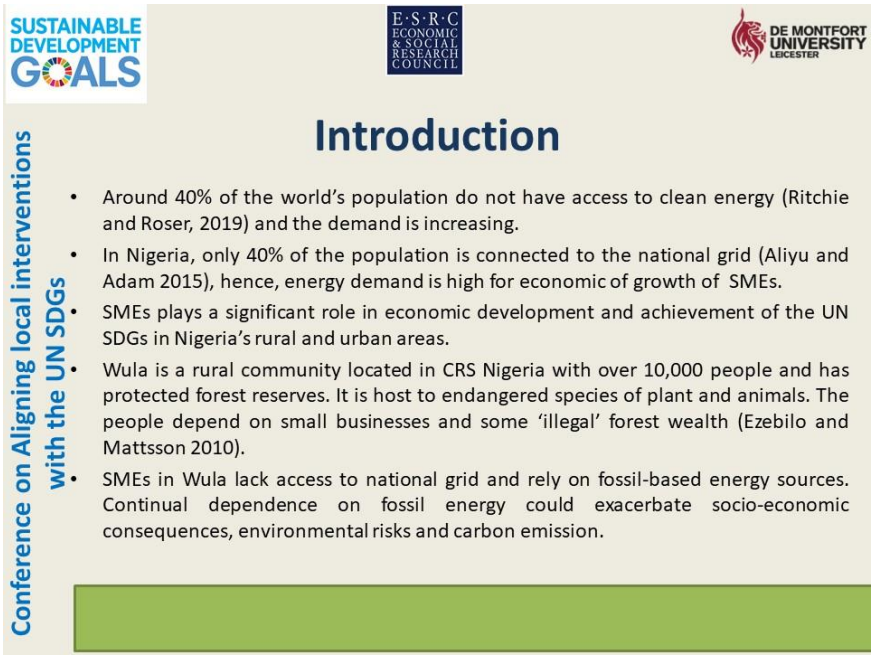
Presentation Outline
A. Introduction and brief Geography
B. Methodology and Evidence of fossil systems
C. Result and Analysis
D. Renewable Energy Potential
E. Conclusion and Recommendation
F. References and further reading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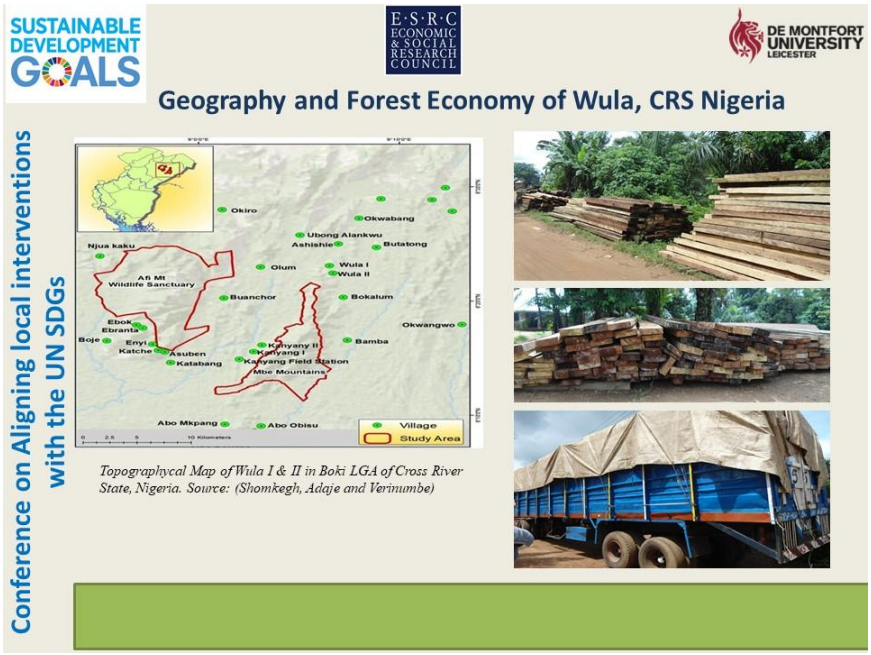
Introduction
Around 40% of the world's population do not have access to clean energy (Ritchie and Roser, 2019) and the demand is increasing.
In Nigeria, only 40% of the population is connected to the national grid (Aliyu and Adam 2015), hence, energy demand is high for economic of growth of SMEs.
SMEs plays a significant role in economic development and achievement of the UN SDGs in Nigeria's rural and urban areas.
Wula is a rural community located in CRS Nigeria with over 10,000 people and has protected forest reserves. It is host to endangered species of plant and animals. The people depend on small businesses and some 'illegal' forest wealth (Ezebilo and Mattsson 2010).
SMEs in Wula lack access to national grid and rely on fossil-based energy sources. Continual dependence on fossil energy could exacerbate socio-economic consequences, environmental risks and carbon emission.


SUSTAINABLE DEVELOPMENT GOALS
E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL
DE MONTFORT UNIVERSITY LEICESTER
Geography and Forest Economy of Wula, CRS Nigeria
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Okiro
Okwabang
Ubong Alankwu
Ashishie
Butatong
Njua kaku
Olum
Wula I
Wula II
Afi Mt Wildlife Sanctuary
Buanchor
Bokalum
Ebok Ebranta
Boje
Enyi
Katche
Asuben
Katabang
Kanyang II
Kanyang I
Kanyang Field Station
Mbe Mountains
Bamba
Okwangwo
Abo Mkpang
Abo Obisu
Village
Study Area
Topographycal Map of Wula I & II in Boki LGA of Cross River State, Nigeria. Source: (Shomkegh, Adaje and Verinumbe)

Methodology

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- Adopted observatory investigation and semi-structured interviews to scope data on energy type & sources, cost implications, quantity consumed and identified sustainable energy potentials.
- Conducted one-to-one and focus group interviews with relevant community leaders and 16 SMEs to determine their acceptability level of renewable alternatives and formulate strong argument for co-creating sustainable energy.
- The direct fuel cost was calculated using the local retail price of N150.00/litre (about 39 cents) and N300.00/litre (about 77cents) for petrol and diesel respectively. Emissions and carbon footprint were estimated using the formular below according to quantity of petrol and/or diesel consumed per SME (Lingl and Carlson, 2010).

Carbon footprint ($KgCO_2e$) = emission factor (CV (kWh)) X quantity of fuel consumed

Tons of CO_2 equivalent (tCO_2e) = $KgCO_2e/1000$

- Standard emission factors for Petrol gross calorific value **(CV – 0.24099)** and diesel ***(CV – 0.25267)*** were used to estimate and compute carbon footprint (*$KgCO_2e$)* (Liu *et al.*, 2015).

Fossil Energy Generators

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Results and Analysis

1. Energy Source, Consumption and Emissions

- 100% of SMEs' energy is from fossil-fuel; a dare need for intervention
- Each SME consumes an average of 4.44ltrs/5 hrs/day (6 pm and 11 pm)
- Economic activities are severely impacted with cascading impact on livelihoods
- The direct exposure to kerosene have various consequences - **poisoning, dermatitis, chemical depression and headaches, loss of memory and affects respiratory effects, kidney and blood disfunctions** (Epstein *et al.*, 2013).
- These hazards are under reported and ignored by the concerned authorities
- This is in contrast with SDG 3 (Good Health and Well-being) which aim to ensure healthy lives and promote well-being for all, globally

SME TYPE	FUEL TYPE	DAILY USAGE (LITRES)	ANNUAL USAGE (LITRES)	ANNUAL EMISSION (KgCO2e)
Provision store for one-stop shopping	Petrol	4	1460	351.8454
Commercial Foodstuffs vendor	Petrol	6	2190	527.7681
Hair Dressing Shop	Petrol	5	1825	439.80675
Tailoring Shop (Making and mending cloths)	Petrol	5	1825	439.80675
Provision Store and Onestop shopping	Petrol	4	1460	351.8454
Commercial Mobile Phones Charging Shop	Petrol	8	2920	703.6908
Sports viewing Centre and Sale of cool drinks	Petrol	3	1095	263.88405
Sale drinks, Provisional items and Fast Food	Petrol	5	1825	439.80675
Provision Store for Onestop shopping	Petrol	10	3650	879.6135
Commercial Food vendor	Petrol	2	730	175.9227
Medicine Store (Chemist)	Petrol	3	1095	263.88405
Provision Store one-stop shopping	Petrol	6	2190	527.7681
Fast food and Food items	Petrol	3	1095	263.88405
Patent Medicine Store	Petrol	3	1095	263.88405
Medical Diagnostic Laboratory	Petrol	4	1460	351.8454
Iron fabrication and Welding	Diesel	20	7300	1844.491
TOTAL Consumptions & Footprints		71	25,950	8089.74685

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2. Estimating Carbon footprint of SMEs

- The combine carbon footprint of 16 SMEs stands at 8, 089.747 $kgCO_2^e$ (equivalent of 8.089 tCO_2e) per annum.
- An equivalent of 505.609 $KgCO_2e$/SME /annum. Implies that each SME emits at least 1/2 a ton of Carbon dioxide/year)
- The implication of this on the ambient climate system could be severe and most likely to exacerbate physical and socio-economic consequences (Yao, Huang and Song, 2019).
- And a huge hinderance to the success of the SDGs – mainly 7, 11, 13, and 14

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3. Estimating Financial Cost of Energy (COE) on SMEs

- SMEs in the Wula are struggling with revenue losses due to the cost of energy. Data indicates that SMEs spent an equivalent of $15,432.81 USD annually on 25,950 litres of fossil energy
- That excludes the cost of engine maintenance and parts replacement. The additional costs on SMEs *"has high impacts on...turnover"* and on families – mostly women and children
- On the contrary, a $15,400 USD investment on renewable alternatives (solar, mini-wind and water systems) could serve the energy need of SMEs, offset carbon footprints and accelerate return on investment.
- It could improve the quality of life amongst the rural poor as well as safeguard the environment

SME TYPE	FUEL TYPE	ANNUAL USAGE (LTRS)	FUEL COST/ANNUM (=N=)
Provision store for one-stop shopping	Petrol	1460	219,000
Commercial Foodstuffs vendor	Petrol	2190	328,500
Hair Dressing Shop	Petrol	1825	273,750
Tailoring Shop (Making and mending cloths)	Petrol	1825	273,750
Provision Store and One-stop shopping	Petrol	1460	219,000
Commercial Mobile Phones Charging Shop	Petrol	2920	438,000
Sports viewing Centre and Sale of cool drinks	Petrol	1095	164,250
Sale drinks, Provisional items and Fast Food	Petrol	1825	273,750
Provision Store for One-stop shopping	Petrol	3650	547,500
Commercial Food vendor	Petrol	730	109,500
Medicine Store (Chemist)	Petrol	1095	164,250
Provision Store one-stop shopping	Petrol	2190	273,750
Fast food and Food items	Petrol	1095	164,250
Patent Medicine Store	Petrol	1095	164,250
Medical Diagnostic Laboratory	Petrol	1460	219,000
Iron fabrication and Welding	Diesel	7300	2,190,000
Totals		25,950	6,022,500

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RENEWABLE ENERGY POTENTIAL

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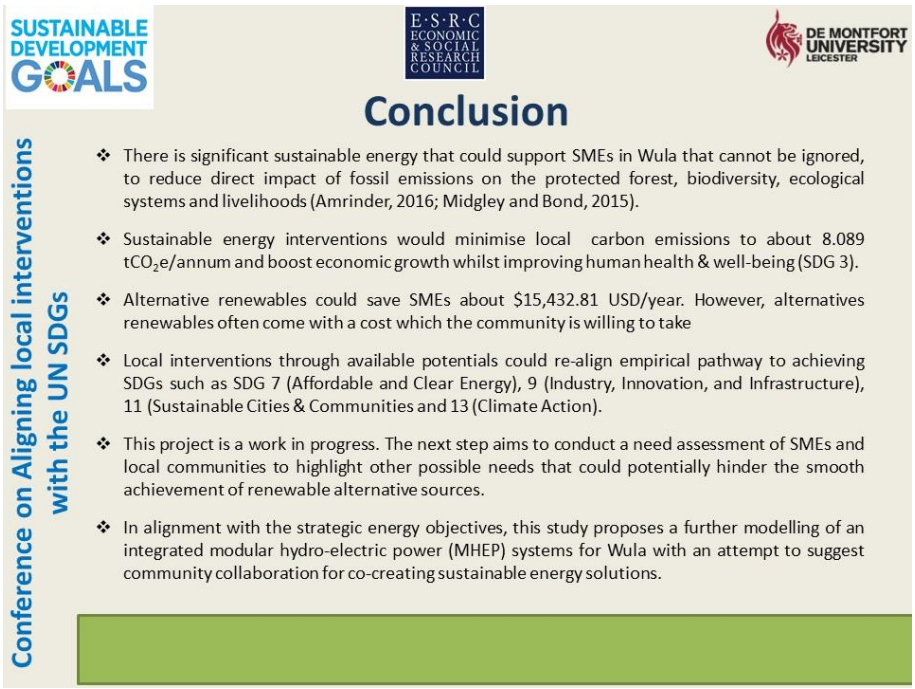

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Conclusion

- There is significant sustainable energy that could support SMEs in Wula that cannot be ignored, to reduce direct impact of fossil emissions on the protected forest, biodiversity, ecological systems and livelihoods (Amrinder, 2016; Midgley and Bond, 2015).
- Sustainable energy interventions would minimise local carbon emissions to about 8.089 tCO_2e/annum and boost economic growth whilst improving human health & well-being (SDG 3).
- Alternative renewables could save SMEs about $15,432.81 USD/year. However, alternatives renewables often come with a cost which the community is willing to take
- Local interventions through available potentials could re-align empirical pathway to achieving SDGs such as SDG 7 (Affordable and Clear Energy), 9 (Industry, Innovation, and Infrastructure), 11 (Sustainable Cities & Communities and 13 (Climate Action).
- This project is a work in progress. The next step aims to conduct a need assessment of SMEs and local communities to highlight other possible needs that could potentially hinder the smooth achievement of renewable alternative sources.
- In alignment with the strategic energy objectives, this study proposes a further modelling of an integrated modular hydro-electric power (MHEP) systems for Wula with an attempt to suggest community collaboration for co-creating sustainable energy solutions.


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Thank you
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