REPORT ON THE RESEARCH ENGAGEMENT OF THE NATIONAL CENTRE FOR ENERGY RESEARCH AND DEVELOPMENT UNIVERSITY OF NIGERIA, NSUKKA, FROM 2010 TO DATE

RESEARCH AND DEVELOPMENT ACTIVITIES

The research and development activities of the Centre spanned across experimental and laboratory work, design and development, and field work on solar thermal systems, solar PV systems, wind and meteorology, biomass energy, fossil energy, energy management and environment, technical and maintenance of renewable energy devices, as well as manpower capacity development training programs in renewable and non-renewable energy technologies. The Center has made very remarkable achievements/breakthrough in various areas its research and development activities, which are disseminated through collaborations, conferences, exhibition and publications in peer-reviewed conference proceedings, and national and international journals.

Summary of research engagement from 2010 to date with photographic evidence and their locations. Impact of the research on the economy or specific industries.

Photocatalytic degradation and gas-sensing properties of hydrothermally synthesized $(ZnO)_X/(NiO)_{1-X}$ incorporated with a functionalized graphene oxide, 2025

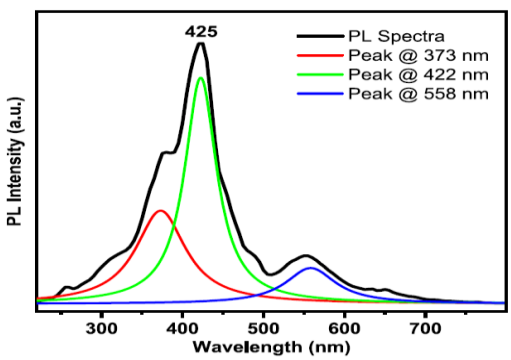

Figure 4: The PL spectra of $GO/(ZnO)_{1-x}(NiO)_x$ compositions for $x = 0.5$.

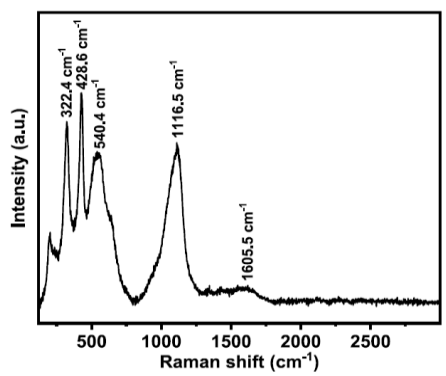

Figure 5: The Raman spectra of $GO/(ZnO)_{1-x}(NiO)_x$ compositions for $x = 0.2$.

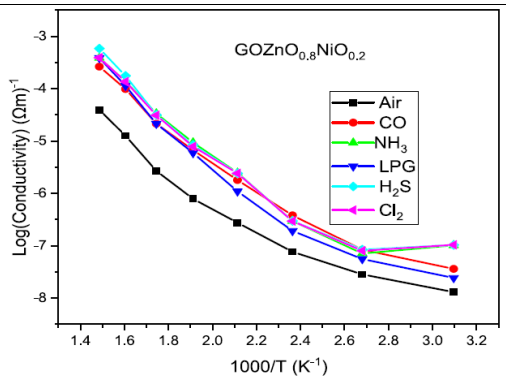

FIG 6: Gas-sensing plots for $GO/(ZnO)_{1-x}(NiO)_x$ compositions for $x = 0.2$.. the electrical conductivity

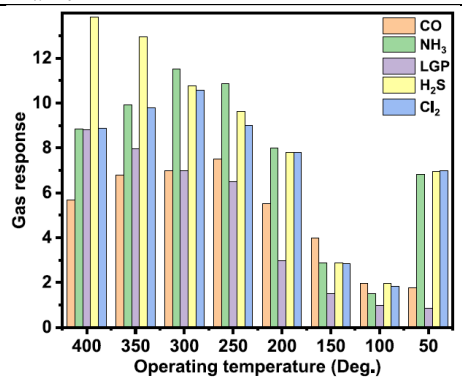

Figure 7: Gas response against operating temperature for $GOZnO_{0.8}NiO_{0.2}$.

values of the different NCs ratios plotted on the vertical axis (Log Conductance) against temperature values 1000/T) at the horizontal axis [79] for different gases: air, CO, NH3, liquified petroleum gas (LPG, i.e., cooking gas), H2S, and Cl2. The conductivity decreased with increasing temperature for the different gases, consistent with the reports in other studies	

IMPACT:
the study reports the synthesis of ternary metal oxide functionalized graphene oxide (GO/(ZnO)x(NiO)1 −x, (x = 0.8, 0.5, 0.2)) using a hydrothermal technique, and the synthesized NCs employed for photocatalytic degradation and gas-sensing applications.

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Short Circuit Evaluation of Grid-Connected Photovoltaic System "Case Study of Nsukka Electricity Distribution Network"

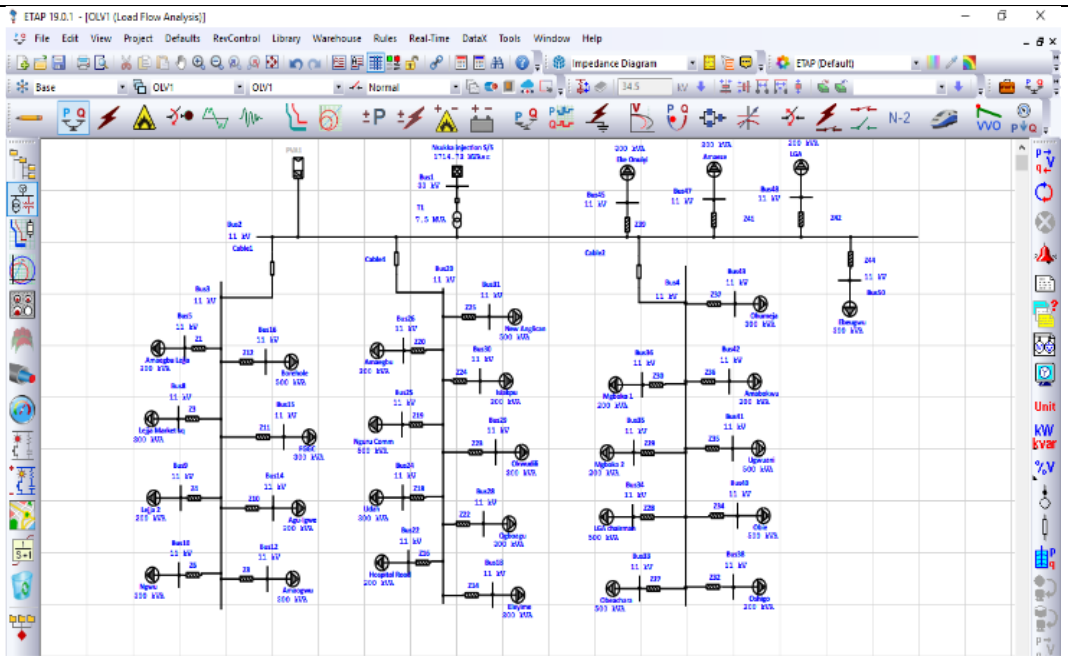

Fig. 5 Oneline diagram of 33/11kV Nsukka distribution network integrated with photovoltaic system

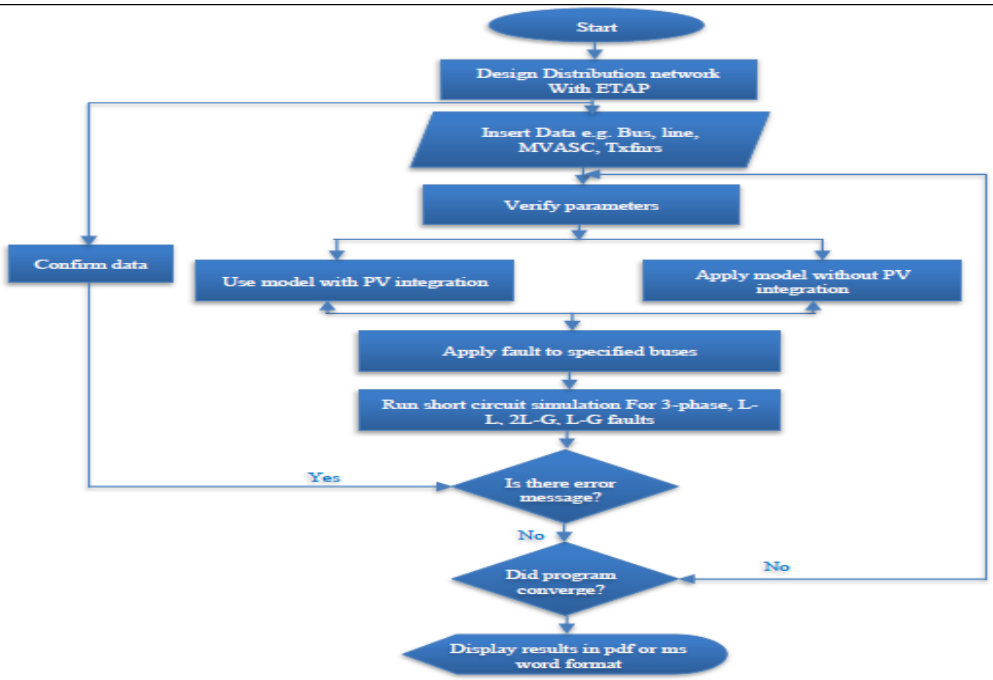

Fig. 6 Flowchart for implementation of fault analysis

Table 2. Short circuit summary report with PV integration

Bus	3-Phase				Line-to-Ground Fault				Line-to-Line Fault				*Line-to-Line-to-Ground			
ID	kV	I"k	ip	Ik	I"k	ip	Ib	Ik	I"k	ip	Ib	Ik	I"k	ip	Ib	Ik
Bus3	11.000	6.758	15.434	3.886	4.632	10.424	4.632	4.632	5.606	12.615	5.606	5.606	6.198	13.948	6.198	6.198
Bus20	11.000	6.759	15.436	3.886	4.632	10.579	4.632	4.632	5.606	12.803	5.606	5.606	6.198	14.156	6.198	6.198
Bus33	11.000	6.758	15.417	3.885	4.631	10.566	4.631	4.631	5.605	12.788	5.605	5.605	6.198	14.140	6.198	6.198
Bus34	11.000	6.758	15.417	3.885	4.631	10.566	4.631	4.631	5.605	12.788	5.605	5.605	6.198	14.140	6.198	6.198

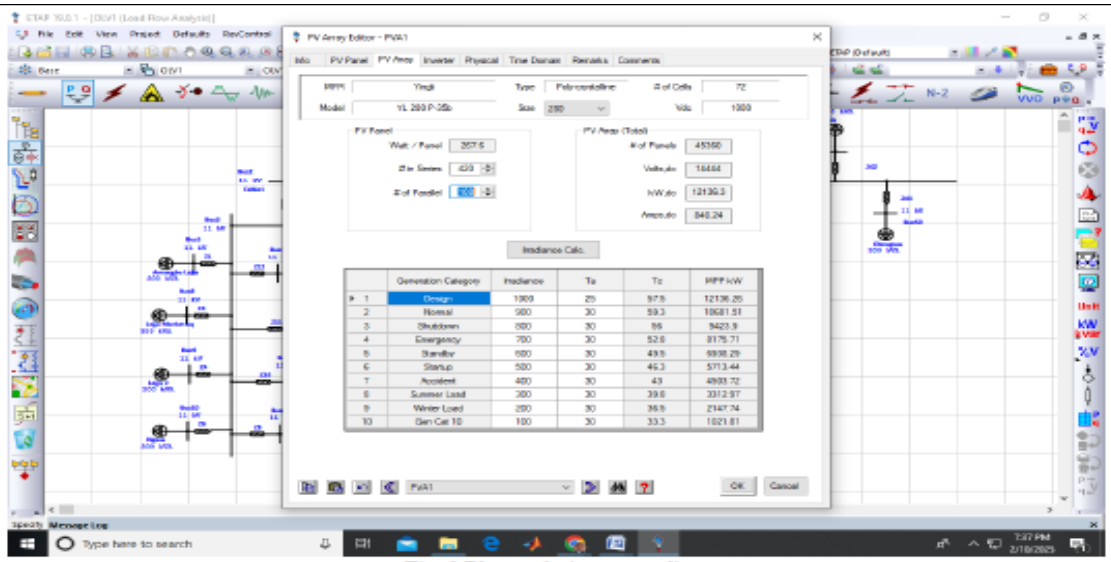

Fig. 9 Photovoltaic array editor

IMPACT:
Short circuit investigation is a power system technique to determine the amount of abnormal current flow in a system in the event of a fault. It provides safe means that disrupt the impact of the abnormal current flow of high magnitude in line with International Electrotechnical Commission's standards 60909.

Comparative study of dyes and effects of purification on selected plants for dye-sensitized solar cells application, 2023

Type of Dye	Band gap e.v (distilled Water)	Band gap e.v (Ethanol)
Odoo	1.07	1.08
Tumeric	1.19	1.15
GG	0.88	0.87
Red U H	0.99	0.90
Red G	0.95	0.97
Beet	0.94	0.96
Uli	0.99	1.16
Laali	0.81	0.78

Table 1 Comparison between the band gaps of the unpurified dyes extracted with distilled water and Ethanol.

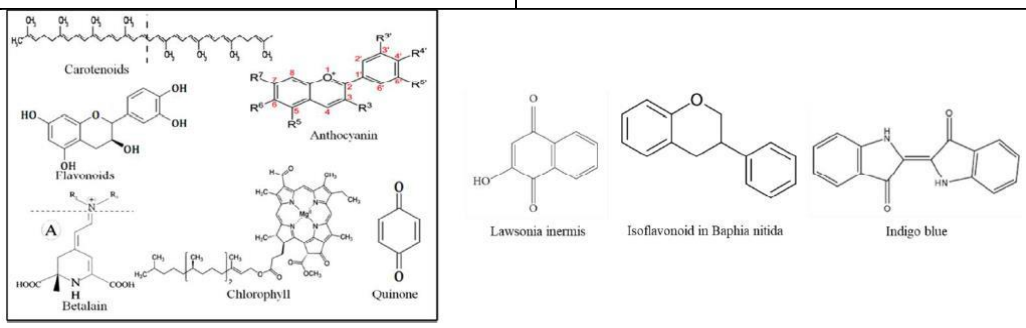

Figure 3. Standard dye components chemical structures utilized for the DSSC fabrication, some structures from *Lawsonia inermis*, *Baphia nitida* [23], and Indigo blue

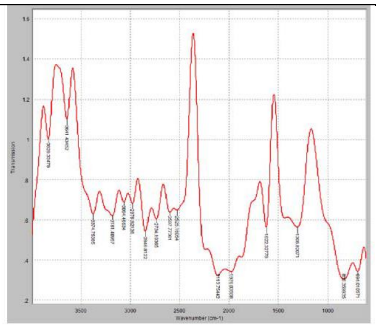

Figure. 4. FTIR spectrum of purified (a) *Lawsonia inermis*, (b) *Baphia nitida* (Uhie), and (c and d) *Indigofera tinctoria* (Indigo red and green)

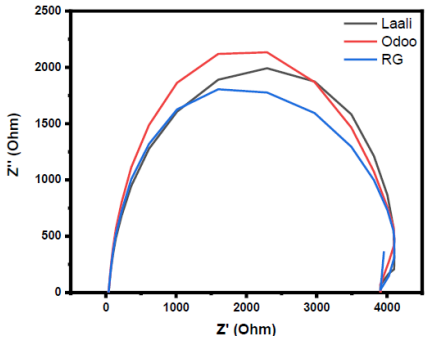

Figure 5. Nyquist plots of EIS spectra of the fabricated DSSCs for (a) non-purified and (b) purified Odoo, and (c) combined purified dyes.

IMPACT:
The study explores the extraction and purification of dyes from different plant sources for solar cell applications. The results obtained from the extracts commonly serve societies ranging from dyes for textiles to medicinal applications for multiple ailments and also for dye sensitized solar cells (DSSC) applications.

Analysis of Electrical Energy Consumption Pattern and Audit for Improved Electricity in Owerri Urban "A Stepwise Approach"

Table 3.12. Summary of actual and audited energy usage

Description	Actual energy consumption		Energy audit calculations.	
Total load(kW)	**Daily energy(kW)**	**Total load(kW)**	**Daily energy(kW)**	
Residential	940.08	6,191.24	808.08	1,491.66
Banks & Offices	174.87	913.79	102.135	854.11
Hospitals	15.42	718.08	67.55	218.78
Hotels	124.335	1,204.30	99.695	589.94
Industries	333.245	2,215.20	258.997	918.097
Total	**1587.95**	**11,242.61**	**1336.457**	**4,072.59**
Future load (50%)	793.98	5,621.31	668.23	2,036.30
Ground Total	**2,381.93**	**16,863.92**	**2,004.69**	**6,108.89**

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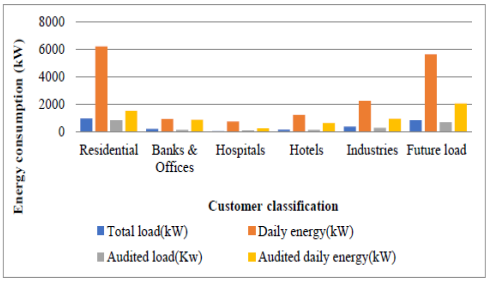


Fig. 3 Comparison of energy consumption

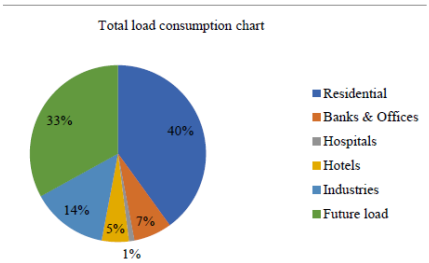


Fig. 4 Piechart of total load consumption

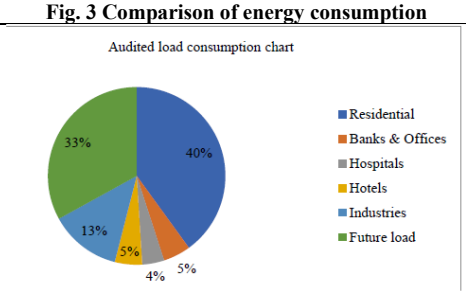


Fig. 6 Piechart of total load consumption

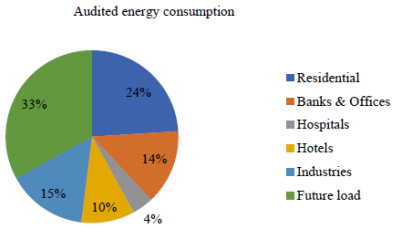


Fig. 7 Percent of audited energy consumption

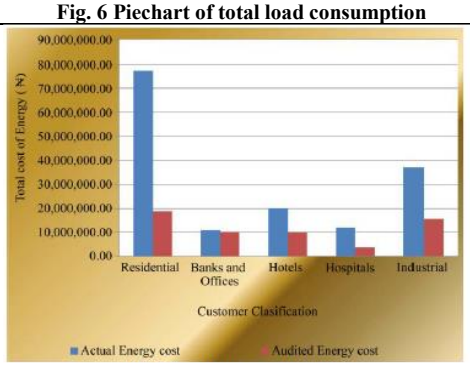


Fig. 9 Cost of energy computation

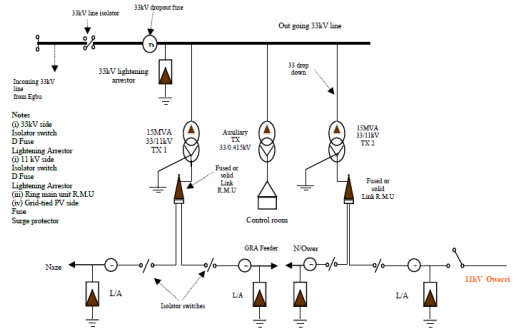


Fig. 10 Schematic diagram of the existing injection substation

IMPACT:

An energy audit investigation conducted using a stepwise approach to mitigate energy consumption and realize energy savings opportunities to assuage exorbitant electricity bills in Owerri town. The survey actualized the objective of the research in line with the sustainable development target. If the recommended energy audit report is implemented, it

will enhance electricity supply and save the cost of N 99,516,417.30 from the electricity bill.

The relative comparison of different Models used for determining PV tilt angle in Anambra and Enugu state- Nigeria (2023).

Table 2 Summary of the Optimum Tilt Angles and Maximum Global Solar Radiation for (both models combined together) each month.

Month	Average Optimum Tilt Angle for all the models in Anambra, β_{opt} (°)	Average Optimum Tilt Angle for all the models in Enugu, β_{opt} (°)	Average Maximum Global, Solar Radiaton, for all the models H_{Tmax} in Anambra (KWh/m²/day)	Average Maximum Global, Solar Radiaton, for all the models H_{Tmax} in Enugu (KWh/m²/day)
January	35.5716	34.6268	7.0499	6.9797
February	24.1837	22.5226	6.5471	6.5088
March	5.0241	3.8417	5.7529	5.7441
April	0	0	5.2900	5.2900
May	0	0	4.9700	4.9700
June	0	0	4.5900	4.5900
July	0	0	4.2000	4.2000
August	0	0	3.9700	3.9700
September	0	0	4.2300	4.2300
October	13.1248	12.7681	4.6993	4.6811
November	27.3668	29.8540	5.6665	5.6188
December	38.644	38.0509	6.7978	6.7264
Average	**11.9929**	**11.8053**	**5.3136**	**5.2924**

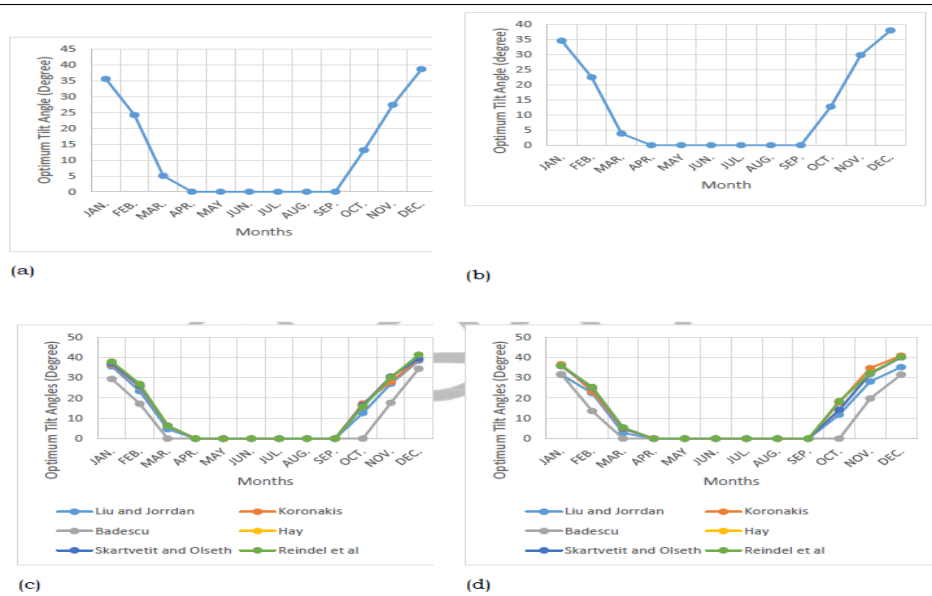


Fig. 1. Graph of Optimum Tilt Angle β (o) versus Months of the year, (a) Average value of all the models, Anambra State, (b) Average value of all the models, Enugu State, (c) All the six models, Anambra State, and (d) All the six models, Enugu State; in Nigeria.

Table 3 Optimum tilt angle of different models for different seasons and year.

Location	Model	Optimum Tilt Angle for Dry Season (°)	Optimum Tilt Angle for Wet Season (°)	Optimum Tilt Angle for a Year (°)
Anambra	Isotropic Models	21.86	0.00	10.93
	Anisotropic Models	26.11	0.00	13.06
	Total Average	**23.99**	**0.00**	**11.99**
Enugu	Isotropic Models	21.51	0.00	10.75
	Anisotropic Models	25.71	0.00	12.86
	Total Average	**23.61**	**0.00**	**11.81**

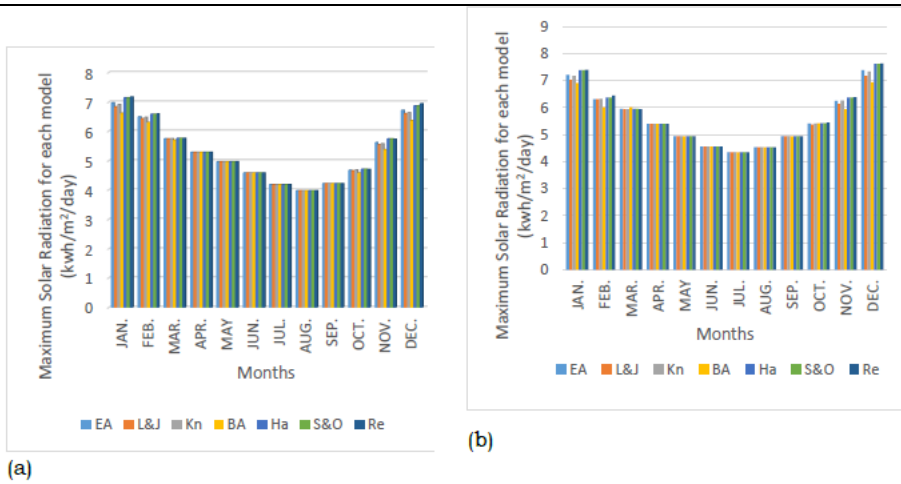


Fig. 2. Comparing the estimated solar radiation for each of the models, (a) Anambra state and (b) Enugu State; in Nigeria.

IMPACT:

Determination of how the result of optimum tilt angle and energy generated making use of isotropic and anisotropic models relates with each other drawn from two south eastern states in Nigeria (Anambra and Enugu state).

The average based annual optimum tilt angle for Anambra State is 11.99o while that of Enugu State is 11.81o. The seasonal optimal tilt angle for rainy season is zero (0) degree for both Anambra and Enugu State, while that of dry season is 23.99o for Anambra State and 23.61o for Enugu State.

Extraction and purification of *Lawsonia inermis* (laali) dyes for applications in dye-sensitized solar cell

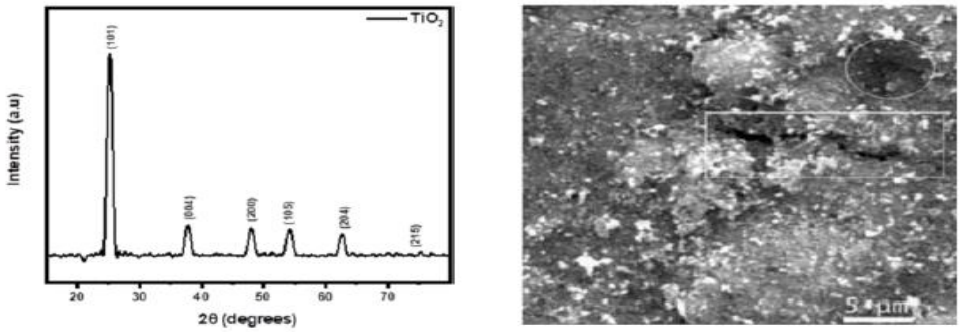


Figure 1. The X-ray diffractograms and an SEM micrograph of the synthesized anatase TiO_2 obtained using a thermally treated doctor-blade deposition technique.

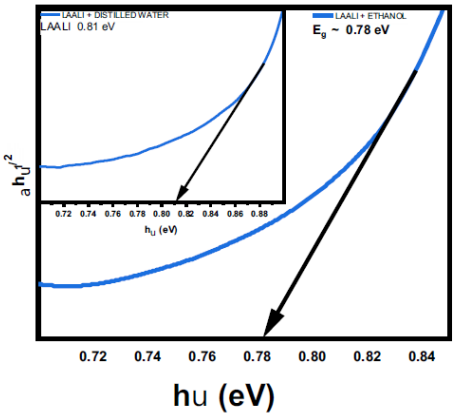


Figure 2. The estimated band gap of dyes extracted using ethanol, (and inset using water) for the dyes

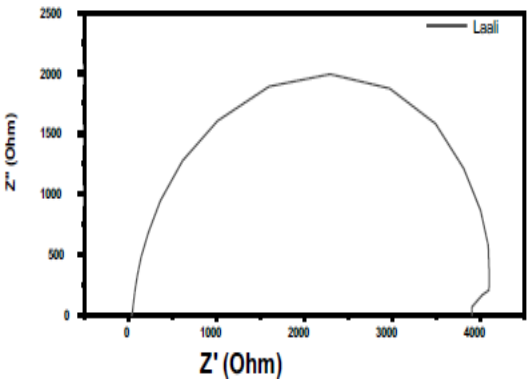


Figure 5. Nyquist plots of EIS spectra of the fabricated DSSCs for purified Laali.

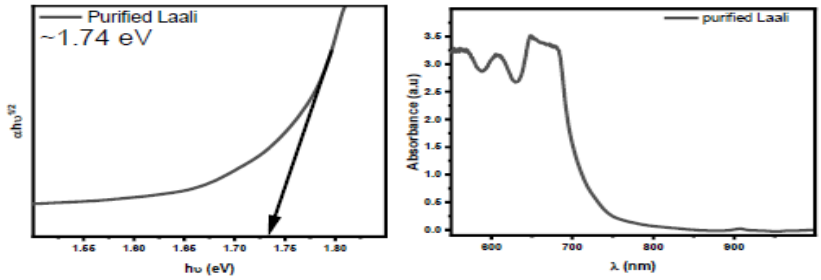


Figure 3. The estimated band gap of purified dyes extracted using ethanol, and the absorption analysis.

IMPACT:

The study was on the extraction of dyes from Lawsonia inermis (Laali) and the effects Of its purification on the natural dye sensitized solar cells applications.

Review on advanced nanomaterials for hydrogen production

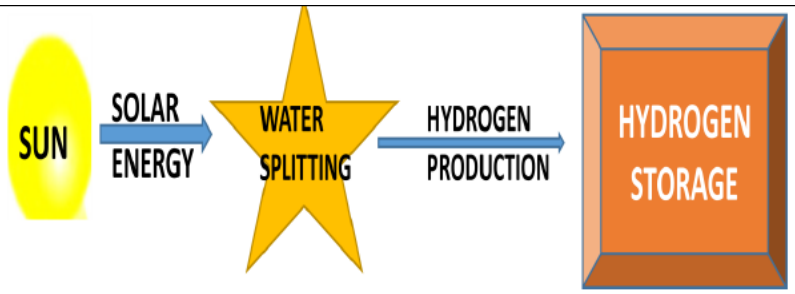


Figure 1: Diagram representing solar energy transformation into hydrogen-based energy technology.

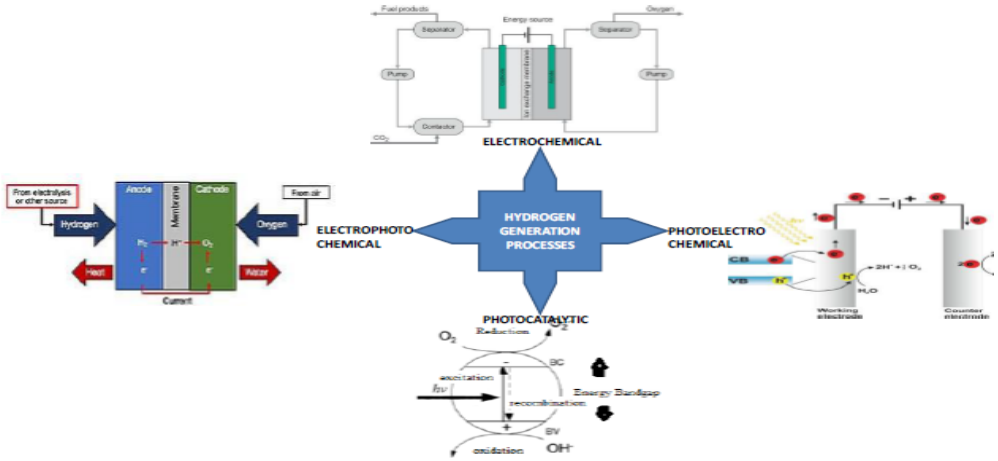


Figure 2: Schematic outline of the various means of generating hydrogen electrochemically, photoelectrochemically, photocatalytically and electrophotochemically.

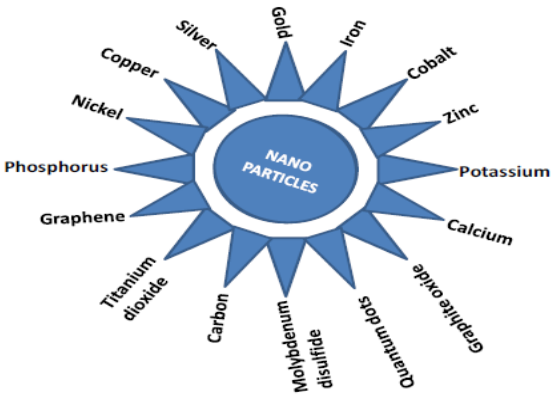


Figure 3: Nanoparticles useful for generating hydrogen

IMPACT:

The mini-review study discussed different advanced nanomaterials useful for producing hydrogen as future energy demands sustainability. Different advanced nanomaterials for hydrogen production including carbon nanomaterials, solid inorganic-organic hybrid materials, graphite oxide, molybdenum disulfide nanomaterials, nickel, quantum dots, decomposed methane, metal sulfides, metallic nanoparticles, and titanium dioxide nanomaterials have been reviewed.

2021

Effects of annealing temperature on TiO_2 photoelectrodes of dye-sensitized solar cells using *Ixora coccenia* dye extract

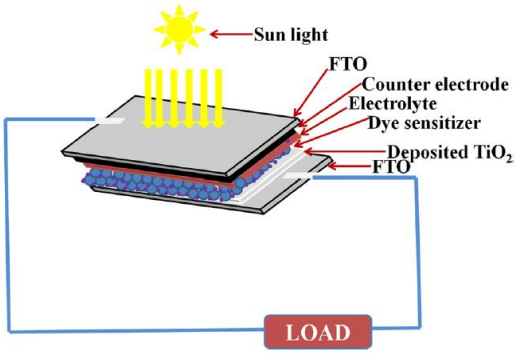


Fig. 3 Structure of assembled sensitized DSSC

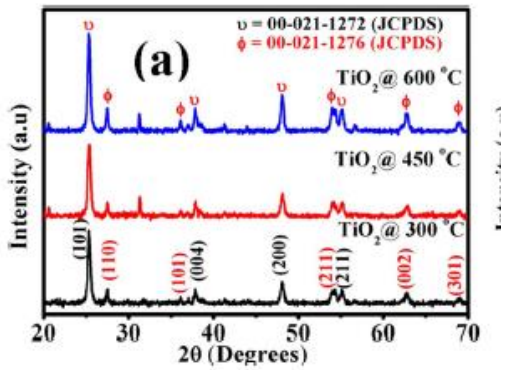


Fig. 4 a XRD spectra and **b** peak shifts of TiO_2 annealed at 300 °C, TiO_2 annealed at 450 °C, and TiO_2 annealed at 600°C

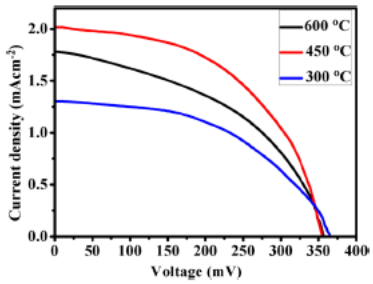


Fig. 9 Photoelectrical properties of the fabricated DSSC annealed at different temperatures

Table 3 Summary of the I–V characteristics for the fabricated DSSC

Sample	Jsc (mA/cm^2)	V_{OC} (mV)	FF	η (%)
TiO_2@300 °C	1.30	365.6	0.51	0.73
TiO_2@450 °C	2.02	354.8	0.53	1.18
TiO_2@600 °C	1.78	365.6	0.49	1.01

IMPACT:

Experimental study of employing Ixora coccinea flower as source of natural dye to fabricate dye sensitized solar cells (DSSCs) using TiO_2 electrodes annealed at various temperatures. The DSSC fabricated based on the Ixora coccinea flower dye extract revealed conversion efficiency of 0.73%, 1.18%, and 1.01% for the TiO2 electrodes annealed at 300 °C, 450 °C, and 600 °C respectively. Annealing TiO2 photoelectrode at 450 °C temperature would produce better efficient DSSC with ixora coccinea natural dye extracts.

Enhancement of the performance of ZnO based natural dye sensitized solar cells via PVA morphology controlled nanorods.

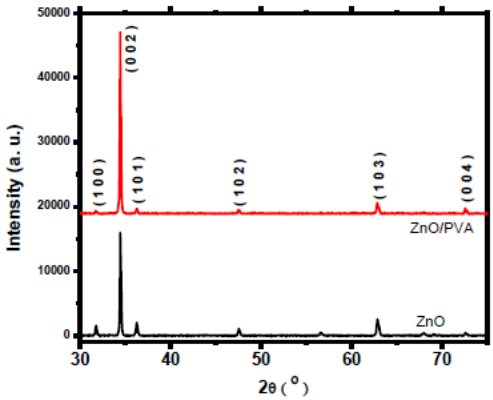


Figure 1: XRD patterns of the nanocrystalline ZnO nano rods

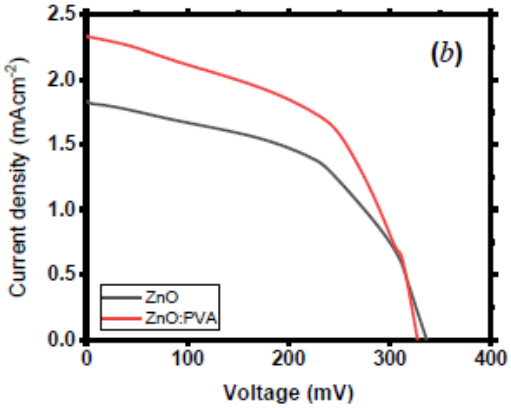


Figure 4: (*b*) the plot of the current density against the voltage of the DSSCs fabricated using the as-grown ZnO and the PVA-capped ZnO as the photo-electrodes

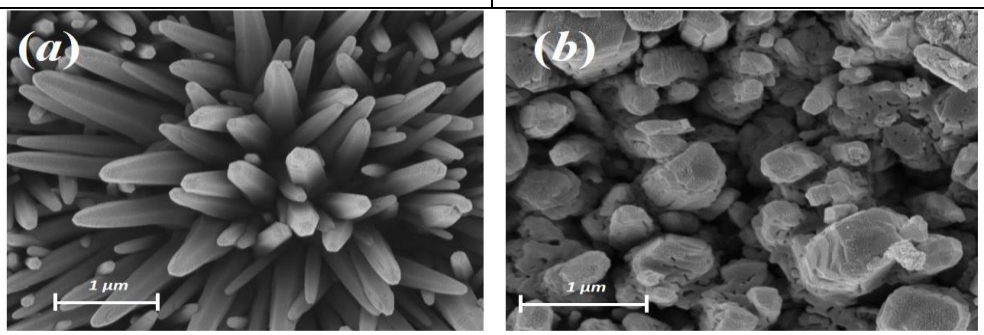


Figure 2: SEM micrographs for (*a*) the as-grown and (*b*) the PVA-capped ZnO nanorods.

Table 2: Photovoltaic parameters for the DSSCs fabricated using the different photoanodes

Parameter	V_{oc} (mV)	I_{sc} (mA)	J_{sc} (mAcm^{-2})	R_{sh} (Ω)	R_s (Ω)	FF	η (%)
ZnO/As-grown	336.5	7.6	1.81	193.9	9.8	0.51	0.65
ZnO/PVA	328.2	9.7	2.31	115.4	7.0	0.56	1.17

IMPACT:
Ployvinyl alcohol (PVA) was used as surfactant to modify the surface features of the ZnO nanorods. The ZnO nano-rods were employed as photo-anode for dye sensitized solar cell (DSSC) and were sensitized by natural dye extracted from Baphia nitida plant. The study revealed that the PVA improved the overall photo-conversion efficiency of the DSSC.

2020

Comparative photo-response performances of dye sensitized solar cells using dyes from selected plants

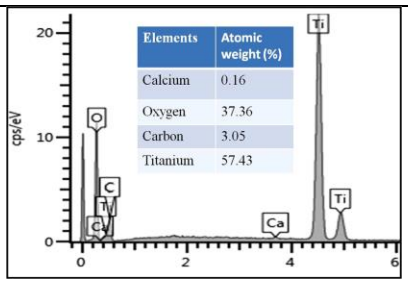


Fig. 6. EDX spectra of TiO_2 film and the percentage weight distributions.

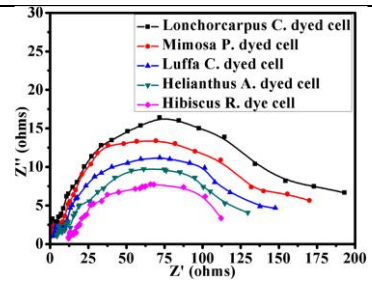


Fig. 11. Nyquest plots of EIS spectra of the fabricated DSSCs.

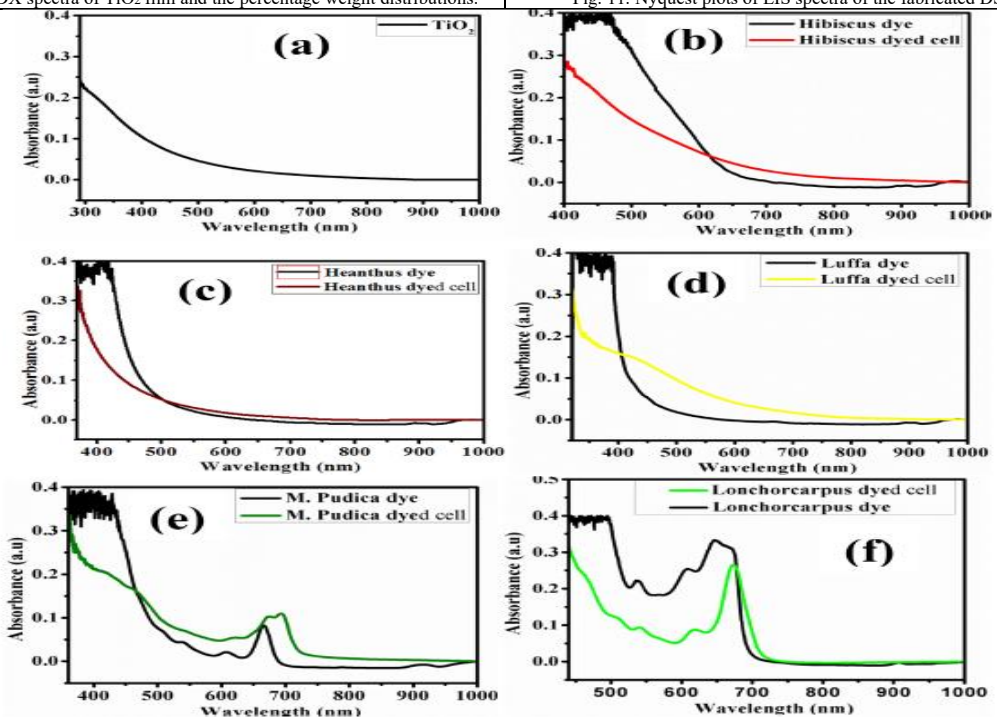


Fig. 8. The plots of absorbance for (a) the pristine TiO_2 photoelectrode, (b-f) the dyes and dyed TiO_2 electrodes for the various dyes.

Table 4: Summary of the photovoltaic parameters for the DSSCs from the five photosensitizers.

Photosesitizer	V_{oc} (mV)	I_{sc} (mA)	J_{sc} (mAcm^{-2})	FF	V_{mp} (mV)	I_{mp} (mA)	η (%)
Hibiscus rosa-sinensis	444.23	8.656	19.67	0.41	284.86	5.510	0.48
Helianthus Annuus	399.83	7.498	15.52	0.42	262.89	4.834	0.35
Luffa cylindrical	382.30	5.582	13.35	0.43	281.91	3.252	0.29
Mimosa pudica	304.88	5.194	11.80	0.35	186.36	2.974	0.17
Lonchorcarpus cyanescens	383.87	2.870	6.23	0.41	238.40	2.870	0.13

IMPACT: *Dye Sensitized Solar Cell (DSSC) conversion efficiencies were studied based on dye extracts from Hibiscus rosa-sinensis flower, Helianthus annuus flower and Luffa cylindrical flower, Lonchocarpus cyanescens leaves and Mimosa pudica leaves. The study revealed overall photocurrent conversion efficiencies of 0.48%, 0.35%, 0.29% 0.17% and 0.13% respectively with Hibiscus rosa-sinensis having an edge over the rest.*

2019

Influence of cadmium precursor concentrations on the structural, optical

and electrochemical impedance properties of CdZnS thin films

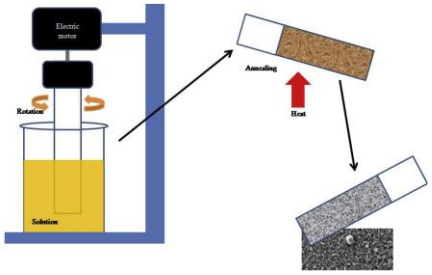


Fig. 1. Schematic description of the depsotion apparatus to obtain a compact film of CdZnS thin film.

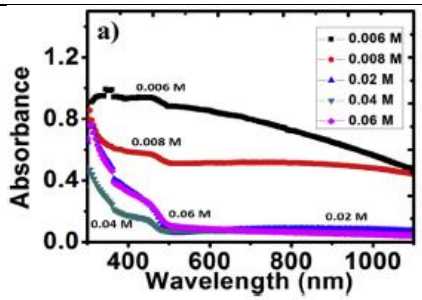


Fig. 9. Plot of (a) the absorbance vs wavelength (b) the transmittance vs wavelength for the Cadmium zinc sulfide thin films.

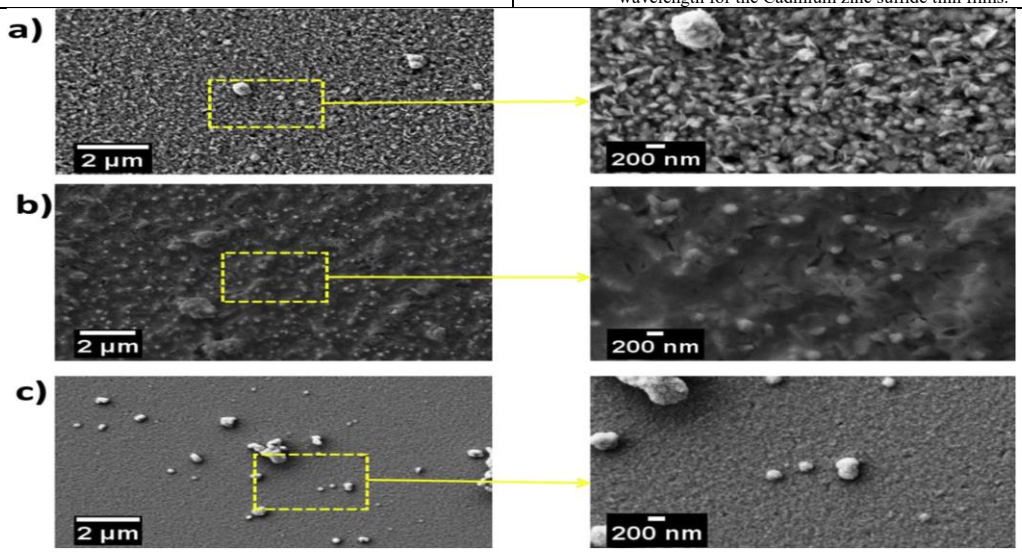
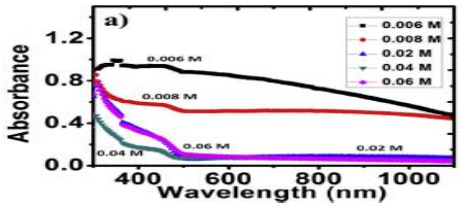
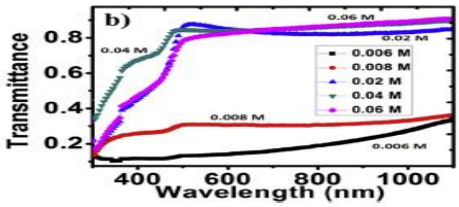


Fig. 2. SEM image of the CdZnS thin films for (a) 0.008M(b) 0.04M and (c) 0.06M Cd precursor concentrations at different magnifications.





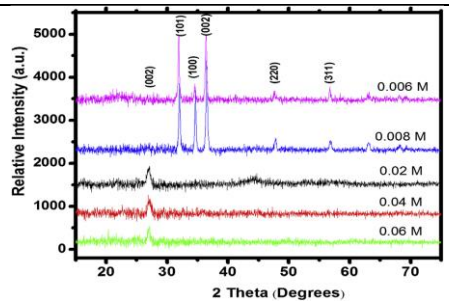


Fig. 3. The X-ray diffraction spectra of the CdZnS thin films deposited on glass substrate with different concentrations of cadmium source.

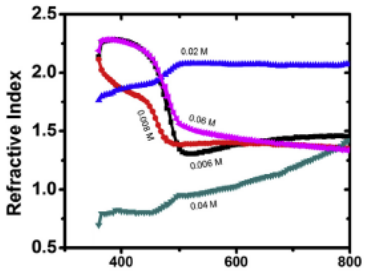


Fig. 11. Plot of refractive index against wavelength for the thin films.

IMPACT:

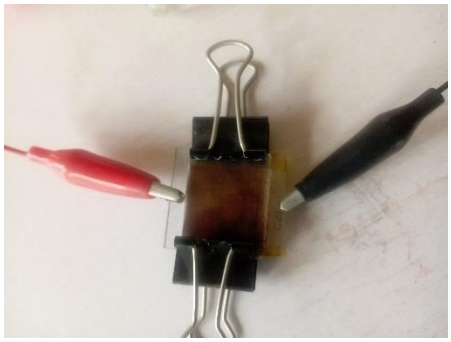
The experimental study was on the growth of CdZnS thin films with different concentrations of Cd source (viz 0.006 M, 0.008 M, 0.020 M, 0.040M and 0.060M concentrations of the $Cd(NO_3)_2$) on continuously rotated glass substrates. The thin films with high concentration

of the Cd source could be applied in window layer of solar cell device. In addition, the thin films with high concentration of the Cd precursor had the maximum capacitance and could thus be useful in capacitor as it has a higher charge storage capacity.

Yield analyses and socio-economic impact assessment of photovoltaic and photovoltaic supported food and energy hybrid systems in tropical Nigeria and Benin climates

IMPACT:
Innovative ways of maximizing food and energy production through maximized land-water use by implementing photovoltaic-supported green-houses for simultaneous food and energy productions.

Basic Research in Dye sensitized solar cells (DSSCs)

	
IMPACT: *Basic researches on dye sensitized solar cells*	

Installation of 10 MW solar modules assembly plant in NCERD with an annex at Akpugo, Enugu State.

Solar cell tester and sorter

Solar module testing station

Solar module laying station

EVA/TPT cutting station

ENERGY COMMISSION OF NIGERIA
NATIONAL CENTRE FOR ENERGY RESEARCH AND DEVELOPMENT
UNIVERSITY OF NIGERIA, NSUKKA

Air compressor for framing machine and EVA/TPT cutting machine

Solar module Framing machine

Tabbing of individual solar cells

Tabbing of individual solar cells

Stringing of the solar cells

Stringing of the solar cells

ENERGY COMMISSION OF NIGERIA
NATIONAL CENTRE FOR ENERGY RESEARCH AND DEVELOPMENT
UNIVERSITY OF NIGERIA, NSUKKA

Stringing of the solar cells

Stringing of the solar cells

Manual Framing of the solar module

Manual Framing of the solar module

Manual Framing of the solar module

Manual Framing of the solar module

IMPACT:*Local Production of solar modules to enhance access to electrical energy in Nigeria*

ENERGY COMMISSION OF NIGERIA
NATIONAL CENTRE FOR ENERGY RESEARCH AND DEVELOPMENT
UNIVERSITY OF NIGERIA, NSUKKA

Biomass energy research and development at NCERD, UNN, 2010 - date

Biomass is organic material of plants and animals' origin. It contains stored energy from the sun. Biomass is a renewable energy source. Biomass fuels are wood, crops, manure, and animal dungs etc. Two main processes for converting biomass to energy: The thermochemical methods are combustion, (including co-firing - mixed coal/biomass combustion), pyrolysis and, gasification. Biological conversion is by digestion and fermentation of biodegradable wastes the products are known as biofuels. The biofuels made from biomass are Biogas, Bioethanol, Biodiesel.

Biogas production from bio-waste

Biogas is a mixture of gases produced by breakdown of organic matter in the absence of oxygen in a device known as Biogas Digester. It mainly consists of carbon dioxide and methane.

Material Composition of Biogas

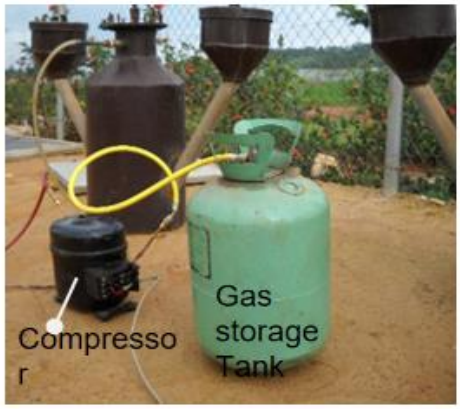
Methane	CH_4	**50–75**
Carbon dioxide	CO_2	**25–50**
Nitrogen	N_2	**0–10**
Hydrogen	H_2	0–1
Hydrogen Sulfide	H_2S	0–3
Oxygen	O2	0-2

Feedstock Materials for Biogas Production

Cow dung, Sewage, Crop residues, Vegetable wastes, Water hyacinth, Poultry droppings, Pig manure , etc.

Biogas digesters designed and fabricated at the Centre

- Three steps: Hydrolysis, Acidification, and Methane Formation.
- Plastic tanks are prone to leakages at piping joints during digestion
- Metal digester may fail over time due to corrosion



Biogas burner

Stages in biogas production :Hydrolysis, Acidification, Acetogenesis and Methane Formation.

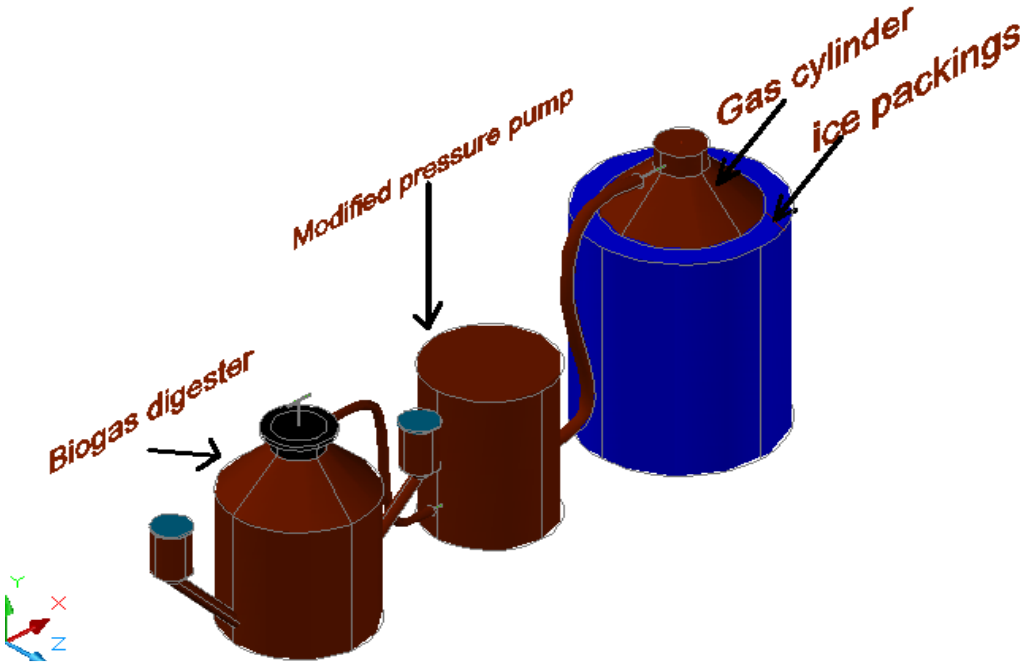
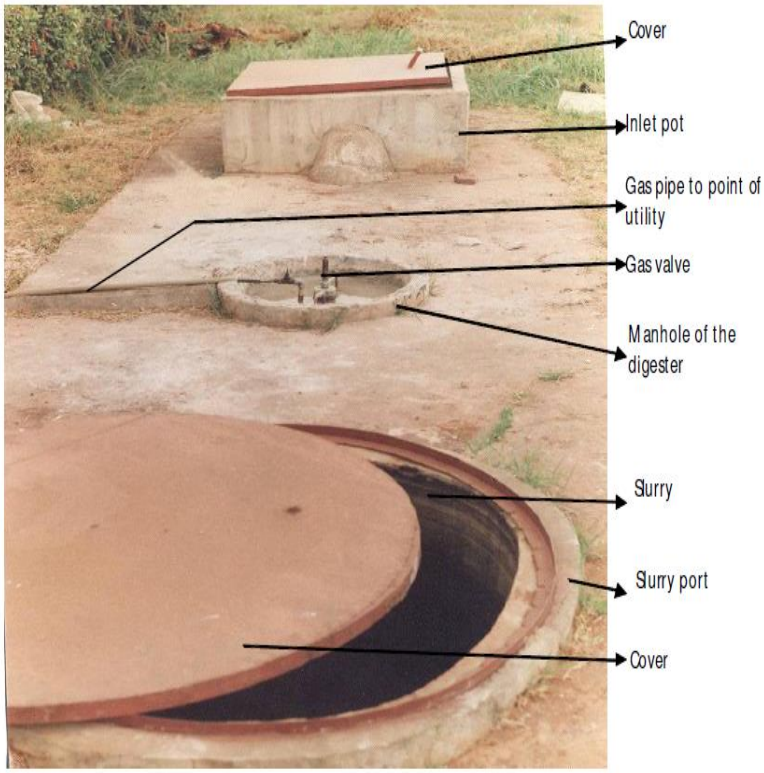
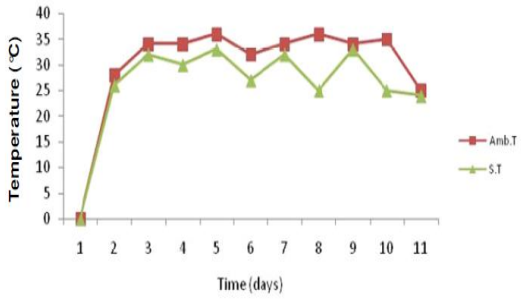


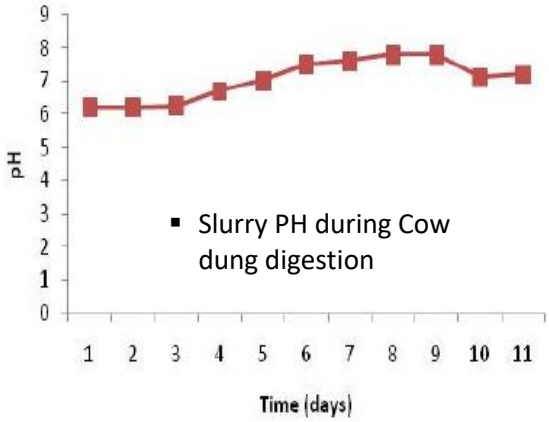
Figure 1. A fixed-dome digester with modified pressure pump for biogas storage

Fixed dome digester type designed by NCERD, UNN, during construction





- Slurry and ambient temperatures during Cow dung digestion
- Optimum temperature is 30 and 42 °C

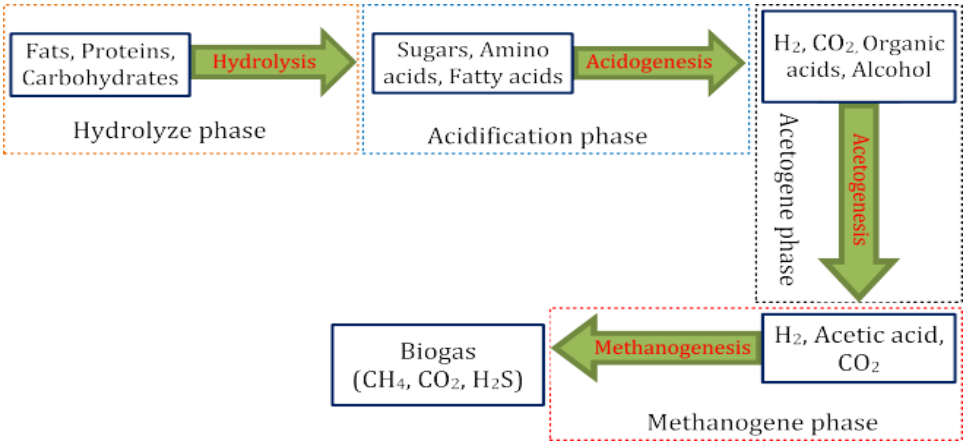


- Slurry PH during Cow dung digestion

10m^3 Capacity Biogas Plant, Designed and Built by National Center for Energy Research and Development

Perfomance of concrete underground biogas digester at NCERD

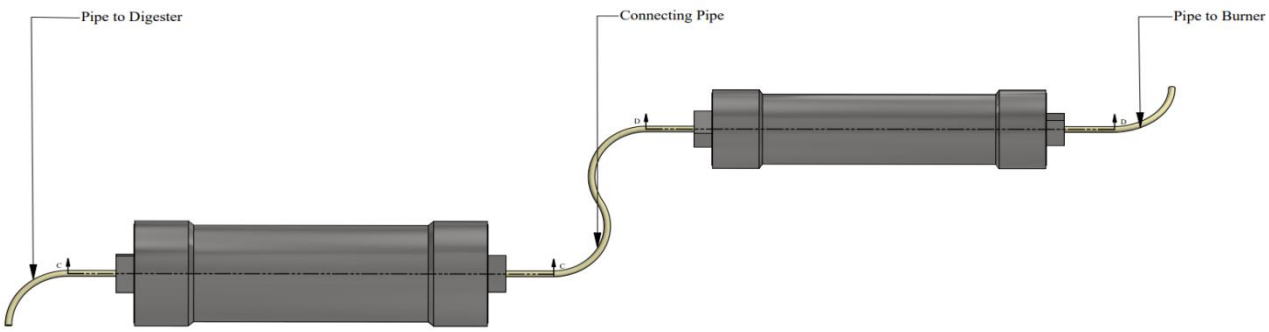
Digester Capacity (m^3)	Digester type	feedstock	Yield (L/kg)	Pressure (bar)
10.0	Underground concrete fixed dome	Cowdung	1.13	0.147



Biogas production steps and production processes

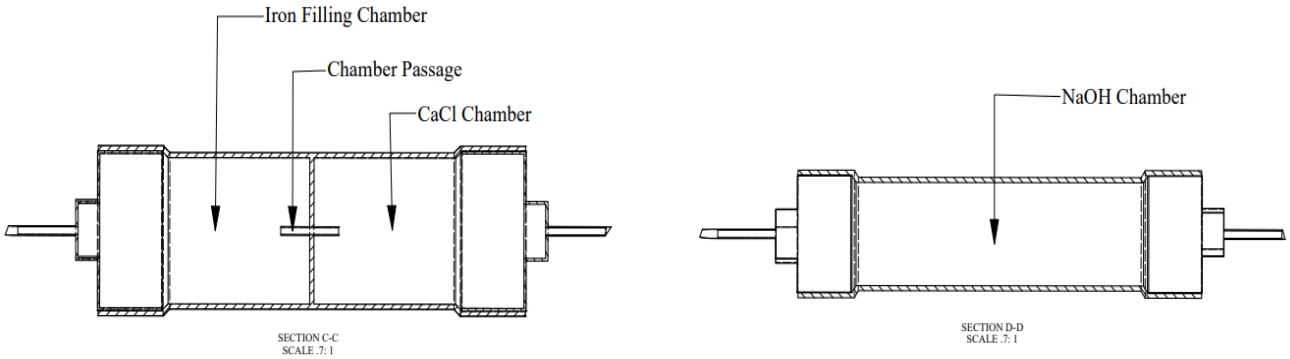
Design of biogas cleaning system research and development at NCERD, 2010 - Date

The biogas cleaning system was designed considering the following parameters: biogas available, gas flow rate in chamber, amount of sulphur bound, amount of H_2S in cleaned biogas, percentage of CH_4, in raw biogas, percentage of CO_2, in raw biogas and H_2S, in raw biogas, ppm. The figure blow shows the designed biogas cleaning system.



Biogas cleaning system

The Biogas has some of the constituents which reduce its calorific value. CO_2 is a recalcitrant gas that decreases the calorific value and density of the biogas. Hydrogen sulfide in combination with the water vapor in raw biogas can form sulfuric acid (H_2SO_4), which is very corrosive to components biogas digester.



Biogas cleaning chamber

The chamber for the biogas cleaning depends on gas flow rate and this can be determined as follows:
(i) Flow rate required = available biogas/day
(ii) Chamber volume: This is the addition of amount of absorbent required and dead volume
(iii) Chamber length: This is determined by the chamber volume divided by the chamber cross section
(iv) Hc = Chamber Volume/Cross-section

Bio-diesel Research and Production at NCERD, UNN, 2014- date

Biodiesel is a renewable, clean-burning fuel that can be manufactured from vegetable oils, animal fats, or recycled restaurant grease. The rising cost of petrol diesel in Nigeria gives concern to everyone, and there is urgent need for an alternative or complementary fuel. Using biodiesel as a vehicle fuel increases energy security, improves air quality and the environment, and provides safety benefits. Biodiesel raises the cetane number of the fuel and improves fuel lubricity. A higher cetane number means the engine is easier to start and reduces ignition delay. The research here focuses on biodiesel reactor, sourcing and assessment of several non-edible seeds/fruits to ascertain suitable ones for biodiesel production.

Biodiesel reactor plant built at NCERD, for batch production of biodiesel from non-edible seed oils to popularize and facilitate the integration of biodiesel into energy-mix in Nigeria.

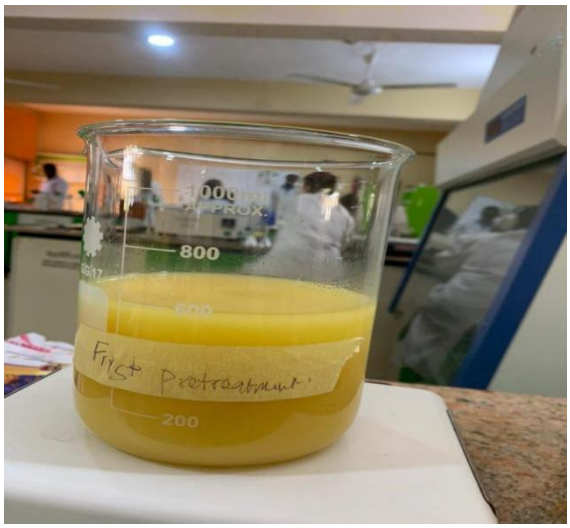
Key features

- Produces biodiesel from vegetable oil.
- Rate of production is 50 litres per hr.
- Has a specific feature of automatic thermo-regulation.

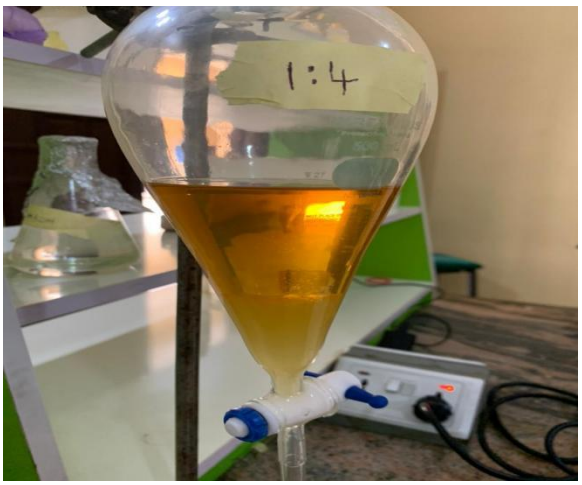
Biodiesel Reactor

SOURCING AND ASSESSMENT OF SEVERAL NON-EDIBLE SEEDS/FRUITS TO ASCERTAIN SUITABLE ONES FOR BIODIESEL PRODUCTION, 2023 - date

Through field visits, primary and secondary searches, a number of non-edible oil sources were considered to be a precursor for biodiesel production. They include, cashew nut shell, African almond seed, Jatropha seed, African walnut seed, Devil beans seed and Neem seed. Other non-edible oil sources, include, palm oil mill sludge POMS, palm kernel oil (PKO) sludge and used cooking oil. Non-edible seeds - Jatropha curcas, African almond seed, cashew seed shell were processed and tested to determine their percentage oil content and suitability for biodiesel production. Extraction of oil from the seeds were carried out and performed the transesterification process and product purification. Methanol, sodium hydroxide (NaOH) and anhydrous sodium sulphate (Na_2SO_4) were used for the experiment.

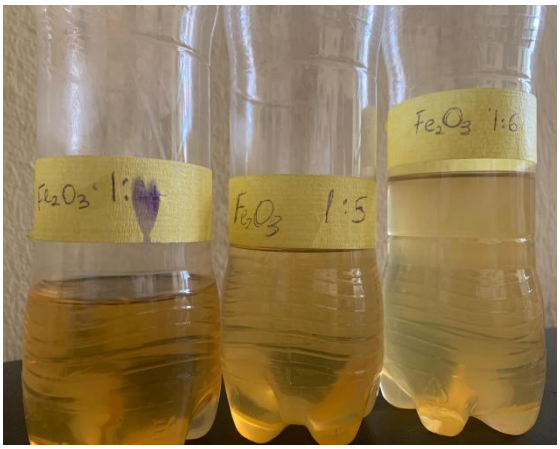


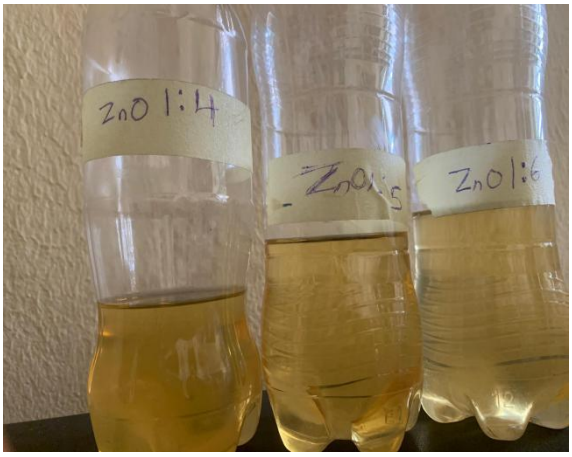
Proof of concept showing Improvised reactor on magnetic stirrer during transesterification of used cooking oil to biodiesel using methanol and NaOH at 75°C

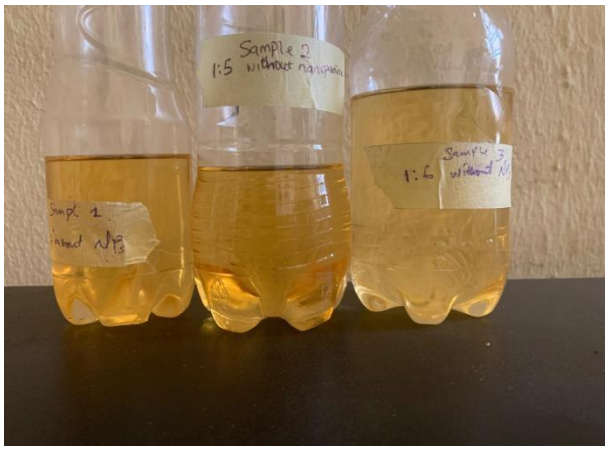


Separation of biodiesel and glycerol

The two layers were separated, the upper layer of biodiesel was purified by distilling the residual methanol at 60°C. The remaining catalyst was removed by successive rinsing with distilled water by adding 1-2 drops of acetic acid to neutralize the catalyst. The residual was eliminated by treatment with anhydrous sodium sulphate (Na_2SO_4) followed by filtration.







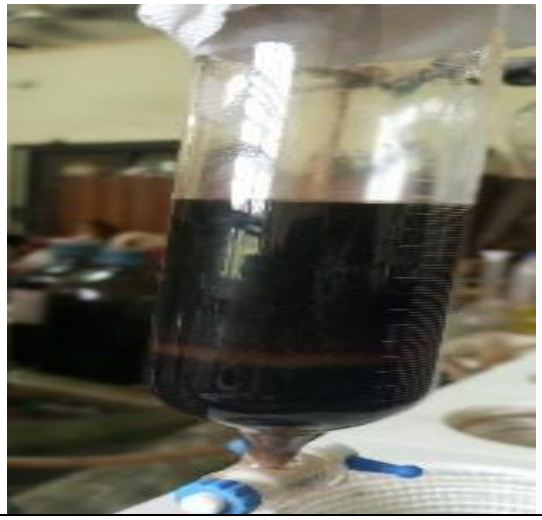
Biodiesel from various ratio of oil to methanol

Characteristics of biodiesel produced from used cooking oil sample

	Item	Value	Standard [ASTM D6751]
1	Methanol to Oil Ratio	1:4	-
2	Yield (%)	58.8	-
3	Density (g/cm^3)	0.8	~0.8-0.9
4	Iodine Value(g/100g)	92	80-106
5	Saponification Value	188.672	150.1
6	Cetane Number	54.529	>49

The cooking oil yield of up to 58% bio-diesel.The produced biodiesel is of approximately with the American Standards for Testing and Materials (ASTM) standards. However, the yield needs to be maximized. The optimization of biodiesel yield from used cooking oil using various ratios of oil to methanol, and by other types of catalysts including nanoparticles which are under investigation will be completed when materials are available

Production of biodiesel from other materials Ripe fruits, seeds and kernels

	 ***Hura crepitans*,** **Ripe fruits and seeds for biodiesel**	 ***Telfairia occidentalis* leaves,** **Ripe fruits, seeds and kernels for biodiesel**
	Biodiesel from HC seeds 	**- Bio-diesel from TO seeds** 
	 Separation of biodiesel from glycerol	

Hildegarde seeds

Figure 10: Fluted Pumpkin Seeds

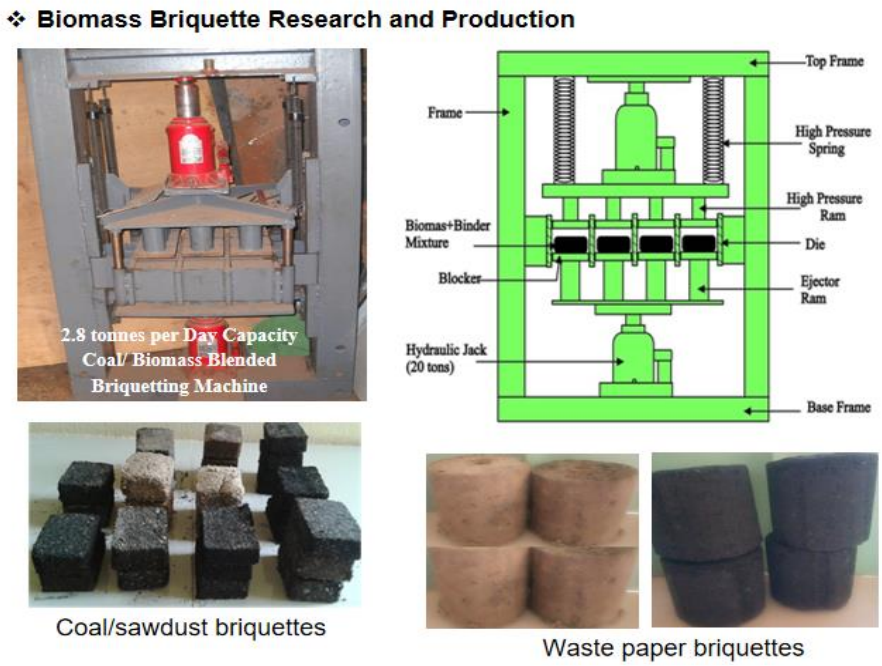
Figure 11: Oil and biodiesel produced from

blend of hildegarde and fluted pumpkin seeds

Biomass briquettes Research work and production at NCERD since 2010

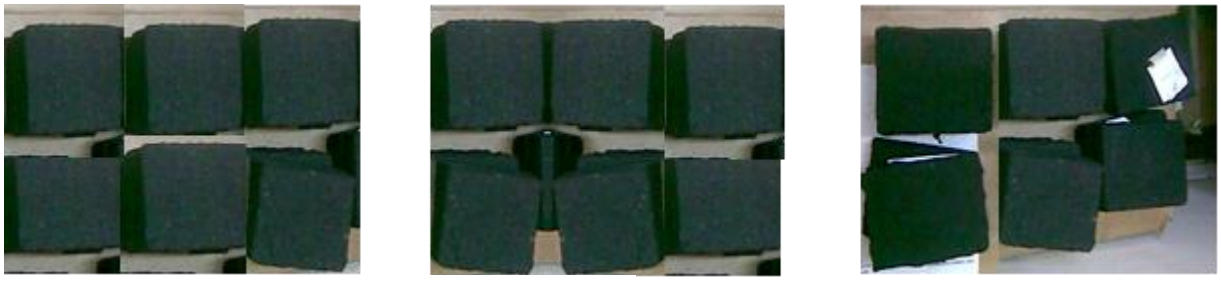
The figures below show the briquetting machine designed and fabricated for producing the sample briquettes at NCERD, indicating different parts of the machine. The machine was designed to be operated manually to avoid power supply issues, suitable for use in remote locations and to minimize running cost for the local users. It uses two hydraulic presses to generate its maximum compaction pressure of 160N/mm 2 and has twelve cavities with cross-sectional area of 70 mm x 100 mm, where the biomass-binder mixture is usually loaded for compaction.

The briquettes are to serve as alternative source of fuel in Brick factories, foundries, laundry and bakery industries and as substitute for fuel wood and charcoal in domestic cooking and heating. Reduce over dependence on firewood, charcoal, kerosene and liquid petroleum fuels, which are not only very expensive, but usually very scarce.



2.8 tonnes per Day Capacity Coal/ Biomass Blended Briquetting Machine.

- **Benefits:** It is independent of the electricity; It is very good in reducing deforestation
- **Commercialization readiness**: Ready for commercialization
- **Investments opportunities**: Expected high returns on investment
- **Obstacles to penetration into market:** Lack of funds to mass-produce prototype;
- Low awareness among potential users.



Samples of Coal Briquettes

Sawdust sample Coal sample

Motorized Coal/Biomass Briquetting Machine

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Produced coal briquettes with the above machine for domestic and industrial uses to stem deforestation due to firewood harvesting and to increase the contribution of coal resource in the energy mix in Nigeria.

Samples of the produced coal briquettes

RESEARCH AND DEVELOPMENT ON CLEAN COAL TECHNOLOGY: LIQUID COALS FOR RUNNING ENGINES AND FACILITIES

RESEARCH AND DEVELOPMENT ON CLEAN COAL TECHNOLOGY

Nigeria is endowed with abundance of the coal resources found in more than thirteen states across the country, but in spite of that, it still remains the smallest contributor to the overall fuel energy mix in the country. Different coals have different characteristics and applications. Availability of information on coals is vital for its utilization. The creation of coal and lignite database is very essential to compile the characteristics of different coal samples collected from fields.

Creation Of Coals and Lignite Data Base, characterization of different coal types

S/No	Location	Colour
1	Amansiodo (AM)	Grey
2	Inyi (IY)	Grey
3	Okaba (OK)	Grey
4	Ogwashi-Uku (OU)	Dark
5	Owukpa (OW)	Grey
6	Ogboyega (OY)	Dark
7	Ribadu (RB)	Dark
8	Onyeama (OA)	Grey
9	Okobo-Enjema (OB)	Grey
10	United Kingdom (UK)	Black

Collected samples of coal: Amansiodo; Inyi; Okaba; Ogwashi-Uku; Owukpa,Ogboyega; Ribadu; United Kingdom; Onyeama; Okobo-Enjema

Characterization Results of different coal types

Proximate analysis results of selected coals using standard methods

Parameters	AM	IY	OK	OU	OW	OY	RB	UK	OA	OB
Volatile matter (%)	67.99	81.30	74.57	73.76	71.24.63	77.54	28.33	69.46	89.29	78.79
Ash content (%)	10.61	6.85	4.86	10.58	9.40	9.67	70.80	0.57	2.82	4.86
Moisture content (%)	2.79	2.90	5.48	5.92	4.59	4.10	0.70	2.53	3.19	5.89
Fixed carbon (%)	18.61	8.95	15.09	9.74	14.77	8.69	0.17	27.44	4.70	10.76

AM= Amansiodo; IY= Inyi; OK= Okaba; OU= Ogwashi-Uku; OW= Owukpa; OY= Ogboyega; RB= Ribadu; UK= United Kingdom; OA= Onyeama; OB= Okobo-Enjema

Ultimate analysis results of selected coals using an Elemental analyser

Parameters	AM	IY	OK	OU	OW	OY	RB	UK
Carbon (%)	83.93	84.58	83.94	85.15	83.38	87.56	85.51	83.68
Hydrogen (%)	4.43	5.31	4.41	5.54	4.09	5.33	5.32	5.59
Nitrogen (%)	1.17	0.29	0.92	0.59	0.51	1.65	0.43	0.67

AM= Amansiodo; IY= Inyi; OK= Okaba; OU= Ogwashi-Uku; OW= Owukpa; OY= Ogboyega;
RB= Ribadu; UK= United Kingdom

Density of selected coal samples using displacement method

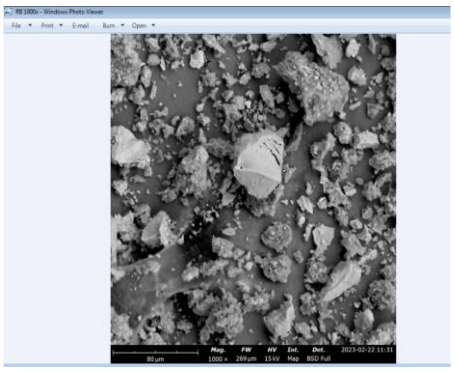
Parameters	AM	IY	OK	OU	OW	OY	RB	UK	OA	OB
Density (g/cm^3)	1.16	1.04		0.50	0.74	1.25	0.63	1.25	1.19	0.98

Pore Size Data of selected Coal Samples using BET Quantachrome Analyser

Parameters	AM	IY	OK	OU	OW	OY	RB	UK	OA	OB
BJH method adsorption pore Diameter (Mode Dv(d)) (nm)	2.144 e+00	2.123 e+00	2.133e +00	1.853 e+00	2.123e +00	2.118e +00	2.131 e+00	2.088 e+00	2.122 e+00	2.072 e+00
DH method adsorption pore Diameter (Mode Dv(d)) (nm)	2.144 e+00	2.123 e+00	2.133e +00	1.853 e+00	2.123e +00	2.118e +00	2.131 e+00	2.088 e+00	2.122 e+00	2.072 e+00
DR method micropore Pore width (nm)	5.740 e+00	6.247 e+00	6.243e +00	6.929 e+00	6.247e +00	5.842e +00	6.181 e+00	6.500 e+00	6.206 e+00	5.555 e+00
DA method pore Diameter (Mode) (nm)	2.820 e+oo	2.940 e+00	2.940e +00	2.760 e+00	2.940e +00	2.800e +00	2.920 e+00	3.000 e+00	2.940 e+00	2.740 e+00
HK method pore Diameter (Mode) (nm)	3.675 e-01	1.847 e+00	1.847e +00	1.847 e+00	1.847e +00	3.675e-01	1.847 e+00	1.847 e+00	1.847 e+00	3.675 e-01
SF method pore Diameter (Mode) (nm)	4.523 e-01	3.497 e+00	3.506e +00	3.340 e+00	3.497e +00	4.523e-01	3.488 e+00	3.488 e+00	3.518 e+00	4.523 e-01
DFT method Diameter (Mode) (nm)	2.647 e+00	2.647 e+00	2.647 e+00	2.647 e+00	2.647e +00	2.647 e+00	2.647 e+00	2.647 +00	2.647 e+00	2.647 e+00

AM= Amansiodo; IY= Inyi; OK= Okaba; OU= Ogwashi-Uku; OW= Owukpa; OY= Ogboyega; RB= Ribadu; UK= United Kingdom; OA= Onyeama; OB= Okobo-Enjema

10.4 RB (Ribadu coal) 1000x SEM image

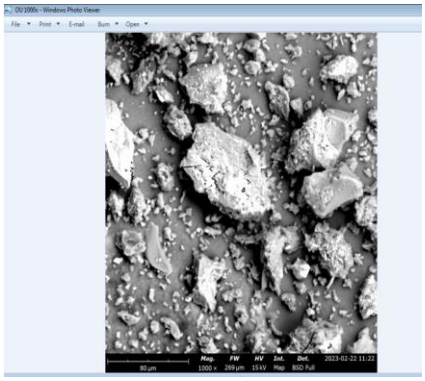


Description of SEM images of RB coal sample: Small lumps, stone-like shape morphology with irregular pores

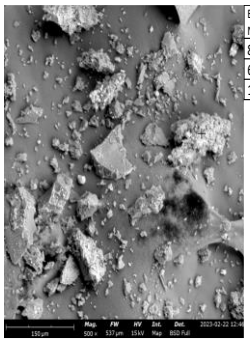
10.6 OY (Ogboyega coal) 1000x SEM image

Description of the SEM images of OY coal sample: Long, pipe-like lump mixed with large stonelike lump with pores and irregular holes

10.10 OU (Ogwashi-Uku coal) 1000x SEM image

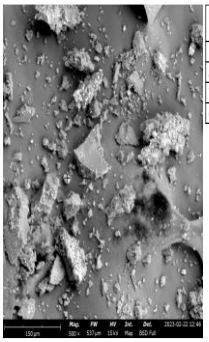


Description of SEM images of OU coal sample: Granulated and stone-like lump features



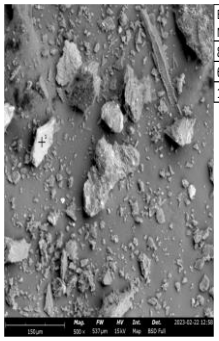
Element Number	Element Symbol	Element Name	Atomic Conc.	Weight Conc.
8	O	Oxygen	60.57	62.64
6	C	Carbon	32.93	25.56
14	Si	Silicon	6.50	11.80

FOV: 537 µm, Mode: 15kV - Map, Detector: BSD Full, Time: FEB 22 2023 12:46



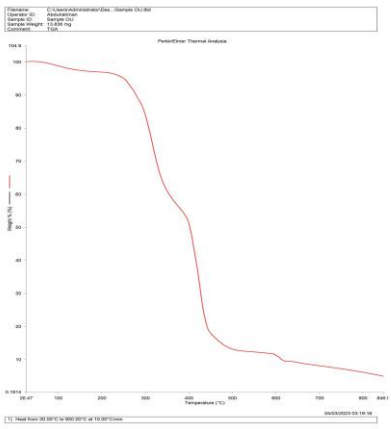
Element Number	Element Symbol	Element Name	Atomic Conc.	Weight Conc.
14	Si	Silicon	47.88	61.72
8	O	Oxygen	41.14	30.21
7	N	Nitrogen	7.75	4.98
6	C	Carbon	2.82	1.55

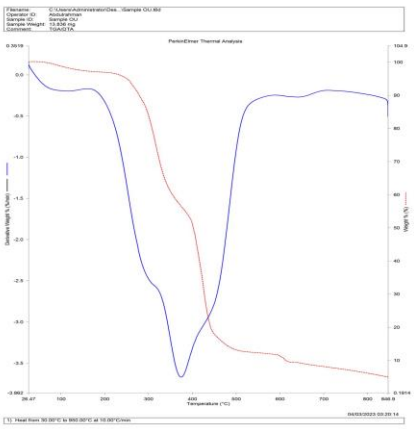
FOV: 537 µm, Mode: 15kV - Map, Detector: BSD Full, Time: FEB 22 2023 12:46

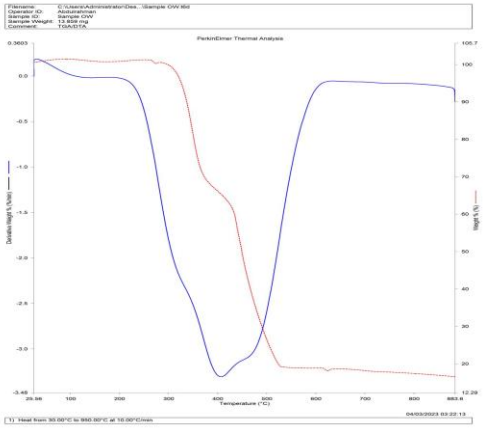


Element Number	Element Symbol	Element Name	Atomic Conc.	Weight Conc.
8	O	Oxygen	52.14	49.69
6	C	Carbon	31.07	22.23
14	Si	Silicon	16.79	28.09

FOV: 537 µm, Mode: 15kV - Map, Detector: BSD Full, Time: FEB 22 2023 12:58







LIQUID COALS CONVERSION FOR RUNNING ENGINES AND FACILITIES

The conversion of solid coal to liquid form is essential to increase utilization of coal in Nigeria including its transportation in pipelines and usage in engines and in blast furnace. Coal is grossly under-utilized as crude oil is largely preferred to coal in modern utility because the utilities are designed to use liquid fuels. Conversion of solid coal to liquid coal and testing its application in running of engines and facilities coal slurries were separately prepared with benzene, ethanol, hexane and water. The nature of the slurries was examined. These solvents were assessed for suitability in preparation of slurries that can be applied as potential substitutes for conventional petroleum-based diesel oil.

COAL LIQUID MIXTURE (CLM)

CLM are intended as a substitute for oil. CLM consist of finely ground coal suspended in a liquid such as oil or water, together with small amounts of chemical additives to improve stability and other physical properties.

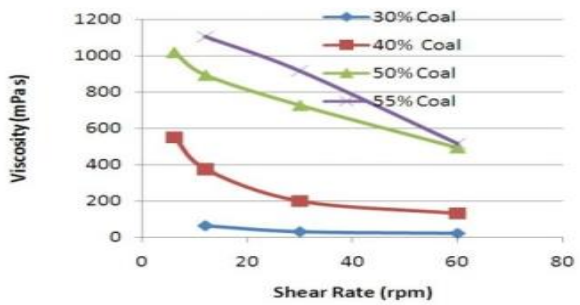
The primary purpose of the coal water slurry (CWS) fuel is to make solid coal behave as a liquid fuel that can be transported, stored and burned in a manner similar to heavy fuel oil. CWS is a finely pulverized high grade coal in water. Chemical additives are used to make the slurry a homogeneous fluid, similar to hydrocarbon such as Heavy fuel oil (HFO)

Mean composition of Proximate analysis

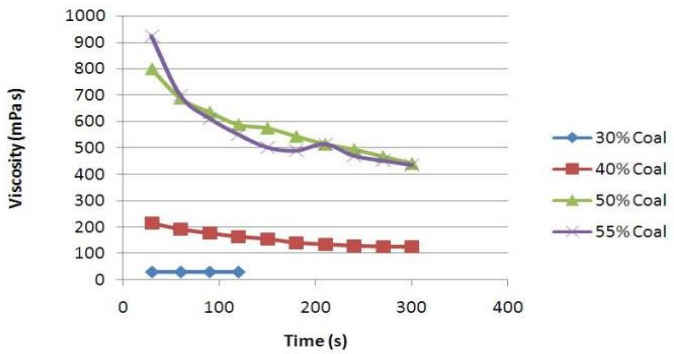
Parameters	Ribadu	Okobo-Enjema
Moisture (%)	5.51	8.17
Ash (%)	8.53	9.35
Volatile matter (%)	38.02	35.93
Fixed carbon (%)	47.94	46.55
Calorific value (kj/kg)	9,538	30,139
Sulphur (%)	0.3549	2.0351

Average level of CWS properties versus the typical No. 2 diesel

Properties	Coal water slurry fuel		No. 2 Diesel
	Okobo	Ribadu	
Density (g/ml)	1.146	1.045	0.952
Boiling point (℃)	52	62.6	188 to 343
Viscosity	145.0	100.4	2.6-4.1



Viscosity as a function of shear rate for coal slurries at room temperature (27 ℃).



Plot of Viscosity vs Time at 30 RPM

Stability rate determination

1. 63.36% water, 3.34% surfactant, 33.3% 250 µm coal

Okobo		Ribadu	
Height (ml)	Time (min)	Height ml)	Time (min)
4.5	0	4.6	0
4.0	20	4.5	20
3.5	40	4.4	40
3.5	60	4.4	60
3.2	80	4.3	80
3.0	100		

46.64% water, 3.34% surfactant, 50% 400 µm coal

Okobo		Ribadu	
Height (ml)	Time (min)	Height (ml)	Time (min)
4.5	0	5.5	0
4.5	20	5.5	20
4.4	40	5.0	40
4.3	60	4.3	60
3.0	80		

63.36% water, 3.34% surfactant, 33.3% 630 µm coal

Okobo		Ribadu	
Height (ml)	Time (min)	Height (ml)	Time (min)
5.0	0	6.2	0
4.9	20	5.9	20
4.5	40	5.5	40
4.5	60	5.4	60
4.5	80	5.4	80
4.3	100		

CWS stability refers to the uniformity of coal slurry during storage and transportation.

BRIQUETTES PRODUCED FROM ENVIRONMENTAL WASTES

RAW MATERIALS FOR BRIQUETTE PRODUCTION

SAMPLE BRIQUETTES

Samples of (**A**) sawdust, (**B**) rice husk, (**C**) coconut fiber, (**D**) coconut shell, and (**E**) coal

Pulverized samples of (**A**) sawdust, (**B**) rice husk, (**C**) coconut fiber (**D**) coconut shell, and (**E**) coal

Pellets produced from (**A**) SDC, (**B**) RHC, (**C**) CFC, (**D**) CSC, and (**E**) bio-coal

Fresh fruits & vegetables preservation device

- Fresh agricultural produce perish or wither away few hours after harvest.
- This results to economic losses and great wastages.
- This device can achieve temperature range of 5 – 7oC lower than the ambient condition
- Keeps fresh tomatoes, mangoes, bananas, oranges and pumpkins fresh for up 7 days

- Suitable for fresh food preservation where grid power is not available.
- Good for market women who deal on perishable food items.
- Recommended for domestic and public uses in the absence of conventional refrigerators

Research and development on the design and fabrication of an incineration system for converting waste to energy for producing hot water, at NCERD, UNN, 2013 - 2017

The use of modern incinerators in burning wastes in Nigeria is very much limited, rather open-air burning of wastes is commonly practiced. A simple incinerator shown below is designed for burning dry solid wastes, especially the domestic or agricultural wastes, to conver combustible waste to energy. It is an alternative energy source by burning waste to create heat energy, which can be used to produce hot water for domestic uses or steam for process heating in industries or to generate electricity for homes and industries. It can reduce the volume of waste that is incerated by nearly 90 to 95% . It traps odours inside and eliminate vermin and insects. Properly controlled incineration provides a very effective means of reducing waste volume. It ensures cleaner and more complete combustion of wastes and the ashes left easily disposable.

NCERD Incinerator for Domestic Hot water Generation

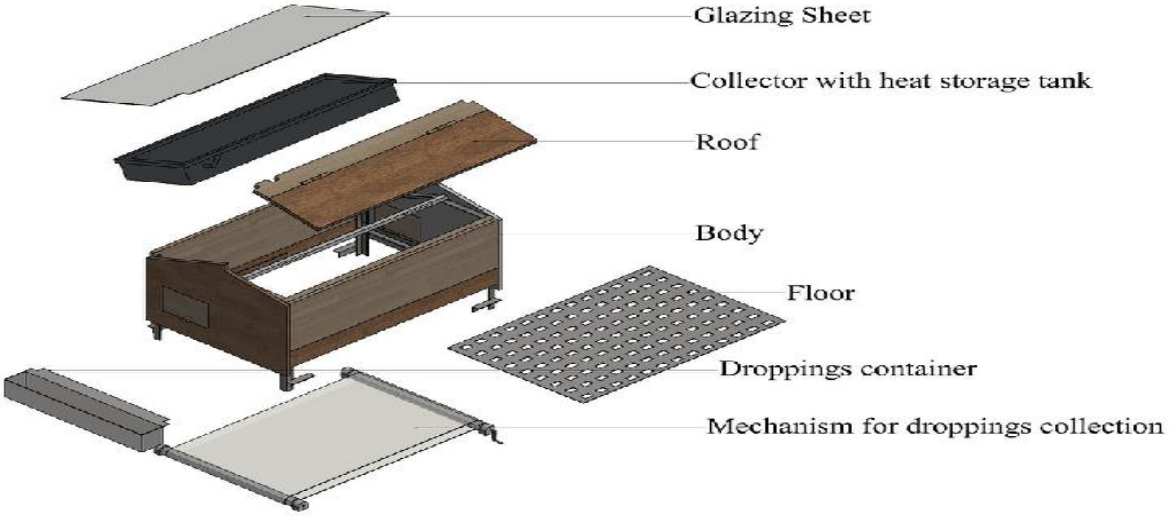
Research and development on solar energy chicken brooder at NCERD, UNN

A unique feature of solar brooder is the utilization of solar energy as heat source in place of electricity, kerosene lamps and stoves normally used in conventional brooders. In comparison with conventional brooders, solar energy brooders are pollution-free, environmentally friendly, have lower maintenance costs and are energy saving; showing over 97% efficiency and about 2-3% mortality rate. The constructed solar powered day-old chicken brooder is capable of brooding 50-day old chicks per batch.

- 50 Birds Capacity Solar Chicks Brooders;
- Better efficiency than the conventional day old chicks brooding methods that depends on heat sources from the grid electricity, kerosene lamps or stoves etc.
- Uses water as the heat storage medium

- Heat storage capacity eliminates the need for auxiliary heat source.
- Capable of handling 30 chicks per batch
- Operating temp. range of 25 ^{o}C to 35 ^{o}C
- Has performance efficiency of up to 97%
- Uses water as heat storage medium

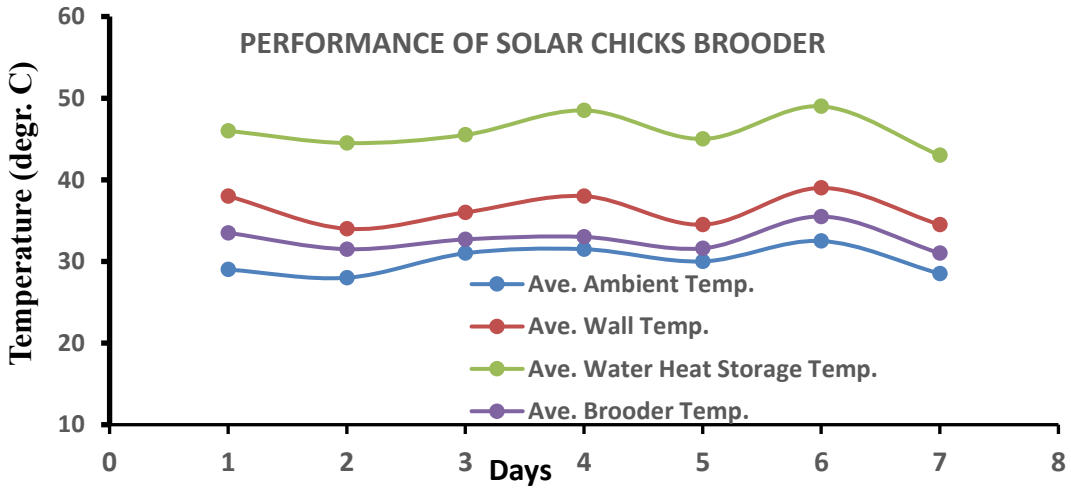
Solar chicks brooder fabrication and assembly



Solar chicks brooder assembly drawing

Solar chicks brooder fabrication and assembly

Testing the Solar Chicks Brooder performance



The Centre has developed Small (50 birds), Medium (150 birds) and Commercial scale (2000 birds capacity) Solar Powered Chicken Brooding systems, with better efficiency than the conventional day old chicks brooding methods that depends on heat sources from the grid electricity, kerosene lamps or stoves etc.

Solar Energy Poultry Chick Brooding System

Key Features:
High performance efficiency of over 97% has been attained.
Uses gravels or pebbles painted black as auxiliary heat storage medium.
Heat storage capacity eliminates the need for auxiliary heat source.
Waste handling system for efficient sanitation.
Capable of handling 2000 chicks per batch
Operating temperature range of 25 ºC to 35 ºC

- **Birds transferred from the Brooding House to the rearing house**

Solar poultry chick brooding system utilizes solar energy to meet the heat requirements for day-old poultry chicks brooding The use of solar energy innovation in poultry production results from: The need for sustained heat supply in poultry production, Ensuring safety by preventing environmental pollution and risks of fire incidents, Growing chicks of improved feed conversion ratios and low mortality rate. Achieving higher profit margins than conventional brooding systems

SOLAR PHOTOVOLTAIC (PV) POWERED POULTRY EGG INCUBATOR

- PV powered poultry egg incubator with egg capacity of 375 eggs per batch
- Ave. measured temperatures of the incubator: 36 – 39ºC
- Ave. measured relative humidity of the incubator: 50 – 70%
- Using fertilized poultry eggs showed 74% efficiency

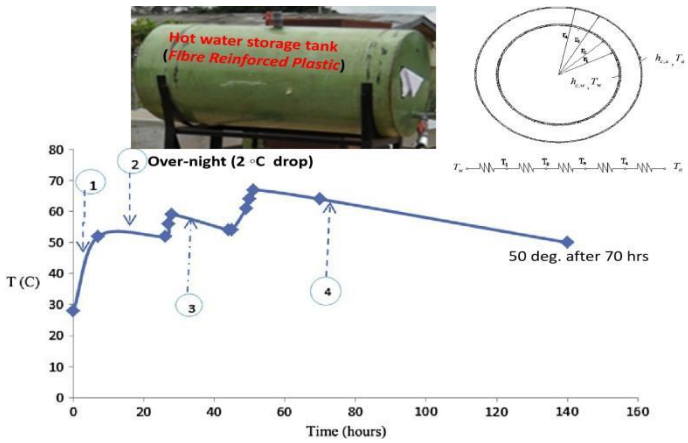
Design and Development of Solar Thermal Devices for Poultry Farmers

50 Eggs Capacity Solar Powered Egg Incubator; with 65 % efficiency

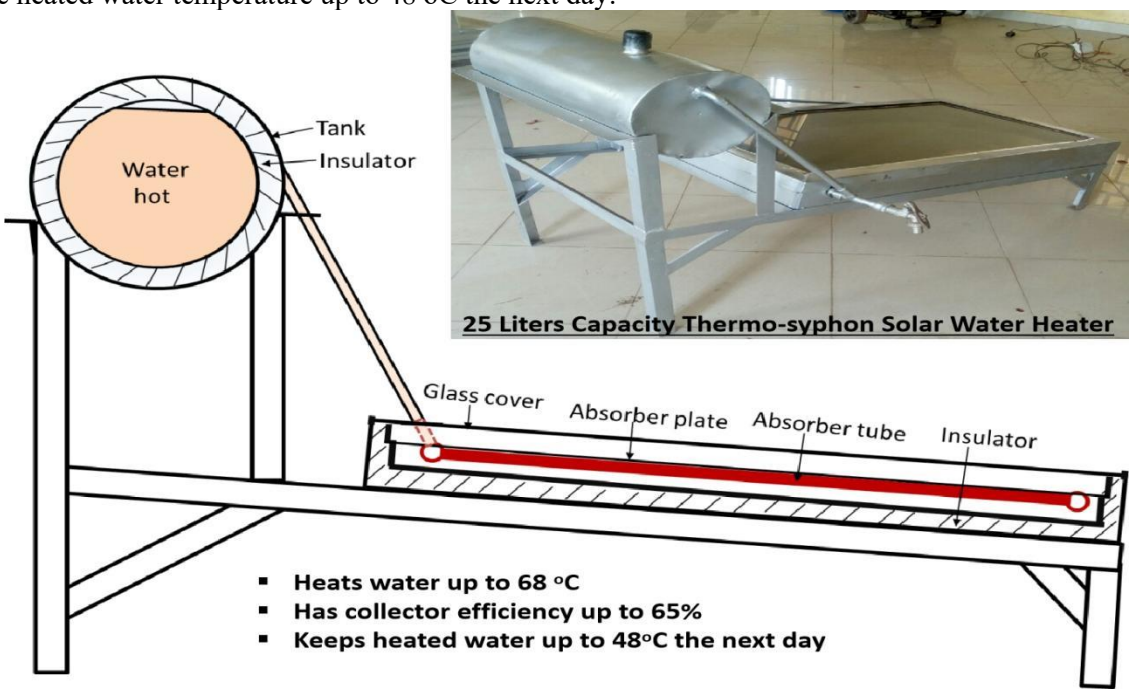
Research and development of the solar water heater at NCERD, UNN

Solar water heater is a device that uses solar radiation to heat water. Solar water heaters can be applied for provision hot water in homes, hostels, hotels, hospitals, and industries such as the textile, paper, and food processing industries. A thermosyphon solar water heater is designed and fabricated in this project. It consist of three major components- the flat plate collector, water storage tank and connecting pipes. The collector is made of glazed cover and the absorber plate made of 1mm aluminum sheet painted with dull-black commercial paint. Hot water is widely needed at: Homes, Institutions, Hospitals, Hotels, etc.

(i) Design and Development of Solar Thermal Devices for Water Heating for domestic, institutions and industrial applications.



250 L Capacity Solar Water Heater with Innovative Composite Storage Tank
Heats water up to temperature of 75 oC . Has collector efficiency up to 78%
Keeps the heated water temperature up to 48 oC the next day.



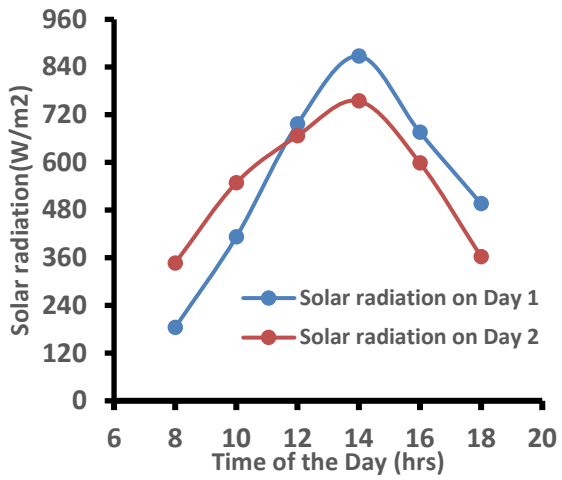


Figure (1)

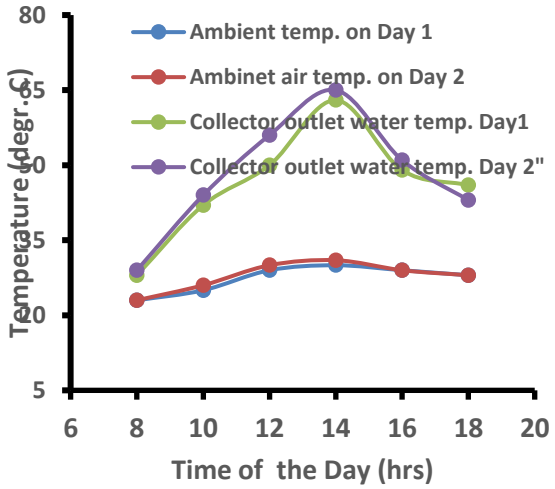
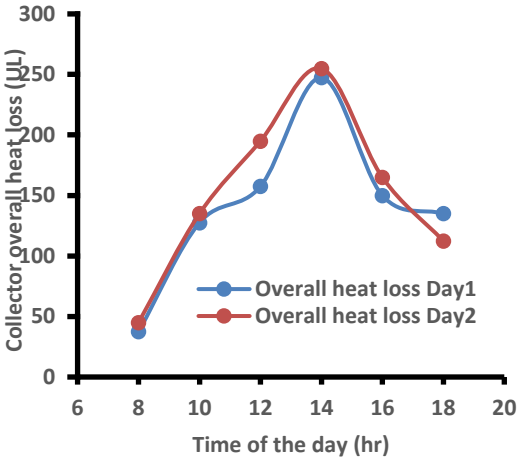
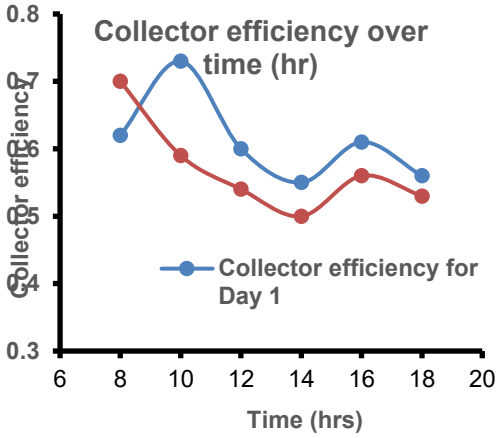


Figure (2)



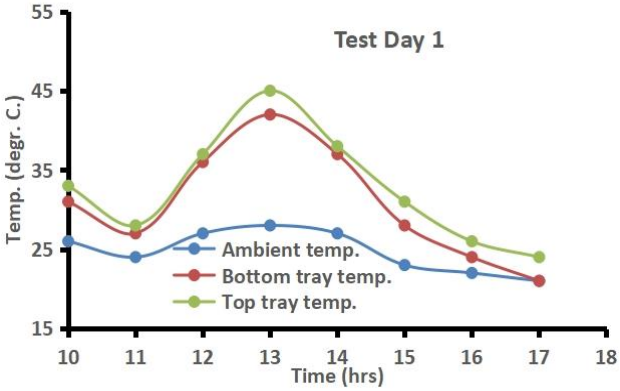


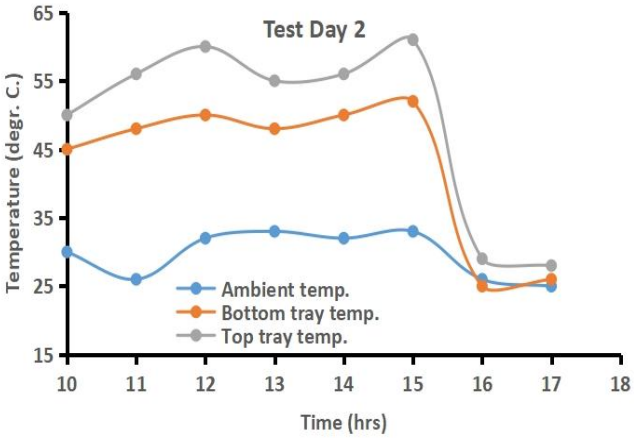
The collector efficiencies for day 1 and 2 are shown in Figures 4. It shows that the collector efficiency decreased with time. The maximum collector efficiencies on day 1 and day 2 were 0.74 and 0.70 and minimum were 0.57 and 0.51 respectively. The efficiency can be improved when the loss factor is minimized by optimizing the design parameters and fabrication materials. The ambient temperature and solar radiation have direct variation effect on the hourly collector efficiency.

Research and development on solar crop dryer at NCERD, UNN, SINCE, 2010- DATE

Open air sun drying is still largely practiced by farmers in Nigeria and large quantity of agricultural food products usually got damage during and post harvesting periods. Over 45% post- harvest losses encountered by farmers on spoilage consist of 50% fruit and vegetables, 40% root crops and 20% cereals. The solar thermal crop dryers are designed to eliminate or reduce the moisture content of crops such as root tubers, vegetables and fruits to safe moisture content level to enhance and improve their shelf life and for preservation purposes.The designed solar crop dryer for this project is for domestic multipurpose dryer for dying crops like cassava, yam, vegetable, fruits such as mango at homes. The dryer has two layers of drying trays capable of holding up to 50 kg of drying crop per batch.

Solar dryer fabrication and assembly





The tests results indicated that the dryer is suitable for dying crops like cassava, yam, vegetable, fruits such as mango at homes.

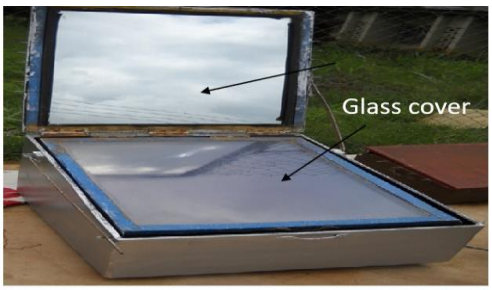
Passive Type Direct Solar Dryer

- 0.4 m3 Capacity Greenhouse Type Solar Dryer
- Suitable for drying peppers, tomatoes, vegetables, plantain chips
- Gives better quality product than open air drying

Passive Solar Powered Fish Dryer

<u>Passive Solar Powered Fish Dryer</u>

- The device uses solar energy to dry fish loaded on the racks inside the dryer
- It uses natural movement of heated air inside the dryer compartment by solar radiation for dehydrating the moisture contents of the fish
- The dryer needs to be exposed to sunlight for efficient performance.
- It is cheaper and ensures a high quality hygienic product



- **Box Type Solar Cooker**

- **Solar dryer for drying peppers, tomatoes, vegetables, plantain chips; gives better quality product than open air drying**

- **Passive Indirect Type Solar Powered Fish dryer**

<u>Active Solar Dryer powered Solar PV</u>

Key Features:

- Has heat storage system (PCM blend with nanoparticles -Aluminum oxide)for better operation.
- Capacity of 8 kilograms of vegetable per drying batch
- Suitable for drying peppers, tomatoes, vegetables, plantain chips, etc.

<u>Indirect passive solar dryer</u>

Suitable for drying medicinal plants that do not require direct exposure to sunlight

Active Indirect Solar Dryer for Drying Cassava; gives better quality than open air drying

Rice dryer ready for commercialization and dissemination to rural farmers.
The dryer is fired by biomass briquettes, which are readily available. It has temperature control system and chimney.
Combustion chamber located below the drying

Multi-purpose agro-products hybrid solar powered dryers for efficient preservation of agro-products to combats the post-harvest losses encountered by rural farmers

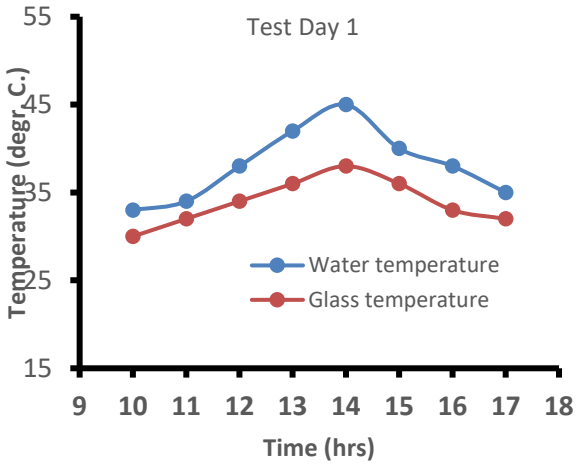
Research and development on solar water still at NCERD, UNN

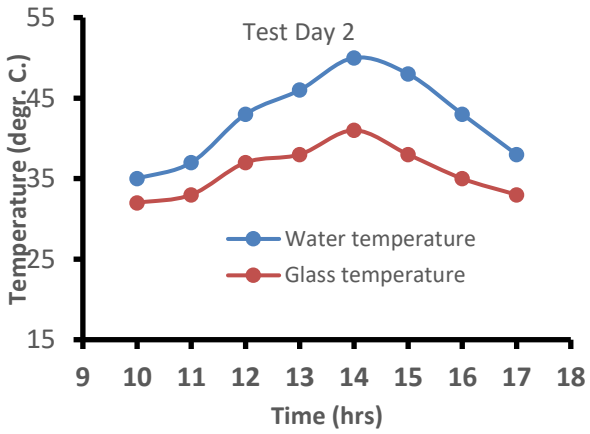
Solar water still is a device to produce potable/fresh distilled water from impure water using solar energy as a fuel. Solar still can desalinate brackish or saline water to get fresh water and salt as products for various domestic, industrial and agricultural applications. In designing the solar still, the following factors such as efficiency, strength, service life, reliability, weight, simplicity and safety, maintenance, convenience of operation, absorptive, transitivity, cost and availability of such materials, thermal energy received by the system, thermal efficiency.

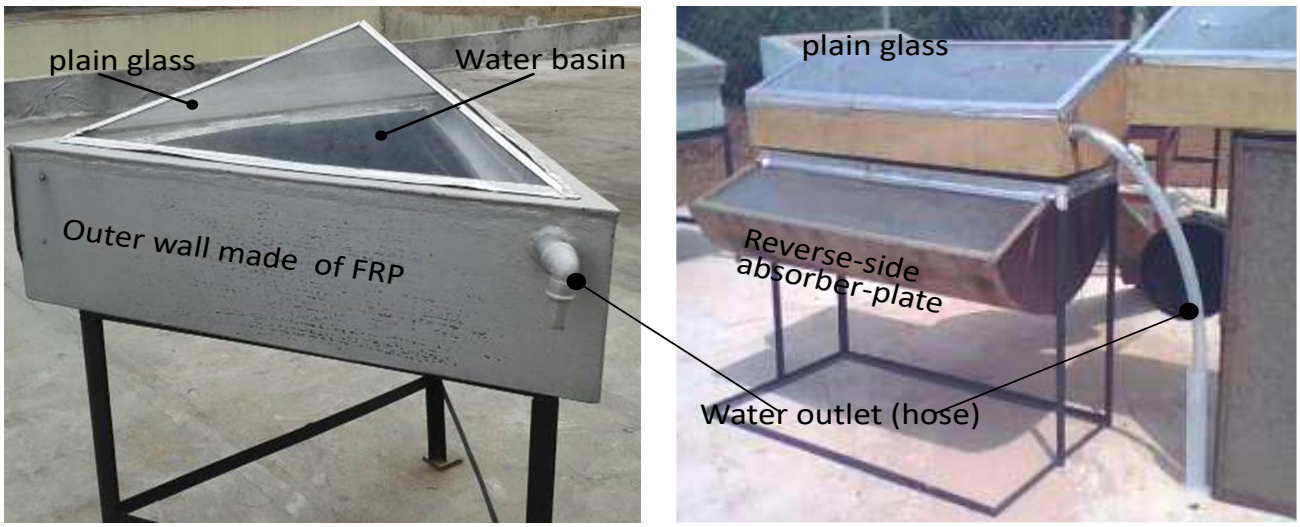
- **Solar water distiller for domestic water treatment and for Salt production from salty water:**
- 50 L capacity single slope solar powered water distiller for domestic water treatment:

- Single slope basin-type passive solar still, between 1.97- 2.923 kgm-2day-1 of the distillate can be obtained

Solar still performance test results







- Pyramidal shaped solar still to increase yield
- with basin area of 0.92 m², up to 5.2 kgm^{-2} day^{-1} distillate yield can be obtained

- Reverse-side absorber-plate solar still with 0.3 m² basin area, 3.203 - 4.263 kgm^{-2}day^{-1} of the distillate can be obtained

- 40 Liters Capacity solar powered pyramidal water distiller for domestic water treatment and salt production.

National Stove Eligibility Laboratory

Laboratory Emission monitoring system (LEMS), a state-of-the-art technology for cookstoves testing and indoor emissions monitoring facility. NCERD is involved in designs, fabrication and performance tests of biomass cookstoves (charcoal, wood and briquettes fired), validation/certification. Manpower training and development of Standard on biomass clean cookstoves

NCERD Laboratory emissions monitoring system with the nozzle type energy

Efficient cookstove mounted inside the metal hood

Nozzle Type Improved Wood Burning Domestic Stoves designed and fabricated at NCERD,UNN

Domestic Biomass Cookstoves; with 68 % fuel wood savings and very low emissions compared to open fire traditional cooking method
Technical Performance: Burning rate was 0.68kg/hr,
Emission reduction is 22.0tCO2 equivalent /year and
Estimated annual thermal energy saving is 44.5TJ

- Developed energy efficient cookstoves for adaptation and commercialization of different models of domestic cookstoves designed to use charcoal, firewood, coal briquettes or coal–char, 2010 – date
-

- Energy efficient fuelwood cookstoves designed, developed and tested by NCERD, UNN

Design and Provision of Energy Efficient Biomass Hexagonal type Clean Cookstoves to Rural Dwellers and Training of women in the Igbo-Eze South and Nsukka Federal Constituency, Enugu State, Nigeria 20th – 24th March, 2018.

Design, fabrication and performance evaluation of a Rocket type institutional energy efficient wood cookstove with chimney for use by Veneta Industry Ltd. Veneta Rd, km 45, Auchi Okene Rd Okpella, Edo State. December, 18th, 2019.

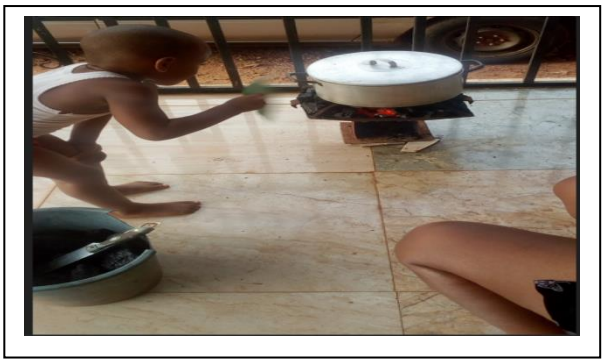
Saves about 68% of the fuelwood compared to the 3-stone open-fire.
Thermal Efficiency (25.8- 30%). Minimal emissions compare to 3-stone open fire.

Survey of Biomass (Fuelwood and Charcoal) Fuel Consumption Using Surveys & Benchmark Model In the South-South and South-East Zones of Nigeria (Nkanu East and Udi L.G.A. of Enugu State)

Firewood Market at Amechi-Awkunanaw in Nkanu East, L.G.A.

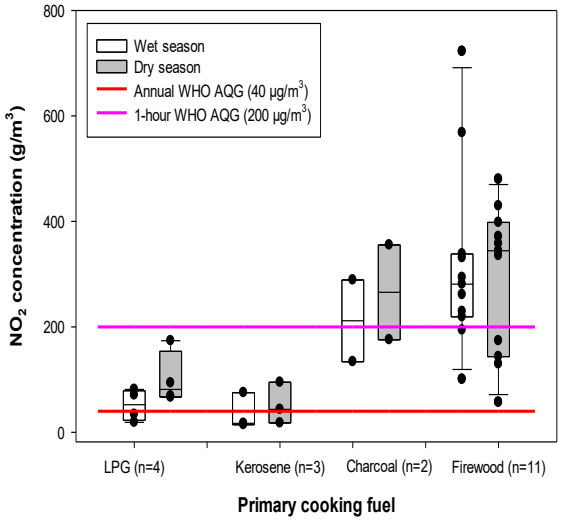
Mini Charcoal shop at Umuode, Nkanu-East L.G.A

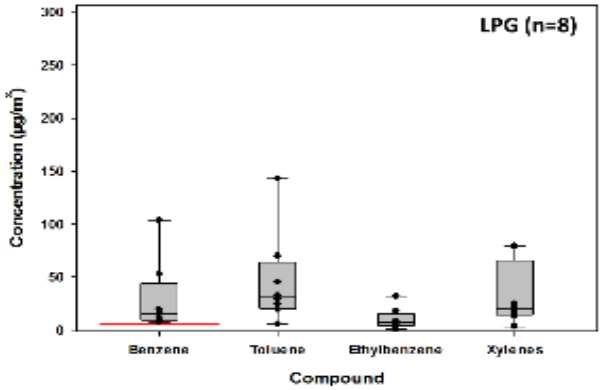
A mini charcoal and fuelwood shop at Ibite-Okpatu, Udi local government area

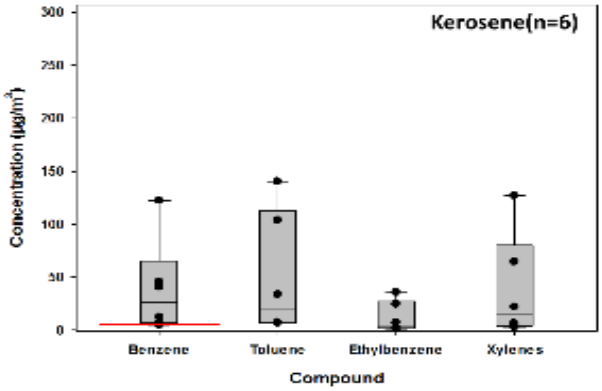


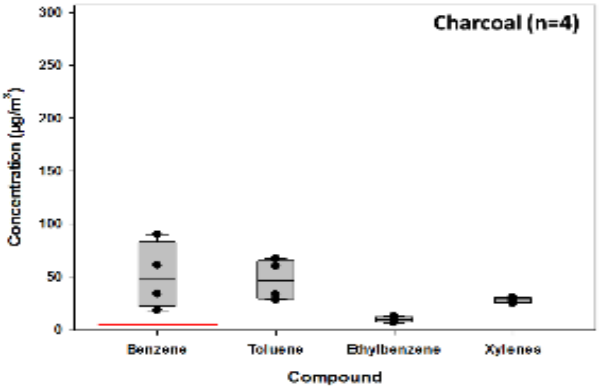
Traditional charcoal stove used by a semi-urban dweller at Ninth mile, Ngwo, Udi L.G.A

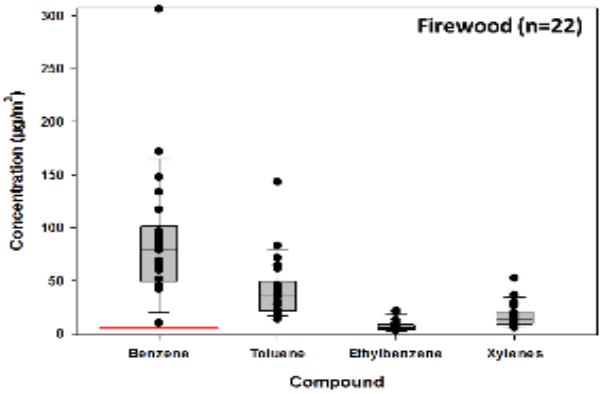
Assessment of the effect of household energy use on indoor air pollution in Southeast Nigeria, 2022.





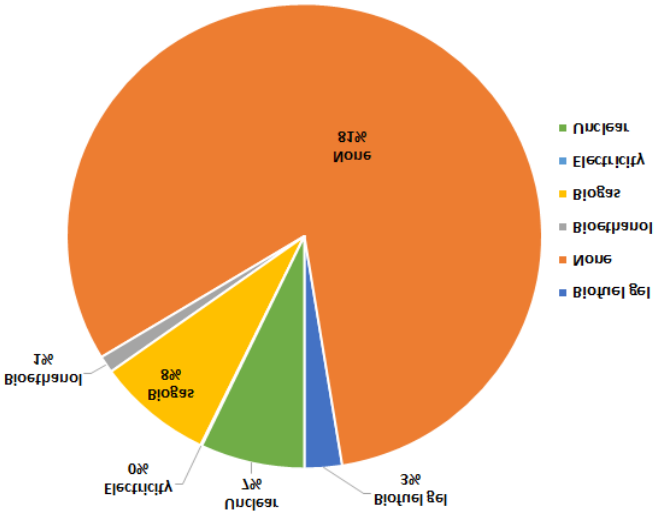


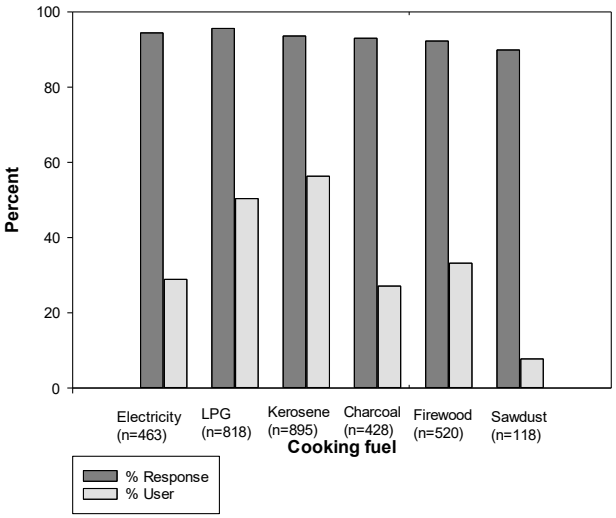




Inventory of Household Energy Sources in Southeast Nigeria 2019, Funded by BOF Ghent University.

Results of the study on the Inventory of Household Energy Sources in Southeast

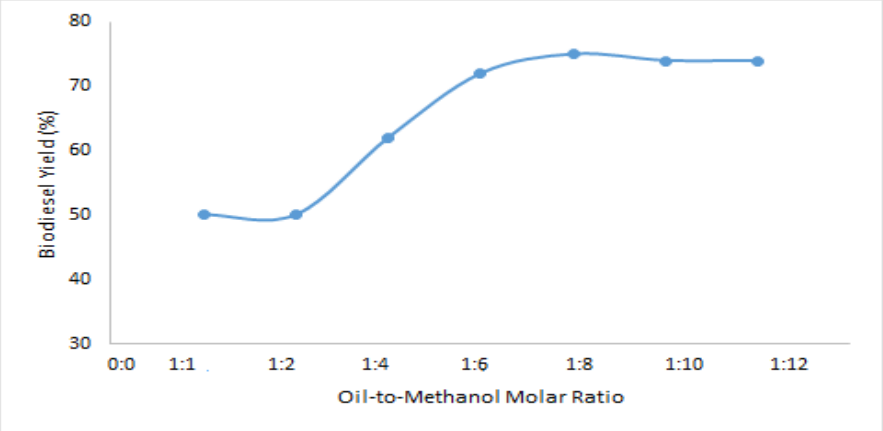




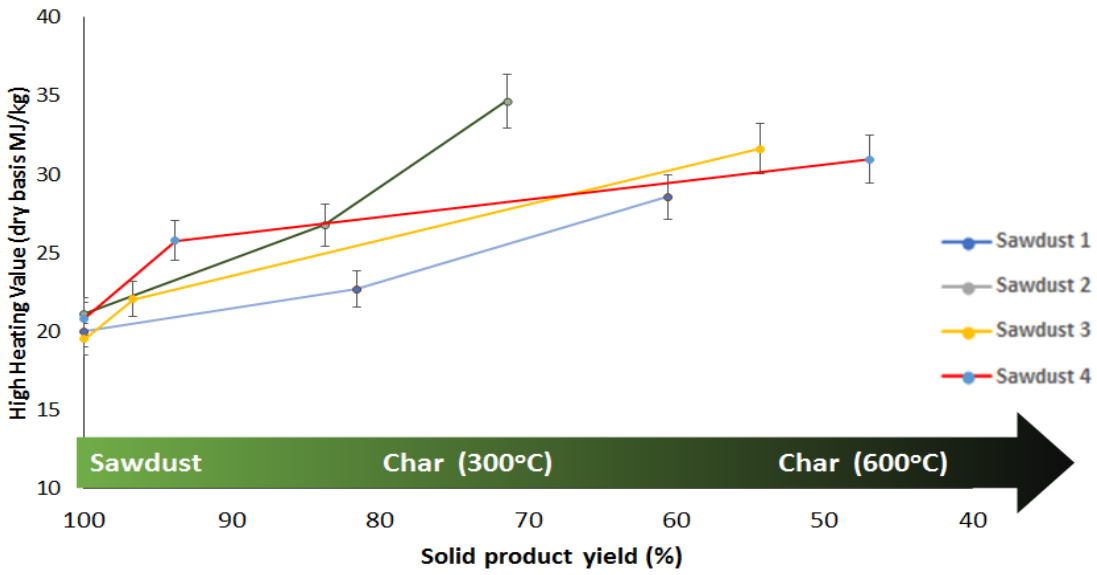
Production and Characterization of biochar from selected biomass (grass, sawdust, waste wood) streams, for energy and soil application, 2015. Funded by VLIR-OUS, Belgium Government.

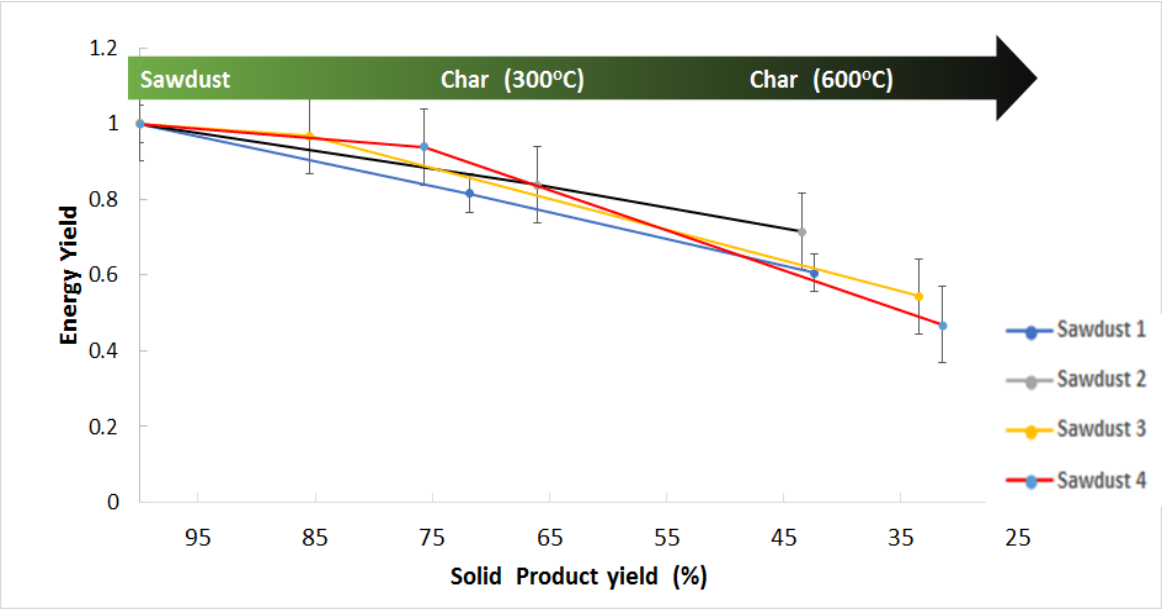
Improving biodiesel yield and production rate with nanoparticles and optimizing oil-to—methanol ratio 2024

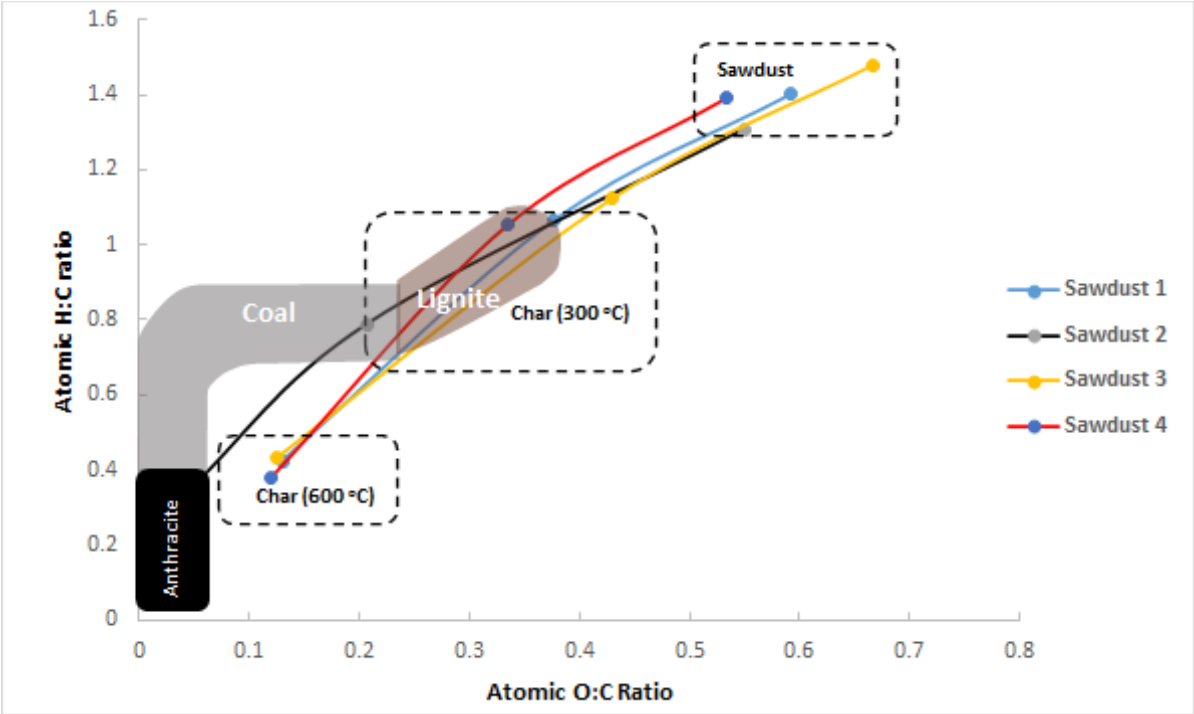
Graphical Results of the study



Thermochemical conversion of sawdust to biochar of improved solid fuel properties, 2024.


High Heating Value (dry basis MJ/kg)
40
35
30
25
20
15
10
Sawdust
Char (300°C)
Char (600°C)
100
90
80
70
60
50
40
Solid product yield (%)
Sawdust 1
Sawdust 2
Sawdust 3
Sawdust 4


Energy Yield
1.2
1
0.8
0.6
0.4
0.2
0
Sawdust
Char (300°C)
Char (600°C)
95
85
75
65
55
45
35
25
Solid Product yield (%)
Sawdust 1
Sawdust 2
Sawdust 3
Sawdust 4



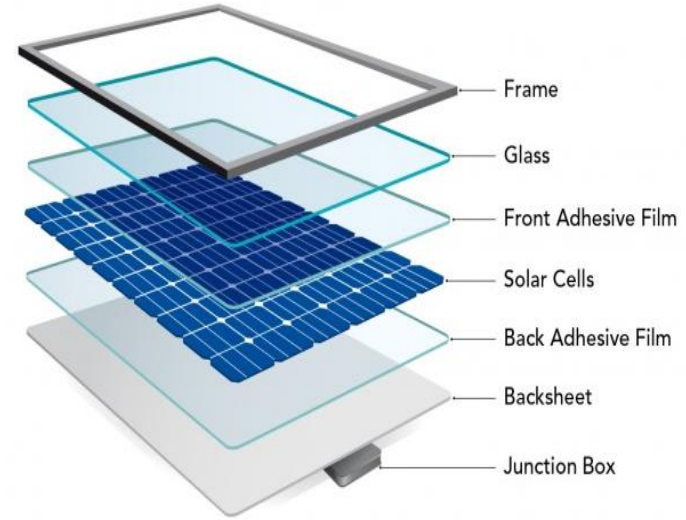
RESEARCH AND DEVELOPMENT OF SOLAR PV MODULE PRODUCTION AT NCERD, NSUKKA

The need for production of the solar PV module locally in the country to reduce to cost and to minimize the challenges of importing renewable energy equipment into the country has become very necessary at this period the quest for sustainable electricity supply is on the increase. Current trend in photovoltaic research is to develop more efficient, environmentally friendly, affordable, reliable and sustainable solar PV module for electric power generation. Setting-up the solar PV module production plant in the Centre is essentially for production of solar PV modules for local users, acquiring research and technical skills, cost reduction and easy diffusion of solar PV technology in Nigeria.

SOLAR PV MODULE PRODUCTION STEPS

Step 1:Testing solar cell efficiency
Step 2: Cut complete solar cell
Step 3:Welding solar cell
Step 4: Cutting EVA/TPT
Step 5: Lay-up
Step 6: Visual inspection
Step 7: Defect check,
Step 8: Lamination
Step 9: Trimming:
Step 10: Glue,
Step 11: Framing,
Step 13: Installing junction box
Step 14: IV Testing
Step 15: Defect check

SOLAR PV MODULE COMPONENT MATERIALS



Solar Cells Testing Machine

Ribbon Cutting Station

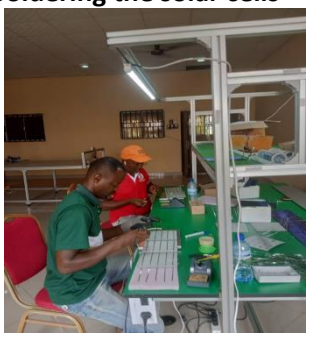
Sample of solar cells

Junction Box connectors

EVA Cutting Station

Framing Machine

Soldering the solar cells



Solar Cell Soldering Station

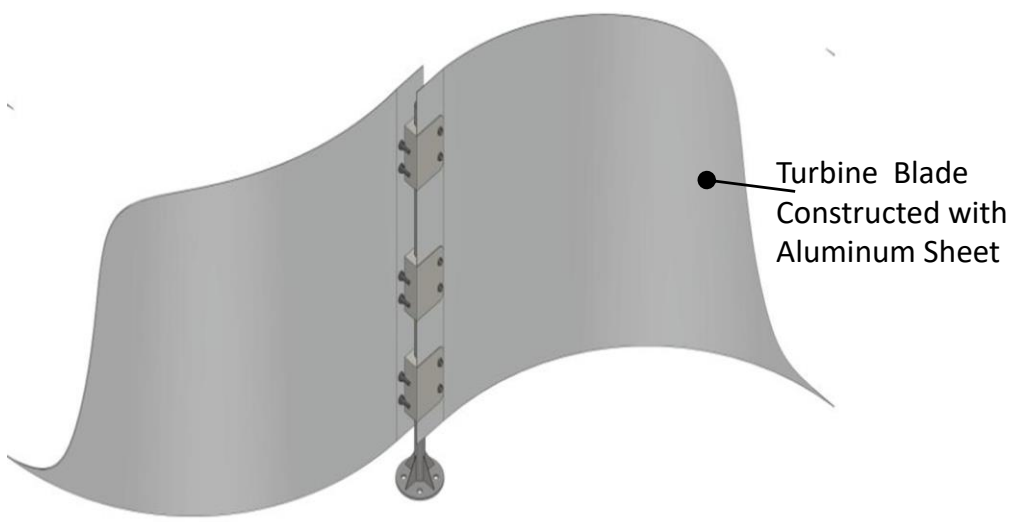
Solar PV Module Laying And Testing Station

Wind energy hervesting at NCERD UNN, 2018 - date

The weather station for expanding wind energy data collection, design and development of wind energy harvesting systems and applications.

Weather Station for recording wind speed, wind direction and weather conditions

Design and development of wind energy harvesting systems for electricity production

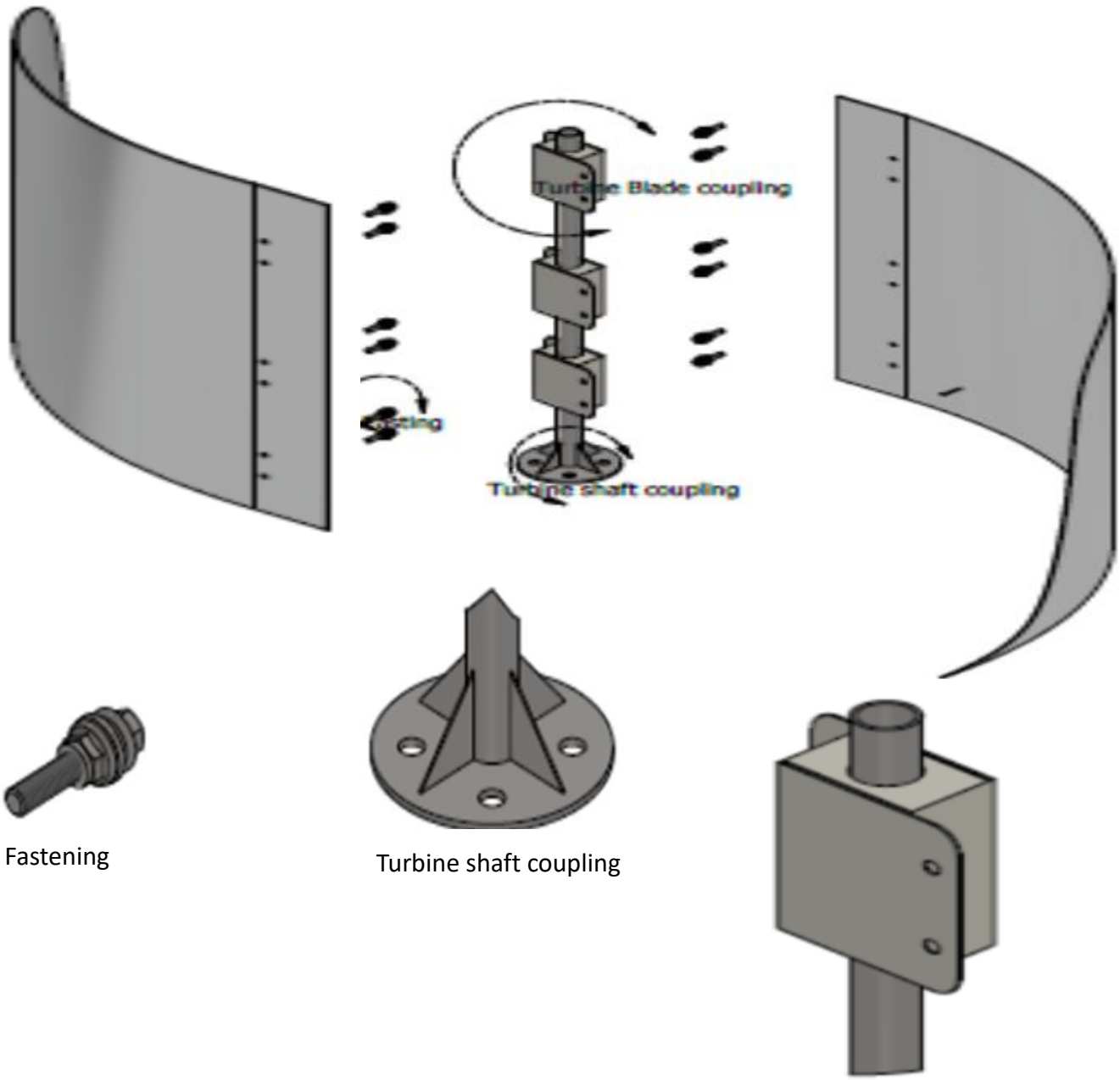


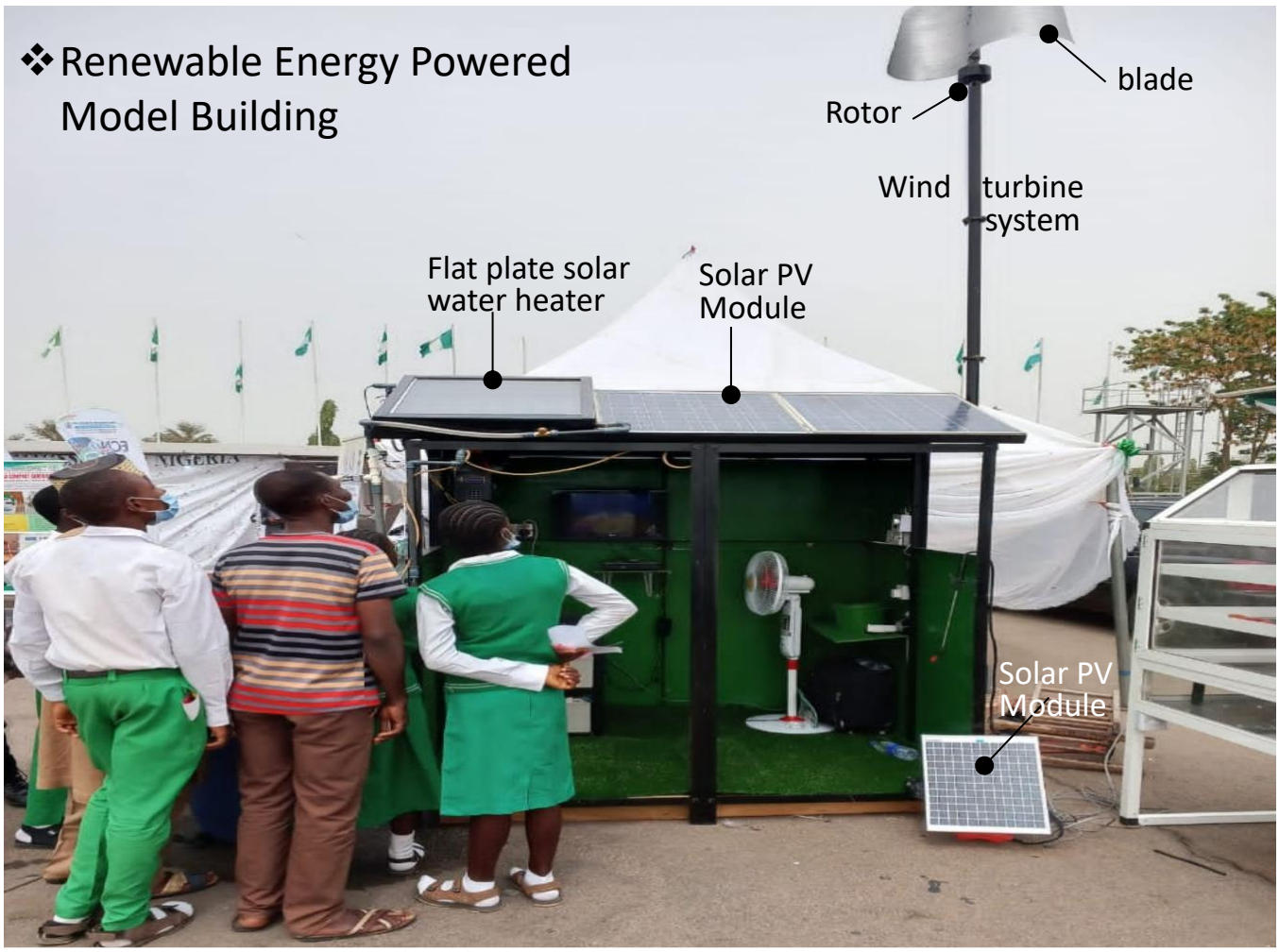
Savonius Wind turbine Blades for harvesting wind energy

Profile of the Wind Turbine Blade model is a fourth order polynomial:

$$Y = -4e^{-0.05}x^4 + 0.0026x^3 - 0.044x^2 - 0.32x + 52$$

Savonius Wind turbine system



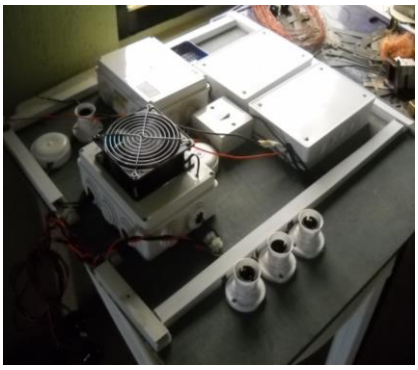


The **Green Energy Model Building** designed, developed and fabricated, having the following:
(i) Solar PV system for electricity generation for powering TV, fan etc.
(ii) Solar thermal water heater with a flat plate collector for hot water production
(iii) Solar PV powered water pumping system, hot water storage tank
(iv) Temperature control system with solenoid valves for controlling hot water storage into tank
(v) Wind turbine system for harvesting wind energy to augment PV system especially in the night when solar radiation is not available.
(vi) Other accessories

Electronic Devices developed by NCERD for Solar PV system applications

NCERD 1kVA Inverter

Hybrid Charge Controller For Solar and Grid power



Smart Power Change Over - Solar to Grid and vice versa

- NCERD has installed a number of renewable energy facilities to enhance access to clean energy in rural communities in the South-east of Nigeria

- 1.3kW PV plant for the Mentally-ill destitute home in Itumbauzo, Abia State

Village Electrification System at Iheapku-Awka in Igbo-Eze South L.G.A.

1.5 kW PV power to 42 households and a television at the village square

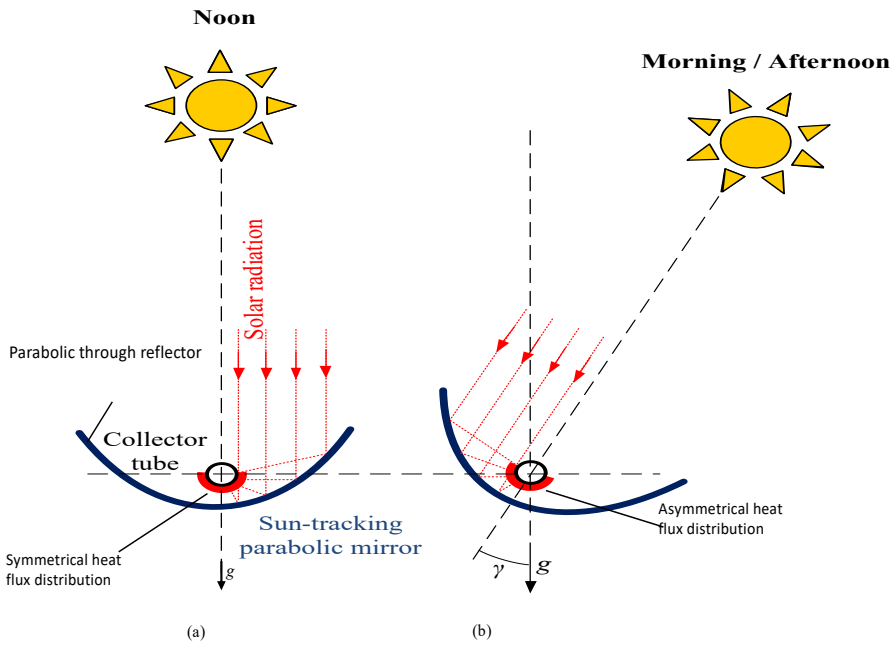
- Solar Powered Water Boreholes in more than 40 Locations in Anambra State

Solar PV Powered Street lights

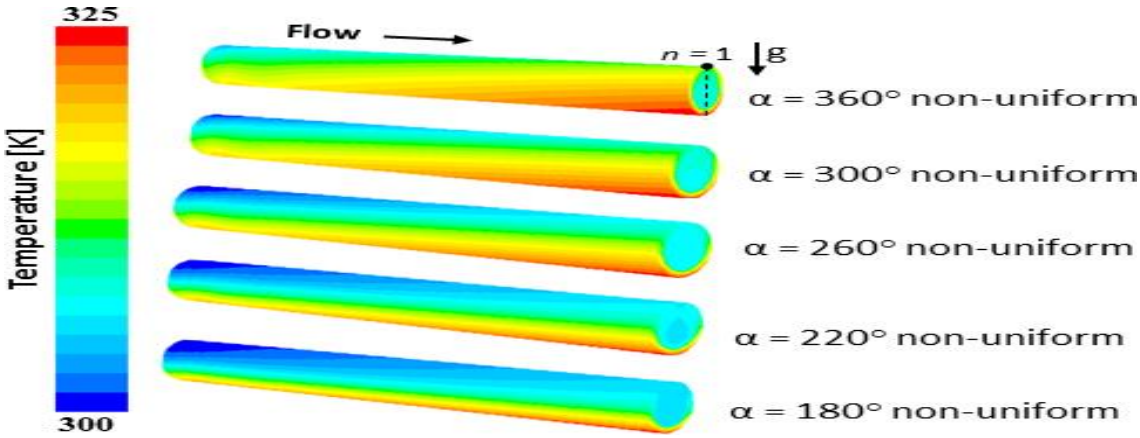
Research and development on solar thermal Concentrating collector systems at NCERD, 2014

The absorber aborber tubes play very critical role in converting the incident solar irradiation into thermal energy of the heat transfer fluid. In linear Fresnel concentrating solar collector, the solar heat flux impinges on the absorber tubes from the underneath independent of the position of the sun, thereby resulting in circumferential non-uniform heat flux around the tube and hence non-uniform heat transfer to the heat transfer fluid. Concentrating collectors e.g. cylindrical, linear Fresnel, parabolic and dish trough type collectors, suitable for medium to high temperature applications for steam generation forindustrial process heat and power generation.

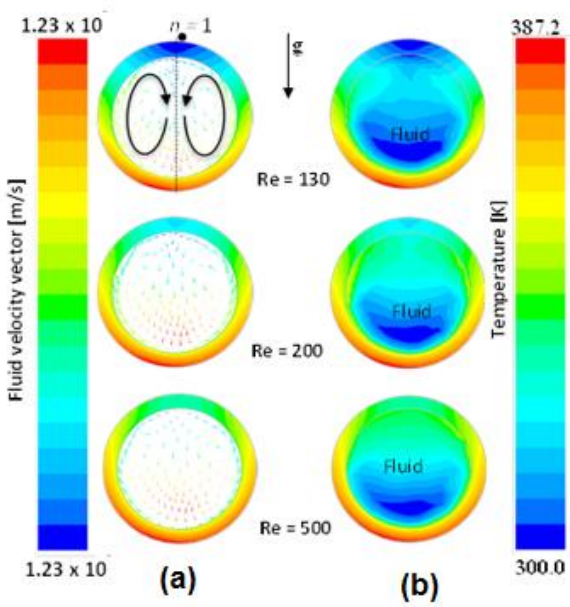
Concentrating Solar Collector



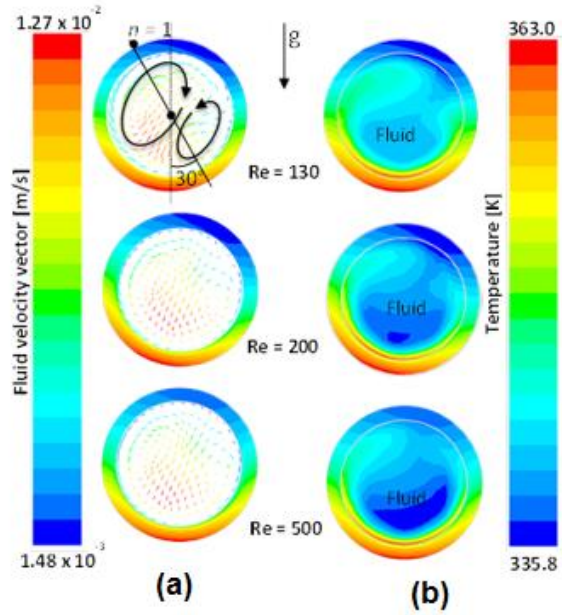
Stainless absorber tubes heated at different span of solar flux



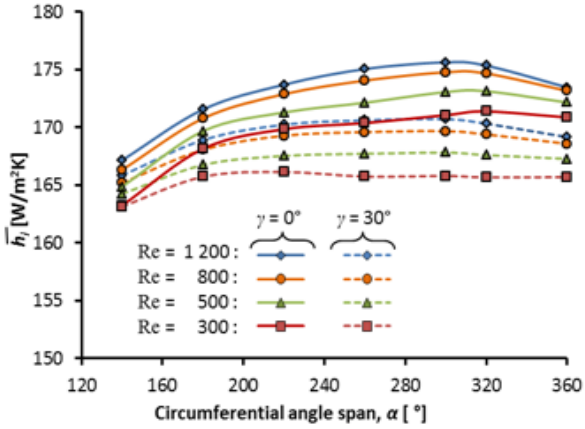
Symmetrical non-uniform heat flux distribution



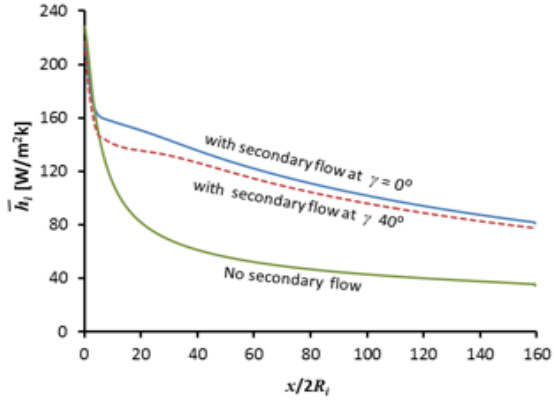
- q_s'' = 7.1 kW/m²
- **(a)** Fluid flow velocity,
- **(b)** Temp. distribution in the fluid
- **α = 220°** span of symmetrical non-uniform heat flux distribution



- q_s'' = 7.1 kW/m²
- **(a)** Fluid flow velocity,
- **(b)** Temp. distribution in the fluid
- **α = 220°** span of asymmetrical non-uniform heat flux distribution



❖ **Average internal heat transfer coefficient for different angle spans of symmetrical and asymmetrical heat flux distributions**



❖ **Axial local heat transfer coefficients for symmetrical and asymmetrical non-uniform heat flux distributions for an inlet Reynolds number of 750**

PUBLISHED RESEARCH PAPERS, REPORTS AND FINDINGS

Published Research Papers, Reports and Findings in Journals in 2025

1.Okafor, I. F., Nwachukwu P. N., Okonkwo I.W. and Okeke, I. D. Sustainable Fuels for Thermal Power Generation for Sustainable Energy Supply in a Low-Density Population Cluster. Int. J. of Energy Technology and Policy (2025) (SJR: 0.160).

2. Kenechukwu E. Ugwu, Chidimma G. Ezema, Cynthia N. Ibeto and Ikechukwu A. Okorie (2025). Physicochemical and combustion characteristics of pyrolyzed coal and biocoal briquettes via thermogravimetric analysis. International Journal of coal preparation and utilization. DOI: 10.1080/19392699.2025.2458074 (SJR 0.455, SNIP 0.974)

3.Femi D. Matthew1,2, Onyekachi M. Nwakanma1, Agnes C. Nkele1,3, Adil Alshoaibi4, Solomon U. Offiah1,5, Perpetua K. Alor1,6, Gotan H. Jain2, Sarika D. Shinde2, B. A. Ezekoye1, A. B. C. Ekwealor1, Ganesh E. Patil2, Fabian I. Ezema1,7,a) (2025)Photocatalytic degradation and gas-sensing properties of hydrothermally synthesized (ZnO)X/(NiO)1−X incorporated with a functionalized graphene oxide. Journal of Materials Research 2025, https://doi.org/10.1557/s43578-025-01554-2

Published Research Papers, Reports and Findings in Journals in 2024

1. Ugwu, K.E., Ezema, C.G., Ibeto, C.N. and **Okafor, I. F.**. (2024), Properties of biocoal briquettes from mesoporous coals and rice husk and their effects on environmental pollution. Discover Environment 2, 106
2. Nnaji, C. E., Okafor, I. F., Akubue, G. U., Uzoma, C. C., Akachukwu, M., Igweh, C. O., & Mba, C. A. (2024). Electricity Consumption Profile of Urban Households in Nsukka, Enugu State: Implications on Energy Expenditures and Savings. African Journal of Environmental Sciences and Renewable Energy, 16(1), 41-59.
3. K.E. Ugwu and C.G. Ezema (2024). Removal of lead(II)ions from aqueous solution using mesoporous and microporous coals: characterization, isotherm and kinetic studies. International Journal of Environmental Sci. and Tech. https://doi.org/10.1007/s13762-024-05480-4 (Thomson Reuter IF 3.519).

4. Agbo K E, Walgraeve C, Eze J.I, Ukoha P, Van Langenhove (2024). Inventorying household cooking energy types and factors mitigating uptake of clean cooking fuels in Southeast Nigeria Accepted Nigerian Journal of Solar Energy.

5. Agbo K. E (2024). Controlled thermochemical conversion of sawdust to biochar of improved solid fuel properties. Accepted Nigerian Journal of Solar Energy.

6. Aralu C.C, Agbo K.E, Nweke N.D, Nwoke S.U, Okah A.T. Abugu H.O, Egbueri J.C, Agbasi J.C, Ezugwu A.L, Omeka M E, Ucheana I. A. (2024).Levels, sources and toxicity assessment of PCBs in surface and groundwater in Nigeria: A systematic review. Journal of Hazardous Material Advances https://doi.org/10.1016/j.hazadv.2024.100527.

7.Abubakar Ibrahim Musa, Mahmoud Abdulhamid, Bappah Adamu Umar, Izuchukwu Francis Okafor and E. C. Anne Novel Prototyping Development Board (Source-Era) for an Encompassing Software/Hardware Production. Journal of Research in Engineering and Computer Sciences, Vol. 2, No. 2 (2024), pp. 23-33.

8. U. P. Onochie, A. C. Ofomatah, H. I. Owamah, S. C. Ikpeseni, S. C. Onwusa, T. E. Erokare, H. O. Orugba (2024). Assessment of the compatibility of biomass-coal blends for cleaner energy utilization and sustainable development. Biomass Conversion and Biorefinery. https://doi.org/10.1007/s13399-024-05771-3. Pp 1-14. Springer. Impact factor 3.5

9. Nnaji C. E., Okafor I. F.,Uzoma Chigasa C., Onyekaozuru E. F., Adagba C. I., Akachukwu M and Igweh C. O.(2024) Survey of Biomass (Fuelwood and Charcoal) Fuel Consumption Using Surveys & Benchmark Model In the South-South and South-East Zones of Nigeria. Advance Journal of Science, Engineering and Technology. Volume:9; Issue: 7. Available at https://aspjournals.org /ajset /index. php/ajset

(10) Book chapter: **Okafor, I. F.** and Okeke I. D. Thermal Performance Analysis of a Linear Fresnel Solar Thermal Collector System. Current Approaches in Engineering Research and Technology. 2024/BPR/2002. BP International, Guest House Road, Street no - 1/6, Hooghly, West Bengal, India

(11)Book of Proceedings, 6th International Conference/Training Workshop on Energy for Sustainable Development in Africa: Sustainable Energy: Towards Energy Access in Africa, June 25 – 27, 2024, Edited by **Engr. Dr. I. F. Okafor**, Dr. S. Offiah and Dr. A. Ofomatah

Published Research Papers, Reports and Findings in Journals in 2023

1.Kenechukwu Ugwu, Mmesoma Ugwueke and Chidimma Grace Ezema (2023). Chemical composition and fuel potentials of Irvingia gabonensis seed. Trends in Applied Science and Research. https://doi.org/10.17311/tasr.2023.1.7

2.Kenechukwu E. Ugwu, Julius U. Ani, Anthony C. Ofomatah (2023), Biosorption of potassium ion using bean seeds and its energy saving application, Heliyon 9 (2023) e16266, https://doi.org/10.1016/j.heliyon.2023.e16266

3. I F. Okafor and Bappah A U Mixed Convection Heat Transfer in an Absorber Tube with Non-uniform Heat Flux Distributions Boundary for a Linear Fresnel Solar Thermal Collector: Review Work. Journal of Material Sciences & Engineering Vol. 12 (01) 2023, pp 1-5.

4. Okwe Gerald, Okafor Izuchukwu, Offiah Solomon, N. Okebaram Protus, Akwukwaegbu Isdore, Olubiwe Mathew, Obichere John Kennedy, C. Akujobi Leonard. Design and Simulation of 500kW On-Grid Photovoltaic Power System using PV*SOL.SSRG International Journal of Recent Engineering Science Vol.10(5), (2023) pp. 30-38.

5. Izuchukwu F. Okafor and Solomon E. Esomu. Efficient Energy Consumption and Load Balancing for Smart Cities: A Review of Analytics-Based Solutions. Global Journal of Engineering and Technology. DOI: 10.28933/GJET. Vol. 6 (4), (2023) pp. 1-12.

6. Okwe Gerald. I, Okafor I. F**,** Offiah S.U, Okebaram P.N, Akujobi L.C. Design and Analysis of Earth Resistance for Efficient Protection of Photovoltaic Installation (A Case Study of Owerri Municpal) Journal of Electronics and Communication Engineering Research, Vol. 9 (4) (2023) pp: 07-14

7. Nnaji, C.E., Okafor, I. F., Uzoma, C. C., Akubue, G. U., Adagba C. I and Onyekaozuru, E. F Determinants of Solar Energy Demand in Households in Nsukka Area, Enugu State. International Journal Of Research And Innovation In Social Science (IJRISS)|Vol.7 (4) (2023) pp. 373-392

8. Izuchukwu F. Okafor**,** Bappah A. Umar, Uche P. Chukwu, Michael C. Amonye, Screw Shaft Flywheel Stabilizing HydroTurbine for Run of River Installations. International Journal of Novel Research in Engineering and Science Vol. 10 (1), pp. 13-20, 2023.

9. K. P. Alor, B. A. Ezekoye, P. E. Ugwuoke, S. U. Offiah, F. I. Ezema, S. Akor, **I. F. Okafor** and O. V. Ekechukwu. A Review of Advances on Natural Dye Sensitized Solar Cells (NDSSCs). Journal of Engineering Research and ReportsVol. 25 (10) (2023) pp.153-166.

10.Monograph: Physico-chemical Characteristics, Environmental Effects and Potential Applications of Nigerian Coals, by K.E. Ugwu, I.F. Okafor and C.N. Ibeto, (ISBN: 978-978-780-729-3) NCERD, 2023.

11. R A Akwolu, S U Offiah, A Agbogu, O Nwakanma, O. V. Ekechukwu, F. Okafor and P E Ugwuoke (2023) Comparative study of dyes and effects of purification on selected plants for dye-sensitized solar cells application. IOP Conf. Series: Earth and Environmental Science 1178 (2023) 012004. doi:10.1088/1755-1315/1178/1/012004

12. Okwe Gerald1, Okafor Ephraim2, Uzoechi Lazarus3, Akwukwaegbu Isdore4, Okafor Izuchukwu5, Offiah Solomon6, Opara Raymond7, Nosiri Onyebuchi8 (2023) Analysis of Electrical Energy Consumption Pattern and Audit for Improved Electricity in Owerri Urban "A Stepwise Approach" International Journal of Recent Engineering Science Volume 10 Issue 5, 49-63, Sep-Oct 2023 ISSN: 2349–7157 / https://doi.org/10.14445/23497157/IJRES-V10I5P106

13. G. E. Orizu1, P. E. Ugwuoke2, I. Humphrey3, N. I. Obot3, and S. U. Offiah4.The relative comparison of different Models used for determining PV tilt angle in Anambra and Enugu state- Nigeria (2023). Global Scientific Journal: Volume 11, Issue 7, July 2023, Online: ISSN 2320-9186. www.globalscientificjournal.com

14. K. P. Alor a*, B. A. Ezekoye b, P. E. Ugwuoke b, S. U. Offiah b,c, F. I. Ezema b, S. Akor c, I. F. Okafor c and O. V. Ekechukwu d A Review of Advances on Natural Dye Sensitized Solar Cells (NDSSCs). Journal of Engineering Research and Reports, Volume 25, Issue 10, Page 153-166, 2023; Article no. JERR.108296. ISSN: 2582-2926

15. Okwe Gerald1, Okafor Izuchukwu2, Offiah Solomon3, N. Okebaram Protus4, Akwukwaegbu Isdore5, Olubiwe Mathew6, Obichere John Kennedy7, C. Akujobi Leonard8 (2023) Design and Simulation of 500KW On-Grid Photovoltaic Power System using PV*SOL. SSRG International Journal of Recent

Engineering Science, Volume 10 Issue 5, 30-38, Sep-Oct 2023, ISSN: 2349–7157/ https://doi.org/10.14445/23497157/IJRES-V10I5P104

Published Research Papers, Reports and Findings in Journals in 2022

1. Agbo K. E (2022). The Effect of Household Energy Use on Residential Indoor Air Pollution in Southeast Nigeria, Afrika Focus 35 (2022) 388–407.

2. Agbo K. E, Walgraeve C, Eze J.I, Vandermeersch L, Ukoha P, Van Langenhove H (2022). Residential VOCs concentration levels in Nsukka, Nigeria. Atmospheric Environment 289 (2022) 119307.

3. Agbo K.E (2022). Effect of household energy use on residential indoor air pollution in Southeast Nigeria. Published Ph.D. Thesis, Ghent University, Belgium, Ghent University Press.

4. Cosmas Anyanwu, Chinazom Animoke, Bonaventure Agu, Izuchukwu Okafor, Nneka Ogbuagu, Samuel Bentson, Onyekwere Ojike. Studies on some Physical and Emission Properties of Blended Bio-Coal Briquettes Derived from Agro-Wastes in Nigeria. Advances in Science, Technology and Engineering Systems Journal (2022) (SNIP: 0.298)

5. I F. Okafor. Heat Transfer Performance of a Linear Fresnel Solar Collector Absorber Tubes With Circumferential Non-Uniform Heat Flux Distributions. International Research Journal of Applied Sciences, Engineering and Technology Vol.8, No. 12, 2022, pp. 1 – 9.

6. Nnaji C.E**.,** Okafor I. F., Onyekaozuru E.F. and Adagba C.I. Energy Efficiency Indicators and Energy Utilisation in Nigeria's Economic Sectors. Nigerian Journal of Solar Energy, 33 (1&2), (2022), pp. 43 – 50.

7. I. F. Okafor and I A. Obi Thermal Performance Analysis of a Linear Fresnel Concentrating Solar Collector Absorber Tube. Journal of Energy Research and Reviews ***12(1): 65-71, 2022,*** DOI: 10.9734/JENRR/2022/v12i130293

8. I. F. Okafor and I. A. Obi. Promoting the Use of Alternative Fuels for Road Transport in Nigeria International Journal of Engineering and Modern Technology (IJEMT) E-ISSN 2504-8848 P-ISSN 2695-2149 Vol. 8 (5), 2022, pp. 93 – 99.

9.Ugwu Kenechukwu Emmanuel and Ezema Chidimma Grace (2022). Metal analysis and fuel potentials of Irvingia gabonensis seed. Journal of Biological Research and Biotechnology. Vol. 20 No. 3; pp. 1712-1720. ISSN: 1596-7409

10.C G Ezema, O Ojike and W I Okonkwo (2022). Evaluation of an incinerator for thermal decomposition of domestic solid waste and hot water supply. Proceedings of 5th International Conference and Training Workshop on Energy for Sustainable development in Africa at National Centre for Energy Research and development, UNN.

11.Kenechukwu E. Ugwu and Anthony C. Ofomatah (2022). Bioavailability and health risk assessment of potentially toxic elements in salty water environment of Okposi, Southeastern Nigeria. SN Applied Sciences (2022) 4:204 https://doi.org/10.1007/s42452-022-05080-2. Impact Factor 2.6 Springer.

12.B.N. Enemchukwu, J.T.C. Onwuatuegwu, A.C. Ofomatah, O.C. Ezeigwe, O.F. Orinya, E.L. Iloanya, C.M. Okeke and E.I. Onyedinma (2022). Biochemical and haematological effects of Telfairia occidentalis and Amaranthus viridis extracts on anaemic rats. J. Appl. Sci. 22: 144-151.

13. Alor K.P.1, Offiah S.U.2 & Nwokoye A.O.C.1 (2022) Comparative Studies of the Monthly Average Global Solar Radiation of a Northern and a Southern Location in Nigeria. Nigerian Journal of Solar Energy (August, 2022), 33 (1&2): 63 – 70. ISSN: 0794-9537

14. C. E, Nnaji, M, Onyia C.C. and Obetta, A. E. (2022) "The Socio-Economic Impact Assessment Of Solar Photovoltaic(PV) Systems Within Nsukka Local government Area of Enugu State". Irish International Journal of Engineering and Scientific Studies, Volume: 5; Issue: 04, pp.29-46.

(15)Book of Proceedings, 5th International Conference/Training Workshop on Energy for Sustainable Development in Africa: Energy Solutions for Attainment of Sustainable Development Goals in Africa, 17th – 19th M ay, 2022, Edited by Engr. Dr. I. F. Okafor, Dr. S. Offiah

Published Research Papers, Reports and Findings in Journals in 2021

1. Agbo K. E, Walgraeve C, Eze J.I, Ugwoke P, Ukoha P, Van Langenhove H (2021). A review on ambient and indoor air pollution status in Africa Atmospheric Pollution Research (12) 243–260.

2. Agbo K. E, Walgraeve C, Eze J.I, Ugwoke P, Ukoha P, Van Langenhove H (2021). Household indoor concentration levels of NO_2, SO_2 and O_3 in Nsukka, Nigeria. Atmospheric Environment 244, 117978.

3. Mike U. Ajieh, Kesiena Owebor, Lawrence C. Edomwonyi-Otu1 & **Izuchukwu F. Okafor**. Integration of perennial grass into energy mix as an alternative to fuelwood in selected Niger Delta communities, Nigeria. Biomass conversion and bio-refinery, Vol. 13, Issue 5, (2021) **(TR: 4.050)**

4.Emelda N. Okolo, David I. Ugwu, Benjamin E. Ezema, Joseph C. Ndefo, Florence U. Eze, Chidimma G. Ezema, James A. Ezugwu & Oguejiofo T. Ujam (2021). New chalcone derivatives as potential antimicrobial and antioxidant agent. Scientific Reports 11: 21781.

5. Kenechukwu E. Ugwu and Anthony C. Ofomatah (2021) Concentration and risk assessment of toxic metals in indoor dust in selected schools in Southeast, Nigeria. SN Applied Sciences. 3:43. Pp 1-13. doi.org/10.1007/s42452-020-04099-7. Springer

6.Momoh A. Mumuni, Kenechukwu C. Franklin, Calister E. Ugwu, Adedokun O. Musliu, Akeem A. Agboke, Chinazom P. Agbo, Emmanuel C. Ossai, Anthony C. Ofomatah, Darlington C. Youngson, Chidozie E. Omeje, Ben C. Amadi (2021). Development and Evaluation of Arthemether-loaded Microspheres Delivery System for Oral Application in Malaria Treatment. Trop J Nat Prod Res. 5(11): 2030-2036. Schimago Journal Rank 0.127

7.C.N Ibeto, C.E Enyoh, A.C Ofomatah, L.A Oguejiofor, T. Okafocha and V. Okanya (2021). Microplastics pollution indices of bottled water from South Eastern Nigeria. International Journal of Environmental Analytical Chemistry. Pp 1-20. https://doi.org/10.1080/03067319.2021.1982926. Thomson Reuters Impact factor: 2.826

8.Assumpta Chinwe Nwanya, Miranda M. Ndipingwi, Ofomatah Anthony. Fabian I. Ezema, Malik Maaza and Emmanuel Iwuoha (2021). Impedance studies of biosynthesized Na0.8Ni0.33Co0.33Mn0.3302 applied in an aqueous sodium-ion battery (2021). Int. J Energy Res. 2021: 1-12. Doi: 10.1002/er.6594. Thomson Reuters Impact factor: 5.164

9.Emmanuel O Njoga, Ekene V Ezenduka, Chiazor G. Ogbodo, Chukwuka U. Ogbonna, Ishmael F. Jaja, Anthony C. Ofomatah and Charles Odilichukwu R. Okpala (2021). Detection, Distribution and Health Risk Assessment of Toxic Heavy Metals/Metalloids, Arsenic, Cadmium and Lead in Goat Carcasses Processed for Human Consumption in South-Eastern Nigeria. Foods. 10,798.httpd://doi.org/10.3390/foods10040798. Thomson Reuters Impact factor: 4.350

10. Akor S. Enemuoh F.O, Anionovo U.E. and Offiah S.U. (2021) Embedded power system for improved voltage profile in Nigeria Distribution Network Using Power Factor Equality. Nigerian Journal of Solar Energy 32 (1): 17 – 24. ISSN: 0794-9537

11. Emmanuel O. Onah · M. A. Onuorah · S. U. Offiah · Raphael M. Obodo ·O. V. Ekechukwu · P. E. Ugwuoke · Fabian I. Ezema. (2021) Effects of annealing temperature on TiO2 photoelectrodes of dye-sensitized solar cells using Ixora coccenia dye extract. J Nanopart Res (2021) 23: 228, https://doi.org/10.1007/s11051-021-05335-w

12. S.U. Offiah, S.N. Agbo, C.G. Ezema, P.E. Ugwuoke, A.B.C. Ekwealor, A.N.C. Agbogu B.A. Ezekoye and F.I. Ezema (2021).Enhancement of the performance of ZnO based natural dye sensitized solar cells via PVA morphology controlled nanorods. IOP Conf. Series: Earth and Environmental Science 730 (2021) 012033. doi:10.1088/1755-1315/730/1/012033

13. Akor S. Enemuoh F.O, Anionovo U.E. and Offiah S.U. (2021) Embedded power system for improved voltage profile in Nigeria Distribution Network Using Power Factor Equality. Nigerian Journal of Solar Energy 32 (1): 17 – 24. ISSN: 0794-9537

14. Emmanuel O. Onah · M. A. Onuorah · S. U. Offiah · Raphael M. Obodo ·O. V. Ekechukwu · P. E. Ugwuoke · Fabian I. Ezema. (2021) Effects of annealing temperature on TiO2 photoelectrodes of dye-sensitized solar cells using Ixora coccenia dye extract. J Nanopart Res (2021) 23: 228, https://doi.org/10.1007/s11051-021-05335-w

15. Chigasa Uzoma, Chimezie Atama, IjeomaIgwe,Amadi Kingsley (2021) A Policy Analysis of Grid Rural Electrification in Nigeria since 1981. Pakistan Journal of Social Sciences17(5):248-254.

16.Ogwo, U. (2021). Information and Communication Technologies: A Need for Curriculum Reform for Library and Information Science Education in Nigeria" (2021). Library Philosophy and Practice (e-journal). 5252. https://digitalcommons.unl.edu/libphilprac/5252

17.Igwe, N. J., Ogwo, U. & Abbah, O. I. (2021). Perceived Role of Extension Education in Promoting the Use of Biogas for Sustainable Agricultural Development in Nigeria. IOP Conference Series: Earth and Environmental Science, 730 012034. https://iopscience.iop.org/article/10.1088/1755-1315/730/1/012034

Doi: 10.1088/1755-1315/730/1/012034

18.Adejo, A. A., Ogwo, U. & Babatunde, K. A. (2021). Information Literacy Skills for the Utilization of E-Library Resources among Students in Tertiary Institutions in Nigeria. Lagos Journal of Library and Information Science, 10(1/2), 137-147.

19.Ayolugbe, C. J., Jidere, A. J. and Ogwo, U. (2021). Utilization of Zoom as an Interactive Platform in Repositioning Library Administration for Effective Service Delivery in Academic Libraries in Nigeria. Library Philosophy and Practice (e-journal). 6514. https://digitalcommons.unl.edu/libphilprac/6514

20.Adejo, A. A., Ogwo, U. & Babatunde, K. A. (2021). Internet of Things: Technical Benefits in Perspectives and Potentials for Service Delivery in Nigerian Libraries. Benue Journal of Library Management and Information Science (BJLMIS). 11 (2), 135-146

21.Ogwo, U.; Ebong, M. & Nwachukwu, V. N., (2022). Continuing Professional Development as a Medium in the Empowerment of Library and Information Science Educators for Effective Knowledge Delivery and Sustainable Education in South East, Nigeria. Library Philosophy and Practice (e-journal). 7086. https://digitalcommons.unl.edu/libphilprac/7086

22.Igwe, J.N., Abbah, O. I. & Ogwo, U. (2022). Knowledge, Attitude and Practice of Physical Activities in Post COVID 19 Lockdown among Adult Learners in South East Nigeria. Journal of Advances in Sports and Physical Education. https://saudijournals.com/media/articles/JASPE_59_204-210.pdf

DOI: 10.36348/jaspe.2022.v05i09.001

23.Aniekwe, C. C.; Ogwo, U.; & Ayolugbe, C. J., (2022). Availability And Utilization Of Ict Resources In Management Of Students With Speical Needs In Academic Libraries In Enugu State. Library Philosophy and Practice (e-journal). 7415. https://digitalcommons.unl.edu/libphilprac/7415\\

Published Research Papers, Reports and Findings in Journals in 2020

1. **I. F. Okafor**, and G.O. Unachukwu. Design, Fabrication and Performance Evaluation of a Nozzle Type Wood Cook Stove for Indoor Emissions Reduction, International Journal of Engineering and Modern Technology E-ISSN 2504-8848 P-ISSN 2695-2149 Vol 6 No12 2020, pp. 1-16.

2. I. F. Okafor, and A. I. Obi, Linear Fresnel Solar Thermal Concentrator Cavity Receiver Type: A Review Work. Nigerian Journal of Solar Energy 31 (1), 2020, pp. 23 –27.

3. A. I. Obi , C. A. Mgbemene and I. F. Okafor, Performance Evaluation of a Hybrid Photovoltaic/Thermal (PV/T) Thermosiphon Solar Water Heater, Nigerian Journal of Solar Energy 31 (1), 2020, pp. 13 –18

4. C. N. Ibeto, C. J. Obiefuna & K. E. Ugwu. (2020), Environmental effects of concretes produced from partial replacement of cement and sand with coal ash, International Journal of Environmental Science and Technology, 17(5): 2967-2976. Doi 10.1007/S13762-020-02682-4

5. K.E. Ugwu (2020), A Review of environmental issues in coal processing and utilization, and the mitigation of the environmental impacts, Nigerian Research Journal of Chemical Sciences, 8(1): 82-91, (ISSN: 2682-6054)

6. Ugwu, K.E. and Ofomatah, A.C. (2020), Detection and determination of associated metals from charcoal by atomic absorption spectroscopy, Nigerian Journal of Solar Energy (NJSE), 31(1): 28-30

7. Ugwu K and Ofomatah A.C (2020). Detection and Determination of Associated Metals from Charcoal by Atomic Absorption Spectroscopy. Nig. Journal of Solar Energy. Vol. 31(1). Pp 28-30.

8.O.L. Alum; C.E. Eledalachi1; E.M. Orji1; H.O. Abugu; A.C. Ofomatah and N.C Isienyi (2020). Feed Analyses of Proximate Composition and Heavy Metals: A Case Study of Some Poultry Feeds Distributed in Aba, Southeastern, Nigeria. Pacific Journal of Science and Technology. 21(2):286-292.

9.Veronica Ezekoye, Peter Offor, Anthony Ofomatah, Agbogu Ada and Ezekoye David (2020). Methane Production Enhancement and Comparative Study of Biodegradation of Some Plants and Animal Wastes. Indian Journal of Biochemistry and Biophysics (IJBB). Vol 57 (4) Pp 449-457. Schimago Impact factor 0.253

10.Mumuni A. Momoh, Kenechukwu C. Franklin, Chinazom P. Agbo, Calister E. Ugwu, Musiliu O. Adedokun, Ofomatah C. Anthony, Omeje E. Chidozie and Augustine E. Okorie (2020). Microemulsion-based Approach for Oral Delivery of Insulin: Formulation Design and Characterization. Heliyon 6. (2020) e03650. Pp 1-8 http://doi.org/10.1016/j.heliyon.2020.e03650. Elsevier. Impact factor: 2.85

11.Mumuni Audu Momoh, Franklin Chimaobi Kenechukwu, Chinekwu Sherridan Nwagwu, Philip Uzor, Vincent Obieze, Aminu Nafiu, Oyeniyi James, Anthony Chibuzo Ofomatah, Abdulmuminu Isah, Sanni Muhammad Salihu (2020). Formulation and in Vitro Characterization of Ibuprofen-Loaded Solid Dispersions. African Journal of Pharmaceutical Research and Development.12 (1) pp 056-069.

12. E.O. Onah, S.U. Offiah, U.K. Chime, G.M. Whyte, R.M. Obodo, O.V. Ekechukwu, I. Ahmad, P.E. Ugwuoke, F.I. Ezema (2020). Comparative photo-response performances of dye sensitized solar cells using dyes from selected plants. Surfaces and Interfaces 20 (2020) 100619. https://doi.org/10.1016/j.surfin.2020.100619

13. Daniel Lozano-Martín, Gerald Ugwu Akubue, Alejandro Moreau, Dirk Tuma and César Chamorro (2020), Accurate experimental (p, ρ, T) data of the (CO2 + O2) binary system for the development of models for CCS processes, The Journal of Chemical Thermodynamics, vol 150, 106210.

14.1.Valentine S. Enyi, Mamilus A. Ahaneku, Offorma S. Ugwu and Gerald U. Akubue (2020) Outdoor Environment Gsm Network Path loss Measurements and Forcasting at Nsukka Urban Using Regression Analysis Model, International Journal of Engineering Science Invention, pp. 47 – 55.

15. Nnaji, M.; Eze, A.A.; Uzoma, C. C.; Nnaji, C. E. & Madueme S.I. (2020) "Energy Challenge and the Nigerian Economy" Nigerian Journal of Solar Energy, Vol.31, Issue1, pp. 31-34

16. Chukwu, Jude Okechukwu, Chimere O. Iheonu and Chibueze, E. Nnaji (2020) " Foreign Direct Investment, Financial Deepening, Energy Innovations and Environmental Quality in Selected African Economies" Nigerian Journal of Social Sciences, Vol.14, Issue 2,pp. 1-8

(17) Book of Proceedings, 4th International Conference/Training Workshop on Energy for Sustainable Development in Africa: Energy Solutions for Attainment of Sustainable Development Goals in Africa, 11th – 13th November, 2020, Edited by **Engr. Dr. I. F. Okafor** and Prof. P. Ugwoke

18. Ayolugbe, C. J., Ogwo, U. and Ikaelogbon, O. J. (2020). Impact of Climate Change on Agriculture, Food Security and Sustainability in Nigeria. In: Climate Change in Africa: Problems, Prospects and Perspectives, I. A Kanu and E. J. O. Ndubisi (eds.). A Publication of the Association for the Promotion of African Studies (APAS).https:// www.researchgate.net/publication/338124246_2019_ ASSOCIATION_FOR_THE_PROMOTION_OF_AFRICAN_STUDIES_INTERNATIONAL_CONFERENCE

Published Research Papers, Reports and Findings in Journals in 2019

1. I. F. Okafor, J. Dirker and J. P. Meyer. Heat Transfer Coefficients and Thermal Efficiency for a Linear Focusing Solar Collector Type Absorber Tubes with Different Inner Diameter and Wall Thickness. Nigerian Journal of Solar Energy, Vol. 30 (2), 2019, pp. 70-74.

2. A. I. Obi1, C. A. Mgbemene and I. F Okafor. Design, Construction and Testing of Hybrid Photovoltaic/Thermal Solar Water Heater. Nigerian Journal of Solar Energy, Vol. 30 (1), 2019, pp. 37-45.

3. I. F. Okafor. Optical Design and Performance Analysis of Linear Focusing Solar Thermal Collectors. International Journal of Systems Engineering. Vol. 3, No. 1, 2019, pp. 9-16.

4. I. F. Okafor. Energy Efficient Biomass Cookstoves: Performance Evaluation, Quality Assurance and Certification. Sci. Journal of Energy Engineering. Vol. 7, No. 4, 2019, pp. 54-62.

5. Godswill Chijioke Onuegbu, Fabian Ifeanyi Eze, Peter Chikezie Ayogu, Mattias O. Agbo, Chidimma G. Ezema, Benjamin G. Ezema (2019). Phytochemical and In Vitro Antimicrobial Properties of Premnahispida(Verbenaceae) Linn. IOSR Journal of Pharmacy and Biological Sciences Vol. 14, Issue 5 Ser II, PP 64-74.

6. K.E. Ugwu and I.O. Obi (2019): Conversion of carbon dioxide to synthetic organic fuels through photocatalysis - a review, Nigerian Research Journal of Chemical Sciences, 7: 377-389, (ISSN: 2682-6054)

7.Veronica Ezekoye, Rita Adinde, David Ezekoye and Anthony Ofomatah (2019). Synthesis and Characterization of Biodiesel from Citrus Sinensis Seed Oil. Scientific African 6(2019) e00217. http//doi.org/10.1016/j.sciaf.2019.e00217. Elsevier. SJR 0.298

8..Ezekoye, V, Adinde, R, Ezekoye, D and Ofomatah, A (2019). Characterization and Analysis of Biodiesel Produced from Lonchocarpus Sericeus Seed Oil. Proceedings of the 2nd Biennial General Meeting and Scientific Conference, Women in Science. Pp 23-35.

9.J.U Ani, U.C Okoro, L.E Aneke, O.D Onukwuli, I.O Obi, K.G Akpomie and A.C Ofomatah (2019). Application of response surface methodology for optimization of dissolved solids adsorption by activated charcoal. Applied Water Science. 9: 60. http//doi.org/10.1007/s13201-019-0943-7. Springer. Thomson Reuters Impact factor: 3.874

10. E.I. Achuka, S.U. Offiah and I.E. Ottih (2019).The performance of dye sensitized solar cell fabricated using dye extracted from Newbouldia Laevis leaves. Nigerian Journal of Solar Energy, Vol. 30, 87 – 92

11. S. U. Offiah, A. N. C. Agbogu, A. C. Nwanya, A. C. Nkele, U. K. Chime, B. T. Sone, M. M. Duvenhage, S. Botha, A. B. C. Ekwealor, R. U. Osuji, M. Maaza, F. I. Ezema.Influence of cadmium precursor concentrations on the structural, optical and electrochemical impedance properties of CdZnS thin film . Vacuum 160 (2019) 246–254. https://doi.org/10.1016/j.vacuum.2018.11.041

12. Ogwo, U; Abbah, O. I. & Igwe, N. J. (2019). Perceived Impact of Information and Communication Technology in Enhancing Entrepreneurship in Sports among Health and Physical Education Teachers in Anambra State, Nigeria. Library Philosophy and Practice (e-journal). 2712. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=6411&context=libphilprac

13. Ebong, M. D., Ogwo, U. and Nwachukwu, V. N. (2019). Availability and Access of Electronic Information Resources to Medical Library Users in Universities in South-South, Nigeria. Library Philosophy and Practice (e-journal). 2736. https://digitalcommons.unl.edu/libphilprac/2736

14. Ogwo, U., Ayolugbe, C. I. and Igwe, N. J. (2019). Entrepreneurship Education: A Viable Tool in Enhancing Post Basic in Awka Education Zone, Anambra State, Nigeria. Library Philosophy and Practice (e-journal). 2713. https://digitalcommons.unl.edu/libphilprac/2713

Published Research Papers, Reports and Findings in Journals in 2018

1. I. F. Okafor, Jaco Dirker and Josua P. Meyer, Asymmetrical Non-Uniform Heat Flux Distributions for Laminar Flow Heat Transfer With Mixed Convection in a Horizontal Circular Tube, HTE. 0317, Heat Transfer Engineering, 2018. **(TR: 2.431).**

2. **I. F. Okafor** and P. E. Ugwuoke (2018) Thermal Performance Analysis of a Linear Fresnel Solar Thermal Collector System- A Review Work, Nigerian Journal of Solar Energy, Vol. 29, pp. 69-80.

3. Benjmin E. Ezema, Chidimma G. Ezema, Pricillia N. Abuekwu, Mattias O. Agbo and Kovo G. Akpomie (2018). Total Alkaloids, Tannin Content, and Antiulcer Assay of four selected Medicinal Plants in Nigeria. The Pacific Journal of Science and Technology 19(2), 284-294. (Thomson Reuter IF 1.73)

4. Benjamin E. Ezema, Sunday N. Okafor, Sunday A. Agada, David I. Ugwu, and Chidimma G. Ezema (2018). Synthesis, In Silico and In Vitro Studies of Potential Glucosamine-6-phosphate Synthase and Lanosterol-14α-demethylase Inhibitors. ChemistrySelect 3, 12001-12006. . (Thomson Reuter IF 1.81)

5. Benjamin Ezema, Chidimma Ezema, Kovo Akpomie, David Ugwu (2018). Synthetic process of vat-dyes of tetraaza derivatives of three-branched phenothiazine heterocycles. Leonardo Electronic Journal of Practices and Technologies 33, 277-288.

6. .K.E. Ugwu, A.C. Ofomatah and J.U. Akajagbor (2018), Investigation into the ambient concentrations of carbon monoxide in Nsukka Urban, South East, Nigeria, and its likely effects on human health, Journal of Chemical Society of Nigeria, 43 (4): 707 -712

7. K.E. Ugwu and P.O. Ukoha (2018), Polycyclic aromatic hydrocarbons in surface sediments near a mining site in Okobo-Enjema, Nigeria: Concentrations, source apportionment and risk assessment. Environmental Geochemistry and Health. 40: 359-373. DOI 10.1007/s10653-017-9916-7

8. K.E. Ugwu, A.C. Ofomatah and J.U. Akajagbor (2018). Investigation into the Ambient Concentrations of Carbon Monoxide in Nsukka Urban, South East , Nigeria, and its' likely effects on Human Health. J. Chem Soc. Nigeria, Vol. 43, No. 4, pp 707 -712.

9. C. D. Asogwa, S. U. Offiah, P. E. Ugwuoke, T. C. Chibueze, A. B. C. Ekwealor and F. I. Ezema (2018) The effects of deposition cycles on cobalt sulphide thin films synthesized by successive ionic layer adsorption and reaction. Nigerian Journal of Solar Energy, Vol. 29, pp97 – 104

10. Nnadozie B. Odinaka and Gerald U. Akubue (2018) Computational Fluid Dynamics Performance Analysis on Mixed Mode Solar Dryers. International Journal of Scientific & Engineering Research Volume 9, Issue 6, pp. 133 – 144.

Published Research Papers, Reports and Findings in Journals in 2017

1. I. F. Okafor, Jaco Dirker and Josua P. Meyer, Influence of Non-Uniform Heat Flux Distributions on the Secondary flow, Convective Heat Transfer and Friction Factors for a Parabolic Trough Solar Collector Type Absorber Tube, Renewable Energy 108 (2017) 287-302 (TR: 8.634).

2. C. G. Ezema, A. C. Nwanya, B. E. Ezema, Malik Maaza, P. O. Ukoha and F. I. Ezema (2017). Hydrothermal synthesis of brookite TiO2 nanoparticles for dye-sensitized solar cell. Journal of Solid State Electrochemistry 21, 2655-2663. (Thomson Reuter IF 2.316)

3. Ofomatah, A.C and Okoye, C.O.B (2017). Contamination levels, toxicity profiles, and emission sources of polycyclic aromatic hydrocarbons (PAHs) in the soils of an emerging industrial town and its environs in the Southeastern Nigeria. Environ Monit Assess. 189: 1-6. https://doi.org/10.1007/s10661-017-6347-y. Springer. Thomson Reuters Impact factor: 2.513

4. A.C Ofomatah and E.E Obasi (2017). Biogas Optimization Potentials of Cow Dung, Pig Dung and Poultry Droppings with Sugar cane bagasse and Watermelon Peel. FUW Trends in Science and Technology Journal. Vol. 2. No. 1A. 267-270.

5. L.C Ugwuowo, A.G Ezekwe, A.O Ani , S.I Eze, C.N Anyanwu and A. Ofomatah (2017). Methane emissions and volatile fatty acid production from manure excreted by cattle fed diets containing lipids. The J. Anim. Plant Sci. 27(3). Pp 708-713. Impact factor 0.490

6. Chibuko, U. M., Offiah, S. U., Asogwa, P. U., Ugwuoke, P. E. and Ezema, F. I., Influence of deposition parameters on spectral and structural properties of CdS thin films for solar cells applications. Nigerian Journal of Solar Energy, Vol. 28, 2017 Pp 1-7.

7. B N Ezealigo, A C Nwanya, S Ezugwu, S Offiah, D Obi, R U Osuji, R Bucher, M Maaza, P Ejikeme, F I Ezema (2017), Method to control the optical properties: Band gap energy of mixed halide Organolead perovskites, Arabian Journal of Chemistry, (2017), https://doi.org/10.1016/j.arabjc.2017.09.002

8. S. U. Offiah, S. N. Agbo, P. Sutta, M. Maaza, P. E. Ugwuoke, R. U. Osuji & F. I. Ezema. Study of the extrinsic properties of ZnO:Al grown by SILAR technique. Journal olf Solid State Electrochem (2017) 21:2621–2628

Published Research Papers, Reports and Findings in Journals in 2016

1. Van Poucke R., R.W. Nachenius, K.E. Agbo, F. Hensgen, L. Bühle, M. Wachendorf, Y. S. Ok, F.M.G. Tack, W. Prins, F. Ronsse, E. Meers, (2016). Mild hydrothermal conditioning prior to torrefaction and slow pyrolysis of low-value biomass. Bioresource technology 217, 104-112..

2.C. G. Ezema, A. C. Nwanya, B. E. Ezema, B. H. Patil, R. N. Bulakhe, P. O. Ukoha, C. D. Lokhande, Malik Maaza, Fabian I. Ezema (2016). Photo-electrochemical studies of chemically deposited nanocrystalline meso-porous n-type TiO2 thin films for dye-sensitized solar cell (DSSC) using simple synthesized azo dye. Appl. Phys. A 122:435. (Thomson Reuter IF 1.71)

3.Ezema, C.G., Offiah, S.U., Ezema, B.E., Ukoha, P.O. and Ezema, F.I. (2016). Growth and Characterization of Chemical Bath Deposited PVA/PBS Thin Films. Nigerian Journal of Solar Energy, Vol. 27, 79-84.

4. K.E. Ugwu and P.O. Ukoha (2016), Analysis and sources of polycyclic aromatic hydrocarbons in soil and plant samples of a coal mining area in Nigeria, Bulletin of Environmental Contamination & Toxicology, 96(3): 383-387

5. K. E. Ugwu and P.O. Ukoha (2016), Occurrence, source apportionment and predictive model of polycyclic aromatic hydrocarbons in a stream water of a Nigerian coal mine area. Journal of Chemical Society of Nigeria, 41 (2): 31-38.

6. Ezekoye Veronica, Ezekoye Benjamin, Ofomatah Anthony, Onah Daniel and Peter Offor (2016). Biodegradation with heterogeneous catalyst in the production of biogas from wheat wastes, rice husk and spent grains. Int.J. Phy. Sc. Vol. 11(4) pp 050-059.

7. Daniel N. Obiora1, Johnson C. Ibuot, Nyakno J. George and Solomon U. Offiah. Delineation of groundwater saturation indicators and their distributions in the complex argillaceous geological units of Ezza north local government area of Ebonyi state, Nigeria. Current Science, Vol. 110, No. 4, 25 February 2016. Pp 701 – 708

8. Nnaji, C. E., Nnaji , M., Chimah, J.N., Maduekwe, M.C.(2016) "The Energy Intensity of Economic Sectors in MINT Countries: Implications for Sustainable Development. IRA- International Journal of Management & Social Sciences (ISSN 2455-2267),4(1).doi:http://dx.doi.org/10.21013/jmss.v4.n1.p20

Published Research Papers, Reports and Findings in Journals in 2015

1. A.S Kurawa and K.E Agbo, (2015). Jatropha biodiesel production optimization using a co-solvent approach. Journal of Renewable and Alternative Energy Technology Vol 1, pp. 89-97.

2. **I. F. Okafor**, and C. N. Anyanwu (2015) Production of Smokeless Briquette Fuel from Sub-bituminous Coal for Domestic and Industrial Uses. Science Journal of Energy Engineering, 3 (4), pp.33-39

3. Ofomatah A.C. Ezema C.G. and David U.G. (2015). The effect of soaking time on biogas yield of ash-treated and untreated bagasse. Journal of renewable and alternative energy technologies, vol. 1, 130-139.

4. .C.G. Ezema, S.U. Offiah, B.E. Ezema, A.C. Nwanya, P.O. Ukoha, B.E. Ezema, M. Maaaza and F.I. Ezema (2015). Electrochemical studies of PVP-capped PbS thin film deposited by polymer-assisted chemical bath deposition (PACBD). Chalcogenide Letters. 12, 11-23. (Thomson Reuter IF 1.71)

5. Ofomatah, A. C., Ezema, C. G. and Idoko, C. (2015). Production and analyses of biodiesel from Gmelina seed oil (Gmelina Arborea Rox B). Nigerian Journal of Solar Energy, Vol. 26, 135-139.

6. Benjamin E. Ezema, Chidimma G. Ezema, Jude I. Ayogu, David I. Ugwu and Efeturi A. Onoabedje (2015). Synthesis of tetraaza derivatives of benzoxazinophenothiazine. Oriental Journal of Chemistry. 31, 133-139. (SJR 0.192, SNIP 0.412)

7.Jude I. Ayogu, Benjamin E. Ezema and Chidimma G. Ezema (2015). Utility of Suziki-Miyaura cross-coupling reaction in synthesis of Benzo[a]phenothiazine and Benzo[a]phenoxazine derivatives and their antimicrobial screening. Asian Journal of Chemistry. 27(12), 4467-4473. (Thomson Reuter IF 0.355)

8.C.O. Ike, B.E. Ezema, J.I. Ayogu, D.I. Ugwu, C.G. Ezema, A.P. Nwasi, E.O. Adekola (2015), Synthesis and Asian Journal of Chemistry, vol. 27, no. 11, 4115-4119. (Thomson Reuter IF 0.355)

9.Ugwu David I; Ezema Benjamin E; Eze Florence U; Onoabedje Efeturi A; Ezema Chidimma G; Ekoh Ogechi C; and Ayogu Jude I. (2014-2015). Synthesis and antimicrobial activities of Chalcone derivatives. International J. ChemTech Research. 7(4), 1966-1984. (SJR 0.27, SNIP 0.598)

10. B. E. Ezema, L.E.S. Akpanisi, C.G. Ezema and A.E. Onoabedje (2015). A new method of Dimroth rearrangement in fused triazolo[1,5-d]-1,2,4-triazine. J. Heterocyclic Chem., 52, 1411-1414. (Thomson Reuters IF 0.79)

11. Benjamin E. Ezema, Chidimma G. Ezema, Jude I. Ayogu, David I. Ugwu and Efeturi A. Onoabedje (2015). Synthesis of aza derivatives of isomers of angular and complex phenothiazine rings. Oriental J. of Chem. 31(1), 379-385. (SJR 0.192, SNIP 0.412)

12.Ofomatah A.C, Ezema C.G and David U.G (2015). The effect of soaking time on biogas yield of ash-treated and untreated bagasse. J. Ren and Alt. Energy Tech. Vol 1. Pp 130-139.

13.Uzodimma E.O, Ezenwa M.C and Ofomatah A.C (2015). Evaluation of combustion potentials of biogas produced from blends of pig dung and cabbage leaves waste. J. Ren and Alt. Energy Tech. Vol 1. Pp 80-88.

14.L.C Ugwuowo, A.G Ezekwe, A.O Ani , S.I Eze, C.N Anyanwu and A. Ofomatah (2015). The efficacy of palm oil sludge in reducing ruminal methanogenesis using rumen simulation technique. Afr J.Biotechnol. Vol. 14 (42) pp 2937-2942.

15.Ofomatah A.C, Ezema C.G and Idoko C (2015). Production and Analyses of Biodiesel from Gmelina Seed Oil (Gmelina arborea rox b). Nig. Journal of Solar Energy. Vol. 26. Pp 135-139.

16. Ezema, C.G. Offiah, S.U., Ezema, B.E., Ukoha, P.O. and Ezema, F.I. Growth and Characterization of Chemical Bath Deposited PVA/PbS Thin Films Nigerian Journal of Solar Energy, Vol. 26, 2015.

17. C.G. Ezema, S.U Offiah, A C Nwanya, P O Ukoha, B E Ezema, M Maaza, F I Ezema, thin films deposited by polymer assisted chemical bath deposition, Chalcogenide Letters, Vol. 12, No. 1, January 2015 p.11-23

18. A. C. Nwanya, S. U. Offiah, I. C. Amaechi, S. N. Agbo, S. C. Ezugwu, B. T. Sone, R. U. Osuji, M. Maaza, F. I. Ezema. (2015)Electrochromic and electrochemical supercapacitive properties of Room Temperature PVP capped Ni(OH)2/NiO Thin Films Electrochimica Acta Volume 171, 20 July 2015, Pages 128-141

19. F.C. Odo, S.U. Offiah and G U Akubue.Wind resource assessment of Enugu and Owerri for power Development. Nigerian Journal of Solar Energy, Vol. 26, 2015. Pp 1 – 6

20. A.N.C. Agbogu, S.U. Offiah, S.C. Ezugwu, A.B.C. Ekwealor, P.U. Asogwa, F.I. Ezema. Influence of precursor concentration on optical properties of MnxOy thin films Journal of Ovonic Research Vol. 11, No. 2, March - April 2015, p. 91 - 97

21 Akubue, G.U., Odinaka, B.N and Ugwoke, S.C (2015). Effect of Drying Tray Arrangement on the Performance of a Mixed Mode Solar Dryer. Nigerian Journal of Solar Energy, Vol 27, pp. 117-122.

22.F.C. Odo., S.U.Offiah and G.U. Akubue (2015) Wind Resource Assessment of Enugu and Owerri for Wind Power Development. Nigerian Journal of Solar Energy, Vol 27, pp

23. K.E. Agbo, J.I. Eze and G.U. Akubue (2015). A comparative study of the efficiencies of biofuel gel and Kerosene stove, Journal of Renewable and Alternative Energy Technologies, vol 2, pp. 40 – 49.

24.Akubue, G.U., Odinaka, B.N and Ugwoke, S.C (2015). Effect of Drying Tray Arrangement on the Performance of a Mixed Mode Solar Dryer. Nigerian Journal of Solar Energy, Vol 27, pp. 117-122.

25.Nnadozie B. Odinaka and Gerald U. Akubue (2018) Computational Fluid Dynamics Performance Analysis on Mixed Mode Solar Dryers. International Journal of Scientific & Engineering Research Volume 9, Issue 6, pp. 133 – 144.

26.himah, J. N., Ugwuoke, N. J. & Ogwo, U. (2015). Implementing Institutional Repository in Nigerian Universities: Status, Challenges, Prospects, and Role of Librarians and Libraries. International Journal of Applied Technologies in Library and Information Management, 1(1)30-42

Published Research Papers, Reports and Findings in Journals in 2014

1. I. F. Okafor, J. Dirker and J. P. Meyer (2014), Influence of Circumferential Solar Heat Flux Distribution on the Heat Transfer Coefficients of Linear Fresnel Collector Absorber Tubes, Solar Energy 107, pp. 381-397 **(TR: 7.188).**

2. I. F. Okafor, G.O. Unachukwu and O. A. Odukwe (2014), Measuring energy efficiency of the public passenger road transport vehicles in Nigeria. Transport Policy 35, pp. 319–325. (TR: 6.173).

3. E.O. Uzodinma, **I. F. Okafor**, and C.N. Anyanwu, (2014), Biogas Production from Jatropha Curcas Leaf and its Blends with other Wastes under Changing Meteorological Parameters, Nigerian Journal of Solar Energy, Vol. 25, pp. 73-79.

4. Chidimma G. Ezema, Solomom U. Offiah, Pius O. Ukoha, Benjamin E. Ezema and Fabian I. Ezema (2014). Tomato-Like Shaped PVP - Capped PbS Thin Film Chemically Deposited by CBD. Proceedings

of the 1st African International Conference/Workshop on Applications of Page 76 Nanotechnology to Energy, Health and Environment, UNN, March 23 – 29, 2014 pp76-81.

5. Okoroigwe, E.C., Ibeto, C.N. and Ezema, C.G. (2014). Experimental study of anaerobic digestion of dog waste. Scientific research and essays. 9(6), 121-127. (SNIP 0.74)

6. Emmanuel O. Adekola, Benjamin E. Ezema, Jude I. Ayogu, David I Ugwu, Chidimma G. Ezema, Abuekwu P. Nwasi, and Christian O. Ike (2014). Synthesis of benzothiazinophenothiazine derivatives and their antimicrobial screening. Oriental J. of Chem. 30(4), 1-8. (SJR 0.278, SNIP 0.584)

7.David I. Ugwu, Benjamin E. Ezema, Florence U. Eze, Jude I. Ayogu, Chidimma G. Ezema, Daniel I. Ugwuja (2014). Synthesis and biological applications of hydroxamates. American J. of Org. Chem. 4(2), 26-51.

8.Benjamin E. Ezema, Chidimma G. Ezema, David I. Ugwu, Jude I. Ayogu (2014). Synthesis of heterocyclic azo dyes from quinolin-8-ol. Chem. And Mat. Res. 6(9), 1-6.

9. K.E. Ugwu and P.O. Ukoha, (2014), Polycyclic aromatic hydrocarbons in Nigerian coal extracts, Journal of Chemical Society of Nigeria, 39 (2): 1-5.

10.K.E. Ugwu and S.I. Eze (2014), Physicochemical and Rheological characteristics of charcoal slurry fuel, International Journal of Energy and Environment, 5:119-126.

11. S. U. Offiah, A C Nwanya, S C Ezugwu, B T Sone, R U Osuji, M Malik, C D Lockhande and F I Ezema, Chemical bath synthesis and physic-chemical characterizations of NiO-CoO composite thin films for supercapacitor applications.(2014) International Journal of Electrochemical Science 9 (2014) 5837-5848

12. A. B. C. Ekwealor, S. U. Offiah, S. C. Ezugwu, and F. I. Ezema, Variations of optical and structural properties of CoxOy thin films with thermal treatment, (2014). Indian Journal of Materials Science Volume 2014, Article ID 367950, 5 pages http://dx.doi.org/10.1155/2014/367950

13. S U Offiah, M O Nwodo, A C Nwanya, S C Ezugwu, S N Agbo, P E Ugwuoke, R U Osuji, M Malik, and F I Ezema,Effects of post-thermal treatments on morphological and optical properties of NiO/N(OH)2 thin films synthesized by solution growth. Optic 125 (2014) 2905-2908

14. 1.P.U.Akpan and G.U.Akubue (2014). Nigeria's Renewable Energy: A case of Hydropower. Nigeria Institute of Industrial Engineers, Conference proceedings, pp. 93-109.

15. G.U.Akubue; S.O.Enibe; H.O.Njoku and G.O.Unachukwu (2014). Exergy Analysis of a Steam Boiler Plant in a Brewery in Nigeria. International Journal of Scientific and Engineering Research, Volume 5, Issue 5, May-2014, pp. 868-874.

16. Nnaji, C. E, Nnaji, M. and Unachukwu .G. O.(2014) "Demographic Variables, Energy Intensity, Environmental Degradation and Economic Growth Nexus in the Nigerian Economy" Journal of

Environmental Science, Computer Science and Engineering & Technology. ; Sec. A Vol.3.No.4, 1742-1751.

17. Ogbonna, A. U., Igwesi, U. and Enweani, U. V. (2014). Management of Hybrid Libraries for Effective Services in Nigeria: New Trends in Accessing Information. Global Journal of Academic Librarianship. 1(1): 1-7. Available at: http://www.ripublication.com

18. Nwachukwu, V. N., Idu, G. O. and Ogwo, U. (2014). Perception of Teachers in the Use of Library Resources in the Promotion of Peace Education in Secondary Schools in Nsukka Education Zone. International Journal of Development Research. 4(4):875-879. Available at: http://www.journalijdr.com

19. Eskay, M., Chimah, J. N. and Ogwo, U. (2014). Integrating Information and Communication Technology in Instructing Learners with Learning Difficulties: The Special Educator's and Librarian's Perspective. Paripex Indian Journal of Research. 3 (4): 78-80. Available at: http://theglobaljournal.com

20.Eskay, M., Ogwo, U. and Chimah, J. N. (2014). The Use of Information Communication Technologies in Meeting the Information Needs of Exceptional Students in Nigerian Libraries International Journal of Scientific Research..123-126. Available at: http://theglobaljournal.com

21. Ozioko, R. E., Nwabueze, A. U., & Igwesi, U. (2014). Mentoring as a Strategy for Team Building and Management in University Libraries in South-East Nigeria. Nigerian Libraries, Journal of the Nigerian Library Association. 47(1):1-15

22. Nwachukwu, V. N., Asiegbu, F.N. & Ogwo, U. (2014). Academic Libraries and ICT Development in Nigeria's Tertiary Educational System. International Journal of Advanced Research, 2(5):117-124. Available at: http://www.journalijar.com

23. Nwachukwu, V. N., Asiegbu, F. N. & Ogwo, U. (2014). A Study of Information and Communication Technology (ICT) and Skills of State University Libraries, Polytechnics/Monotechnics and Colleges of Education (other Tertiary Institutions in Benue State. International Journal of Advanced Research, 2(5): 107-110. Available at: http://www.journalijar.com

25. Nwachukwu, V. N., Asiegbu, F. N. & Ogwo, U. (2014). Utilization of Library Oriented Software Packages in North Central Zone of Nigeria. International Journal of Advanced Research (2014), 2(5), 111-116. https://www.journalijar.com/article/1605/utilization-of-library-oriented-software-packages-among-university-libraries-in-north-central-zone-of-nigeria/

26. Ozioko R.E; Ogwo, U. and Chigbu B.C. (2014). Meeting the Maternal Health Information Needs of Rural Women in Nsukka Local Government Area of Enugu State, Nigeria. The Information Technologists. 11 (2), pg. 37-48 3.https://www.ajol.info/index.php/ict/article/view/114612

27. Ozioko R. E & Ogwo, U. (2014). Delinquent Readership Problems in Libraries in Colleges of Education in Enugu and Ebonyi States. Indian Journal of Applied Research.

https://www.worldwidejournals.com/indian-journal-of-applied-research-(IJAR)/fileview/April_2014_1396368462_0f81f_81.pdf

Published Research Papers, Reports and Findings in Journals in 2013

1. Agbo K. E., Eze J.I and Ukwueze C.L (2013), Literature survey of possible hydrogen fuel storage materials, Nigerian Journal of Solar Energy, vol 24: 111- 120.

2. **I. F. Okafor** and G.O. Unachukwu. Performance Evaluation of Nozzle Type Improved Wood Cook Stove International Journal of Scientific & Engineering Research, Volume 4, Issue 5, May-2013, 1195 ISSN 2229-551

3. B. E. Ezema, C.G. Ezema, E. A. Onoabedje, and D.I. Ugwu (2013). Synthesis of a new and first triazadibenzo[a,n]triphenodithiazine. Chemical and Process Engineering Research. 8, 35-41.

4. E. A. Onoabedje, B. E. Ezema, C.G. Ezema and D.I. Ugwu (2013). Synthesis of some derivatives of benzophenothiazinone of pharmaceutical interests via nickel catalysed Grignard couplings. Chemical and Process Engineering Research. 8, 6-11.

5. Kenechukwu Emmanuel Ugwu, Anthony Chibuzo Ofomatah and Samson Ifeanyi Eze (2013), Influence of solid concentration on the flow characteristics and settling rate of coal-water slurries, Journal of Energy and Natural Resources, 2(3): 21-24.

6. K.E.Ugwu, A.C. Ofomatah and S.I. Eze (2013), Evaluation of liquid charcoal as an alternative to diesel oil, Nigerian Journal of Solar Energy (NJSE), 24: 132-134.

7.Ugwu K. E. and Ofomatah A. C. (2013), Evaluation of properties of coal slurry from different solvents, International Journal of Physical Sciences, 8(20):1118-1120.

8.Kenechukwu Ugwu and Kevin Agbo (2013), Evaluation of binders in the production of briquettes from empty fruit bunches of Elais guinensis, International Journal of Renewable and Sustainable Energy, 2(4): 176-179

9.Ugwu K.E, Ofomatah A.C and Eze S.I(2013) Evaluation of Liquid Charcoal as an Alternative to Diesel Oil. Nig. Journal of Solar Energy. Vol. 24. Pp 132-134.

10.Ibeto C.N, Ofoefule A.U, Ofomatah A.C and Ugwoke P.E(2013) Bioethanol Production from Acid Pre-Treated Banana (Musa aluminata) Peels. Nig. Journal of Solar Energy. Vol. 24.

11.Oparaku N.F, Ofomatah A.C and Okoroigwe E.C(2013) Biodigestion of cassava peels blended with pig dung for methane generation. Afr. J. Biotechnol. Vol. 12 (40) pp 5956-5961.

12.Oparaku N.F and Ofomatah A.C (2013) Biodegradation of agricultural waste and pig dung in anaerobic digester. Int.J. Phy. Sc. Vol. 1(4) pp 062-068.

13.Kenechukwu Emmanuel Ugwu, Anthony Chibuzo Ofomatah and Samson Ifeanyi Eze (2013) Influence of solid concentration on the flow characteristics and settling rate of coal-water slurries. JENR 2(3) 21-24.

14.Ugwu K.E and Ofomatah A.C (2013) Evaluation of properties of coal slurry from different solvents. Int.J. Phy. Sc. Vol. 8(20) pp 1118-1120.

15.Okoroigwe E.C, Ofomatah A.C, Oparaku N.F and Unachukwu G.O (2013). Production and evaluation of activated carbon from palm kernel shells(PKS) for economic and environmental sustainability. Int.J. Phy. Sc. Vol.8 (19) pp 1036-1041.

16. Ofomatah A.C and Okoye C.O.B (2013) The effects of cow dung inoculum and palm head ash-solution treatment on biogas yield of bagasse. Int.J. Phy. Sc. Vol.8(5)pp 193-198.

17. Offiah S U, Obiora D N, Chukudebelu J U and Ezema P O Resistivity survey for groundwater in Ezza LGA using vertical electrical sounding. (2013). Science Journal of Environmental Engineering Research. Volume 2013 (2013). www.sjpub.org. ISSN: 2276-7495

18. Unachukwu G O, Offiah S U and Odo F C Real time performance evaluation of some solar photovoltaic street light systems installed at NCERD, University of Nigeria Nsukka. Nigeria Journal of Solar Energy, Vol 24, 2013, pp 23-26

19. G U Akubue, F C Odoh, S U Offiah and G O Unachukwu Assessing models for estimating global horizontal solar radiation in Owerri.Nigeria Journal of Solar Energy Vol 24, 2013, pp 23-26

20. F. C. Odoh, G. U. Akubue, S. Offiah, P. E Ugwuoke,Empirical Models for predicting wind wind potential for wind energy applications of Nigeria, International Journal of Energy and Environments, Volume 4, Issue 6, 2013 pp.1053-1060 ISSN 2076-2909,

21.F.C.Odo; G.U.Akubue; S.U.Offiah and P.E. Ugwuoke (2013). Emperical models for Predicting Wind Potential for Energy Applications in Rural locations of Nigeria. International Journal of Energy and Environment, Volume 4, Issue 6, pp.1053-1060.

22. Nnaji, M.,Uzoma, C.C., Nnaji, C.E. and Unachukwu, G.O (2013) "Energy Savings Potential in the Domestic Economy". Nigerian Journal of Solar Energy, 24: 126-131.

23. Oparaku N. F. and Nnaji C. E. (2013). " Feasibility and Technical Studies of Two Water Recirculating Systems Using Two Different Power Sources, Solar Photovoltaic and Fuel Generator. International Journal of Physical sciences. 8(43): 2000-2010

24. C. E. Nnaji, J. O. Chukwu and C. C. Uzoma (2013) "An Econometric Study of CO_2 Emissions, Energy Consumption, Foreign Trade and Economic Growth in Nigeria" Conference proceedings of the 5th Annual NAEE/IAEE International Conference organized by Nigerian Association for Energy Economics, held at Abuja, Nigeria, 23-24th April 2012.Pp.489-508.

25. Chibueze, E. Nnaji, Jude, O. Chukwu and Nnaji Moses (2013) " Electricity Supply, Fossil Fuel Consumption, CO2 Emissions and Economic Growth: Implications and Policy Options for Sustainable Development in Nigeria". International Journal of Energy Economics and Policy 3(3): 262-271

26. Chibueze, E. Nnaji, Jude, O. Chukwu and Nnaji Moses (2013) " Does Domestic Energy Consumption Contribute to Exports? Empirical Evidence from Nigeria". International Journal of Energy Economics and Policy 3(3): 297-306.

27.Nwabueze, A. U., Ozioko, R. E. and Igwesi, U. (2013). Assessment of User Education Programmes in the University Libraries in South-East Nigeria. Nigerian Libraries, Journal of the Nigerian Library Association. 46(1):37-45.

28.Ozioko, R. E. and Ogwo, U. (2013). Igwesi, U., Nwachukwu, V. N. & Chigbu, B. C. (2012). The Use of ICT in Human Capacity Building and Knowledge Management in the 21stCentury.ABUJA INFOLIB, Journal of Library and Information Science, 6(1&2).

29.Ozioko, R. E. and Ogwo, U. (2013). Strategies for Enhancing the Acquisition of Entrepreneurship Competencies among Post-graduate Students of Library and Information Science in Selected Universities in Nigeria. Review of Education, Institute of Education Journal, University of Nigeria, Nsukka. 24(1): 218-235.

Published Research Papers, Reports and Findings in Journals in 2012

1. I. F. Okafor, G.O. Unachukwu (2012), Performance Evaluation of Nozzle Type Improved Wood Cook Stove, American-Eurasian Journal of Sustainable Agriculture, 6 (3) pp. 195-203, ISSN 1995-0748 (SJR: 0.446).

2. T.U. Onuegbu, N.O. Ilochi, I.M. Ogbu, O. F Obumselu. and I. Okafor, (2012), Preparation of Environmental Friendly Bio-coal Briquette from Groundnut Shell and Maize Cob Biomass Waste: Comparative Effects of Ignition Time and Water Boiling Studies, Current Research in Chemistry 4 (4), pp. 110-118.

3. I. F. Okafor and G. Akubue (2012), F-Chart Method for Designing Solar Thermal Systems. International Journal of Scientific & Engineering Research Volume 3(9), ISSN 2229-5518.

4. I. F. Okafor and P. N. Nwosu (2012), Testing and Performance Evaluation of a locally Fabricated Thermosyphon Solar Water Heater, Journal of Engineering Research, University of Lagos, Vol. 17 (3), pp.82-90.

5.B. E. Ezema, L.E.S. Akpanisi, C.G. Ezema and A.E. Onoabedje (2012). Diazoalkylideneamine- 1,2,3-triazole ring-chain tautomerism in 1,2-triazolo[1,5-c] pyrimidines. Chemical and Materials Research 2(5) 12-17.

6. C.G. Ezema, A.C. Ofomatah, and B.E. Ezema. (2012). Production and Characterization of Biodiesel Fuel of Cocos Nucifera (Coconut) Oil and its Blend from Nsukka, Nigeria. International Jour. Chem. 22(2) 77-81.

7. B. E. Ezema, C. O. Okafor, C.G. Ezema and A.E. Onoabedje (2012). Synthesis of New Diaza Angular and Tetraaza Complex Phenothiazine Rings. Chemical and Process Engineering Research. 3, 40-47.

8. Ugwu, K.E., Ofomatah, A.C. and Okoye, C.O.B. (2012), Bagasse and Poultry droppings as feedstock for biogas production, *International Journal of Pure & Applied Chemistry*, 7(4): 305-310.

9.Ugwu K.E, Ofomatah A.C and Okoye C.O.B(2012) Bagasse and poultry droppings as feedstock for biogas production. Int. JPAC. Vol. 7(4) pp 305-310.

10.Ofomatah Anthony Chibuzo, Ibeto Cynthia Nkolika, Okoye Chukwuma Obiajulu Benedict and Unachukwu Godwin Ogechi (2012) Production and storage of biogas from ash-treated and untreated bagasse. Int.JCR. Vol. 4(7) pp 071-074.

11.C.G Ezema, A.C Ofomatah and B.E Ezema (2012) Production and Characterization of biodiesel fuel of cocos nucifera (coconut) oil and its blend from Nsukka, Nigeria. Int. J. Chem. 22(2)77-81.

12. S U Offiah, P E Ugwoke, A B C Ekwealor, S C Ezugwu, R U Osuji and F I Ezema (2012Structural and spectral analysis of chemical bath deposited copper sulfide thin films for solar energy conversions, Digest Journal of Nanomaterials and Biostructures Vol. 7, No. 1, January – March 2012, p. 165 – 173

13. F. C. Odo, S. U. Offiah and P. E. Ugwuoke.Weibull distribution-based model for prediction of wind potential in Enugu, Nigeria.Advances in Applied Science Research, 2012, 3 (2):1202-1208

14. S. U. Offiah, P. E. Ugwoke, F. I. Ezema, B. C. Ekwealor R. U. Osuji. Comparative study of CuxS and CuySe thin films grown by CBD. Chalcogenide Letters Vol. 9, No. 5, May 2012, p. 57 – 264

15. G.U.Akubue; F.C.Odo; S.U.Offiah and G.O.Unachukwu (2012). Assessing models for evaluating global horizontal solar radiation in Owerri. Nigeria Journal of Solar Energy, Vol. 24, pp.23-26.

16. F.C. Odoh and G.U.Akubue (2012). Comparative Assessment of Three Models for Estimating Weibull Parameters for Wind Energy Applications in Nigerian Location. International Journal of Energy Sciences. Vol. 2. No.1

17. G.U. Akubue; C.N. Anyanwu & F.C.Odo (2012). Renewable Energy for Environmental Sustainability in Nigeria. Nigeria Journal of Solar Energy, Vol 23, Pages 132 – 139.

18. Akubue, G.U, Njoku, H.O., and Unachukwu, G.O. (2011). Exergetic Performance Evaluation of an Improved Single Slope Solar Still. Nigeria Journal of Solar Energy, Vol 22, Pages 26 – 31. Distribution functions. Nigeria Journal of Solar Energy, Vol 22, Pages 85 – 89.

19. O.V. Ekechukwu; G. U. Akubue & H. O. Njoku (2011) Measured Performances of an Augmented [Double-Exposure Absorber-Plate] Single-Slope Solar Still. In 30th Biennial Solar World Congress 2011, Kassel, Germany 28 August – 2 September. Volume 1 of 6, Vol 2, Pages 867 – 878.

20. Uzoma, C.C., Nnaji, C.E. and Nnaji, M. (2012) "The Role of Energy Mix in Sustainable Development of Nigeria. Continental J. Social Sciences 5 (1): 21 – 29.

21. Nnaji C.E, Uzoma, C. C. and Chukwu, J.O (2012) "Analysis of Factors Determining Firewood Use for Cooking by Rural Households in Nsukka Area of Enugu State, Nigeria." Continental Journal of Environmental Sciences 6 (2): 1 – 6.

22. Nnaji C, E, Ukwueze E. R. and Chukwu J.O (2012)"Determinants of Household Energy Choices for Cooking in Rural Areas: Evidence from Enugu State, Nigeria" Continental Journal of Social Sciences 5 (2): 1 – 11.

23. Igwesi, U., Chimah, J. N. and Nwachukwu, V. N. (2012). The Use of ICTs and Audio-Visual resources in developing children's reading habits in Nigeria. Library Philosophy and Practice. Available at: http://digitalcommons.unl.edu/libphilprac/825

24. Ezeani, C. N. & Igwesi, U. (2012). Using Social Media for Dynamic Library Service Delivery: The Nigerian Experience. Library Philosophy and Practice. Available at: http://digitalcommons.unl.edu/libphilprac/814

Published Research Papers, Reports and Findings in Journals in 2011

1. Ibeto C.N, Ofuefule, Agbo K.E; A Global Overview of Biomass Potentials for Bioethanol Production: A Renewable Alternative fuel. Trends in Applied Sciences Research. 6 (5): 410-425, 2011.

2. Eze J. I and Agbo K.E; Studies on the Microbial Spectrum in Anaerobic Bio-methanization of Cow Dung in 10m3 Fixed Dome Biogas Digester. International Journal of Physical Sciences 2011 5 (9), 1331-1337.

3. Eze J. I and Agbo K.E; Comparative Studies of Sun and Solar Drying of Peeled and Unpeeled Ginger. American Journal of Industrial Research 2011,2(2): 136-143.

4. Ugwu K.E and Agbo K.E; Briquetting of Palm kernel shell. Journal of Applied Sciences and Environmental Management 2011 15 (3), 447-450.

5. Agbo K.E and Eze J. I, Anaerobic Digestion of Municipal Solid Waste for Energy Generation: Prospects and Challenges in Nigeria. Nigerian Journal of solar Energy, Vol 22, 2011 pg. 130-137.

6. Okoye C.O.B, Agbo K.E (2011). Dispersion pattern of trace metals in soils surrounding solid waste dumps in Nsukka. Journal of Chemical Society of Nigeria, 36 (2), 112-119.

7. C. C. Uzoma**, I.F. Okafor** and C. G. Okpara (2011), Fuel Briquettes Technology Can Save Nigeria's Trees, Continental Journal of Environmental Sciences 5 (1), pp. 20 – 28.

8. C.G. Okpara, N.F. Oparaku and C.N. Ibeto (2011). An Overview of Water Disinfection in Developing Countries and Potentials of Renewable Energy. J Envir. Sci. & Tech. 4 (1): 18-30.

9. Nwoke O. Okala, Uzoma C. Chigasa, Ibeto Cynthia, Okpara Chidimma, Nnaji Chibueze, Obi I. Onuoragbunam, Oparaku U. Ogbonna. (2011). Analysis and survey on the application of solar dryer in eastern Nigeria. Int J Agric & Biol Eng. 4(3): 1-4.

10.Uzoma C.C., Nnaji C.E., Ibeto C.N., Okpara C.G., Nwoke O.O., and Obi I.O. (2011). Renewable Energy Penetration in Nigeria: A Study of South-East Zone. Continental J. Envir. Sci. 5 (1): 1-5.

11.C.N. Ibeto, C.N. Anyanwu, C.G. Okpara, I.S. Eze and G.O. Unachukwu. (2011). Distribution of Heavy Metals in some Sub-bituminous Coals from Nigeria. J. Chem. Soc. Nigeria, 36 (2): 95-101.

12.E.O. Omanayi, C.G. Okpara and G.I.C. Nwokedi. (2011). Heavy Metals in Bioindicators of the River Niger about the Vicinity of the Ajaokuta Iron and Steel Industry in Kogi State of Nigeria. Res. J. of Environmental Sci. 5 (2):142-149.

13.K.E. Ugwu and A.C. Ofomatah (2011), Measurements of some ambient primary pollutants in Nsukka, Enugu State, Nigeria, Journal of Chemical Society of Nigeria, 36 (2): 76-81.

14.C.O.B. Okoye and K.E. Ugwu, (2011), Concentrations of some metals in some Nigerian coals, Journal of Chemical Society of Nigeria, 36 (2): 11-14.

15.Ugwu, K.E. and Agbo, K.E. (2011), Briquetting of palm kernel shell, Journal of Applied Sciences and Environmental Management. 5(3): 447-450.

16.K.E Ugwu and A.C Ofomatah (2011) Measurement of some ambient primary pollutants in Nsukka, Enugu State, Nigeria. J. Chem Soc. Nigeria. 36(2) pp 76-81.

17.A.C Ofomatah, C.O.B Okoye and G.O Unachukwu (2011) Effect of ash on the optimization of biogas production from blends of bagasse and cow dung. J. Chem Soc. Nigeria, 36(2) pp 139-143.

18.S U Offiah, S C Ezugwu, Ezema F I and Oparaku O U. Spectral analysis of chemical bath deposited copper selenide thin films. Nigeria Journal of Solar Energy, Vol 22, 2011, Pp 97-104.

19. F. C. Odo, S. U. Offiah and G. U. Akubue. Prediction of wind potential in Nsukka using Weibull Distribution Function. Nigeria Journal of Solar Energy, Vol. 22, 20 II pg.85-89

20. S. U. Offiah, S. C. Ezugwu, F. I. Ezema, O. U Oparaku, P. U. Asogwa (2010).Effects of deposition media and thermal annealing on chemical bath deposited zinc oxide thin films. Journal of Ovonic Research, Vol. 6, No. 3, Pp 135-141.

21.Akubue, G.U, Njoku, H.O., and Unachukwu, G.O. (2011). Exergetic Performance Evaluation of an Improved Single Slope Solar Still. Nigeria Journal of Solar Energy, Vol 22, Pages 26 – 31.

22.F.C. Odo; S.U.Offiah and G.U.Akubue (2011). Prediction of Wind Potential in Nsukka using Weibull Distribution functions. Nigeria Journal of Solar Energy, Vol 22, Pages 85 – 89.

23. O. V. Ekechukwu; G. U. Akubue & H. O. Njoku (2011) Measured Performances of an Augmented [Double-Exposure Absorber-Plate] Single-Slope Solar Still. In 30th Biennial 24.Solar World Congress 2011, Kassel, Germany 28 August – 2 September. Volume 1 of 6, Vol 2, Pages 867 – 878.

25. Uzoma, C. C. ; Nnaji, C. E; Ibeto, C.N.; Okpara, C.G.; Obi, I.O.; Unachukwu, G. O and Oparaku, O. U. (2011) "Renewable Energy Penetration in Nigeria: A Study of the South-East Zone" Continental J. Environmental Sciences 5 (1): 1 – 5

26. Nwoke, O.O.; Uzoma, C. C. ; Ibeto, C.N.; Okpara, C.G.; Nnaji, C. E; Obi, I.O.; and Oparaku, O. U. (2011). "Analysis and survey on the application of solar dryer in Eastern Nigeria". International Journal of Agricultural & Biological Engineering. Vol. 4 No.3

27. Nnaji C.E, Chukwu J.O and Ukwueze E.R. (2011) "Fiscal Policy and the Management of Foreign Reserves in the Nigerian Economy". Conference proceedings of 51st Nigerian Economic Society Conference on Distortions in the Nigerian Economy: Implications for Sustainable Development held at Abuja, 25th-27th October 2010. Pp.63-76

28. Nnaji C.E, Unachukwu, G.O and Uzoma, C.C (2011) "Electricity Generation, Economic Growth and the Need for Alternative Source of Power in Nigeria." Nigerian Journal of Solar Energy.Vol.22,2011.pp.177- 182

29. Uzoma, C. C. and Nnaji, C.E. (2011) "Fragile States; Addressing Vulnerability through renewable Energy Technologies" Nigerian Journal of Solar Energy.Vol.22, 2011.pp.183- 188.

30. Igwesi, U., Ozioko, R. E., & Eke, H. N. (2011). Generation and Dissemination of Local Content Using ICT for Sustainable Development.PNLA Quarterly, the Online Publication of the Pacific Northwest Library Association, Electronic Journal. Available at: http://unllib.unl.edu/LPP/PNA

31. Eke, H. N., Igwesi, U., and Orji, D. I. (2011). Information Professionals as Agents for Promoting Entrepreneurship and Technology Education in Actualizing Vision 2020 for Nigeria. Library Philosophy and Practice, Electronic Journal. Available at: http://digitalcommons.unl.edu/libphilprac/

Published Research Papers, Reports and Findings in Journals in 2010

1. Eze J.I, Agbo K E. (2010). Maximizing the potential of biogas through upgrading. Am. J. Sci. Ind. Res 1 (3), 604-609.

2. Eze J.I, Agbo K E, I R. Elijah (2010). Performance Assessment of a Solar Water Heater Process Water Purification in Food Processing Industries. Global Journal of Research in Engineering 10 (3) 14-19.

3. Onuegbu T.U., Ogbu I.M., Ilochi N.O., **Okafor I.** , Obumselu O. F. and Ekpunobi U.E (2010) Enhancing the Efficiency of coal Briquette in Rural Nigeria using pennisetum purpurem, Advances in Natural and Applied Sciences, 4(3): 299-304**. (SJR: 0.426).**

4 I. F. Okafor (2010). Designing a Simple Incinerator for Converting Solid Waste into Energy. African Journal of Engineering Research and Development, Vol. 3 (1) pp. 56-61

5.Chigasa C. Uzoma, Cynthia N. Ibeto, Chidimma G. Okpara, Okala O. Nwoke, Innocent O. Obi, Chibueze E. Nnaji, Ogbonna U. Oparaku, and Godwin O. Unachukwu. (2010). Level of Awareness and Utilization of Biogas Technology in South-Eastern Zone of Nigeria. Int. J. Appl. Agric. Res. 5 (5): 569-574.

6.B.E. Ezema and C.G. Ezema (2010). Synthesis of new angular polycyclic azaphenoxazine compounds. International Jour. Chem. 20 (3): 171-174.

7.C.N. Ibeto, N.F. Oparaku and C.G. Okpara. (2010). Comparative Study of Renewable Energy Based Water Disinfection Methods for Developing Countries. J. Envir. Sci. & Tech. 3 (4): 226-231.

8.E.C. Okoroigwe, C.N. Ibeto and C.G. Okpara. (2010). Comparative Study of the Potential of Dog Waste for Biogas Production. Trends in Appl. Sci. Res. 5(1): 71-77.

9.C.O.B. Okoye and C.G. Okpara (2010). Physico-chemical Studies and Bacteriological Assay of Groundwater Resources in Isuikwuato Local Government Area of Abia State, Nigeria. J. Chem. Soc. Nigeria, 35 (1): 182-189.

10.Agbo, K.E and Ugwu, K.E. (2010), Converting empty fruit palm bunch waste to efficient and sustainable energy resource through carbonization and briquetting in Proceedings of the 2nd International Workshop on Renewable Energy for Sustainable Development in Africa held at Abuja between 27 -30th July, 2010, p125-130.

11.G.U. Akubue; H.O. Njoku; S.U.Offiah & G.O.Unachukwu (2010). Performance Evaluation of Improved Single Slope Solar Still. Proceedings of the 2nd International Workshop on Renewable Energy for Sustainable Development in Africa, IWRESDA 2010, 27th – 29th July, 2010, Pages 167 – 172.

12.M.N. Igwebuike; G.U. Akubue & G.O. Unachukwu (2010). "Assessment of Bauchi Location For wind Electricity generation". African Journal of Engineering and Development, Volume 3, Number 2, Pages 129-133. Devon Science Company.

13.Uzoma, C.C., Ibeto, C.N., Okpara, C.G, Nwoke, O. O. and Obi, I. O, Nnaji, C. E., Unachukwu, G.O. and Oparaku, O.U (2010) "Social impacts of Renewable Energy on the South-East Zone of Nigeria. Conference proceedings of 2nd International Workshop on Renewable Energy for Sustainable Development in Africa, with ENEA Research Centre, Italy, held at Reiz Continental Hotel, Abuja, 27-29th July 2010.Pp. 225-238.

14. Uzoma, C.C., Ibeto, C.N., Okpara, C.G, Nwoke, O. O. and Obi, I. O, Nnaji, C. E., Unachukwu, G.O. and Oparaku, O.U (2010) "Level of Awareness and Utilization of Biogas Technology in South-Eastern Zone of Nigeria, International Journal of Applied Agricultural Research,Vol.5, No 5, pp.569-574.

15. Nnaji M., Nnaji C.E and Unachukwu, G.O. (2010) "Solar Water Pumping for Sustainable Agricultural Development in Nigeria". Nigerian Journal of Solar Energy, Vol. 21, pp.169-172.

16. Nnaji C. E. (2010) "Climate Change and Socio-Economic Development in Nigeria". Conference Proceedings on Climate Change and the Nigerian Environment, held at the University of Nigeria, pp. 205-215.

17. Nnaji C.E, Uzoma, C. C. and Chukwu J.O. (2010) "The Role of Renewable Energy Resources in Poverty Alleviation and Sustainable Development in Nigeria", Continental J. of Social Sciences, Vol. 3, pp. 31-37.

18. Igwesi, U. (2010). Globalization and Entrepreneurship: Challenges and Opportunities for Nigerian Libraries. International Journal of Educational Research, 10(3): 226-234.

19. Igwesi, U., Nwachukwu, V. N., and Eke, H. N. (2010). Library Extension Services for Hospitality Industries via ICT: Potentials for Culture and Tourism Development in Nigeria. A Journal of Nigerian Library Association, Cross River State, 3(1): 100-109.

20. Igwesi, U. and Ozioko, R. E. (2010). Digitalized Reference Services in a Globalized Environment. Nigerian Journal of Library, Archival and Information Science (NJLAIS), 1(11): 21-26

21. Igwesi, U., Chimah, J. N., and Nwachukwu, V. N. (2010). Copyright Management in a Digital Environment: Legal Issues and Librarian's Role. Nigerian Journal of Library, Archival and Information Science (NJLAIS), 1(11): 50-57.

22. Igwesi, U., Nwachukwu, V. N., Asiegbu, F. N. (2010). Selective Dissemination of Information (SDI) Services as a Technique for Effective Scholarly Communication in University Libraries. Proceedings of Second Professional Summit on Information Science and Technology (PSIST). Held at the NnamdiAzikiwe Library, University of Nigeria, Nsukka. Pp.242-250

23. Igwesi, U., Orji, D. I., and Eke, H. N. (2010). Blog as tools for Online Information Sharing: Librarians in the Blogosphere. Proceedings of Second Professional Summit on Information Science and Technology (PSIST). Held at the NnamdiAzikiwe Library, University of Nigeria, Nsukka. Pp.430-437.

24. Igwesi, U., Nwachukwu, V. N. and Chimah, J. N. (2010). Software Choice and Use in Libraries as a Requirement for Effective Computer Application in University Libraries in Nigeria. Benue Journal of Library Management & Information Science 1 (1):70-77.

25. Igwesi, U., Nwachukwu, V. N., and Asiegbu, F. N. (2010). ICT Training Skills for Librarians: Bedrock for Effective Application in Nigerian University Libraries.Benue Journal of Library Management & Information Science 1 (1):70-77.

26. Eze, I. O., Ogwu, M.F. & Igwesi, U. (2010). Towards Improving Literature Search in Nigerian Academic Libraries (2010). INFORMATION IMPACT: Journal of Information and Knowledge Management, 1(3): 81-87.

Published Research Papers, Reports and Findings in Conference Proceedings in 2024

1.C.G. Ezema, K.E. Agbo, I.F. Okafor, C.O. Uzoma, S.U. Offiah, B.E. Ezema, and K.E. Ugwu. Improving the NPK nutrient content of liquid digestate using dry grass. 6th International Conference/Training Workshop on Energy for Sustainable Development in Africa. National Centre for Energy Research and Development, UNN/ECN and GIZ. 25 – 27th June, 2024.

2.Agbo K E, Ezema C G, Okafor I F, Ugwoke J U, Ukeje F C, Ukweze K J, Uwakwe E. The effect of catalyst on yield, reaction time, and the fuel properties of biodiesel produced from Used frying oil: A comparative study of Zinc Oxide Nanoparticles and Sodium hydroxide. 6th International Conference/Training Workshop on Energy for Sustainable Development in Africa. National Centre for Energy Research and Development, UNN/ECN and GIZ. 25 – 27th June, 2024.

3.K.E. Ugwu, C.G. Ezema, I.F. Okafor and C.N. Ibeto. Elemental composition of bio coal briquettes and its effect on the environment. 6th International Conference/Training Workshop on Energy for Sustainable Development in Africa. National Centre for Energy Research and Development, UNN/ECN and GIZ. 25 – 27th June, 2024.

4. Agbo K E., Ezema C G., Okafor I F., Ugwoke J U , Ukeje F C . Ukweze K J., Uwakwe E C (2024). The effect of catalyst on yield, reaction time, and the fuel properties of biodiesel produced from Used frying oil: A comparative study of Zinc Oxide Nanoparticles and Sodium hydroxide, 6th International Conference and Training Workshop on Energy for Sustainable Development in Africa ICTWESDA_2024 @ NCERD, UNN: JUNE 25 – 27, 2024. Book of Abstracts P14.

5. Agbo K E., Offiah S. U., Ugwoke J U, Ukeje F C. Ukweze K J ., Uwakwe E C (2024). Production of biodiesel from Waste frying oil using Iron oxide nanoparticles. 6th International Conference and Training Workshop on Energy for Sustainable Development in Africa ICTWESDA_2024 @ NCERD, UNN: JUNE 25 – 27, 2024. Book of Abstracts P27

6. Ezema C G., Agbo K E, Okafor I F., Uzoma C.O., , Offiah S.U., , B.E. Ezema B E., and K.E. Ugwu K E. (2024). Improving the NPK nutrient content of liquid digestate using dry grass. 6th International Conference and Training Workshop on Energy for Sustainable Development in Africa ICTWESDA_2024 @ NCERD, UNN: JUNE 25 – 27, 2024. Book of Abstracts p26.

7. M. Omeje, O. O. Adewoyin, B. N. Ekwueme, S. Soheil, **I. F. Okafor**, G. C. George,T. M. Ukaegbu, N. A. O. Promise, I. T. Tenebe, O. E. Odokuma. Spatial Distribution of Gamma Dose Rates and Radioactivity Levels in Some Parts of Iju Community in Ado-Odo Ota, Ogun State. IOP Conf. Series: Earth and Environmental Science 1342 (2024) 012027. doi:10.1088/1755-1315/1342/1/012027. **(SJR: 0.199)**

8. M. Omeje, O. O. Adewoyin, B. N. Ekwueme, S. Soheil, **I. F. Okafor** , G. C. George, B. Olowoeshin, T. M. Ukaegbu Radiological Risk Exposure to the Residential Area Adjacent to Liquor Company in Ado-Odo Ota, Ogun State, Nigeria**.** IOP Conf. Series: Earth and Environmental Science 1342 (2024) 012031. doi:10.1088/1755-1315/1342/1/012031 **(SJR: 0.199)**

9. Sustainable, Clean and Emerging Energy Technologies Conference on 21-26 July, 2024. **Research Work Presented: (1)** Comparative assessment and evaluation of antimicrobial activities of biodiesel from paullinia pinnata and terminalia catappa seeds

6th International Conference/Training Workshop on Energy for Sustainable Development in Africa on 25th – 27th June, 2024. Research Work Presented: **(1)** Production and characterization of biodiesel from *hildegarde barteri* and fluted pumkin seed oil and with their blend. **(2)** Characterization and evaluation of antimicrobial activities of biodiesel from tropical almond seeds **(3)** Effect of binder on the optimization ratio of the physio-chemical properties of biomass-coal pellets **(4)** Production of oil and biodiesel from annona muricata and citrus sinensis

10 .Ojobor, R. C. & Ogwo, U. (2024). Utilization Of Cloud-Based Management Systems And Services For Enhanced Open Access In Nnamdi Azikiwe Library, University Of Nigeria, Nsukka. 1st International Hybrid Conference held at Nnamdi Azikiwe Library, University of Nigeria, Nsukka.

Published Research Papers, Reports and Findings in Conference Proceedings in 2023

1. Agbo K E (2023). An overview of the application of nanotechnology in improving air quality in developing economies. 5th Biennial African Nano International Conference, held at the University of Nigeria, Nsukka from 10th to 16th Sept 2023 (oral presentation).

2. Agbo K. E (2023). Controlled thermochemical conversion of sawdust to biochar of improved solid fuel properties at the Sustainable, Clean and Emerging Energy Technologies conference SCEETC, 2023 with the theme; clean energy systems for net – zero emission targets, held at NCERD, University of Nigeria Nsukka from 23rd to 28th July 2023 (oral presentation).

3. Agbo K.E (2023). Assessment of Carbon tetrachloride human exposure and cancer risk in Nsukka Urban. 19th Biennial Conference of the Chemical Society of Nigeria (CSN) Coalcitychem 2023 with the theme Sustainable Chemistry Green Technology in National Development at the Center for Environmental Management and Control (CEMAC), University of Nigeria, Enugu Campus on 4 th -6 th July 2023 (oral presentation).

4. I. F. Okafor, U A Bappah, J C Ugwu and C P Ugwuiyi. Production of a Biomass Briquette as a Boiler Fuel for Sustainable Steam Power Generation IOP Conf. Series: Earth and Environmental Science, 1178 (2023) 012011 (SJR: 0.199).

5. C E Nnaji, I. F. Okafor , G U Akubue, C C Uzoma, E F Onyekaozuru and C I Adagba Decomposition effects of energy and CO2 intensities in the Nigerian economy: A logarithmic mean weight divisia index (LMDI) analysis. IOP Conf. Series: Earth and Environmental Science, 1178 (2023) 012009 (SJR: 0.199).

6. C I Nwankwo, T U Onuegbu, I F Okafor and P C Igwenagu. Utilization of agricultural waste in the production of charcoal briquette blend as alternative source of energy. IOP Conf. Series: Earth and Environmental Science 1178 (2023) 012015 (SJR: 0.199)

7. Omeje M., C. Chijuo, I. F. Okafor, O. O. Adewoyin, E. S. Joel, B. N. Ekwueme, M. C. Nwankwo, O. O. Bello. Measurements of Terrestrial Gamma Dose Rate Distributions along Idiroko Road, Ota, Ogun State, Nigeria: Health Implications on Roadside Dwellers. IOP Conf. Series: Earth and Environmental Science 1178 (2023) 012031 (SJR: 0.199)

8.A C Ofomatah, G I Okoro, V A Ezekoye, A Agbaogu and D Ezekoye (2023). The effects of catalyst and co-digestion on the performance of biogas yield. IOP Conf. Ser: Earth Environ. Sci. 1178 (2023) 012014 doi:10.1088/1755-1315/1178/1/012014 Pp 1-11. Impact factor: 0.41

9. Sunday C Agbo, Olufemi A Odewole, Francis K Ojo, Ogechi L Alum, Kovo G Akpomie, Anthony C Ofomatah, Helen O Chukwuemeka-Okorie, Julius U Ani and Caius C Onu (2023) Development of refractories for the pyro-processing (heatbased) industry in Nigeria through the evaluation of mixtures of Enugu Iva-Pottery clay, Nsu-clay and palm kernel shell waste. IOP Conf. Ser: Earth Environ. Sci. 1178 (2023) 012019 doi:10.1088/1755-1315/1178/1/012019 Pp 1-9. Impact factor: 0.41

10. Kovo G Akpomie, Anthony C Ofomatah, Helen O Chukwuemeka-Okorie,Julius U Ani, Sunday C Agbo, Olufemi A Odewole, Francis K Ojo, Ogechi L.Alum and Jeanet Conradie (2023). Equilibrium isotherm investigation on the sequestration of ciprofloxacin from solution via adsorption onto yam peel powder. IOP Conf. Ser: Earth Environ. Sci. 1178 (2023) 012020 doi:10.1088/1755-1315/1178/1/012020. Pp 1-8. Impact factor: 0.41

11.Ogechi L Alum, Kovo G Akpomie, Anthony C Ofomatah, Helen O Chukwuemeka-Okorie, Julius U Ani, Sunday C Agbo, Olufemi A Odewole, Francis K Ojo, and Hillary O Abugu (2023) Assessment of Pollution Status of River Ajali in Enugu State Using water quality index. IOP Conf. Ser: Earth Environ. Sci. 1178 (2023) 012024 doi:10.1088/1755 1315/1178/1/012024. Pp 1-10 Impact factor: 0.41

12. Julius U Ani, Sunday C Agbo, Olufemi A Odewole, Francis K Ojo, Ogechi L Alum, Kovo G Akpomie, Anthony C Ofomatah, Helen O Chukwuemeka-Okorie, Okechukwu D Onukwuli (2023) Adsorption treatment of fibre-cement industry effluent by activated gossweilerodendron caesalpinoideae stem waste: kinetic and thermodynamic studies. IOP Conf. Ser: Earth Environ. Sci. 1178 (2023) 012023. doi:10.1088/1755-1315/1178/1/012023. Pp 1-11. Impact factor: 0.41

13.H O Chukwuemeka-okorie, J U Ani, S C Agbo, O A Odewole, F K Ojo, OL Alum, K G Akpomie, A C Ofomatah and C C Aralu (2023). Adsorptive performance of green synthesized zinc oxide nanoparticles

for the removal of cadmium (II) and lead (II) ions. IOP Conf. Ser: Earth Environ. Sci. 1178 (2023) 012021 doi:10.1088/1755-1315/1178/1/012021. Pp 1-11. Impact factor: 0.41

14. Olufemi A. Odewole, Francis K. Ojo, Ogechi L. Alum, Kovo G. Akpomie, Anthony C. Ofomatah, Helen O. Chukwuemeka-Okorie, Julius U. Ani, Sunday C. Agbo, Emmanuel E. Omeje (2023). Investigation on the physicochemical properties of Nru clay deposit and its industrial application. IOP Conf. Ser: Earth Environ. Sci. 1178 (2023) 012025 doi:10.1088/1755-1315/1178/1/012025. Pp 1-8 Impact factor: 0.41

15 .Anthony C. Ofomatah, Helen O. Chukwuemeka-Okorie, Julius U. Ani, Sunday C. Agbo, Olufemi A. Odewole, Francis K. Ojo, Ogechi L. Alum, Kovo G. Akpomie, K.E Ugwu (2023). Effects of abattoir effluent and dumpsite on the physicochemical properties and heavy metal levels of soil and water within ogbor hill, Aba. IOP Conf. Ser: Earth Environ. Sci. 1178 (2023) 012029 doi:10.1088/1755-1315/1178/1/012029. Pp 1-8. Impact factor: 0.41

16. Francis K. Ojo, Ogechi L. Alum, Kovo G. Akpomie, Anthony C. Ofomatah, Helen O. Chukwuemeka-Okorie, Julius U. Ani, Sunday C. Agbo, Olufemi A. Odewole, Bbatunde, T Ogunyemi (2023). Theoretical investigation of the performance of benzimidazole derivatives as mild steel organic corrosion inhibitors in acidic environments. IOP Conf. Ser: Earth Environ. Sci. 1178 (2023) 012010 doi:10.1088/1755-1315/1178/1/012010. Pp 1-8 Impact factor: 0.41

17. U P Onochie, A C Ofomatah , C Onwurah , A A Tyopine , O O Akingba ,B F Kubeynje , C C Aluma , C Alozie (2023). Potentials of Biomass Waste Resources with Respect to their Calorific Value, Proximate and Ultimate Analysis for Energy Utilization. IOP Conf. Ser: Earth Environ. Sci. 1178 (2023) 012012 doi:10.1088/1755-1315/1178/1/012012. Pp 1-9. Impact factor: 0.41

18.R A Akwolu, O Nwakanma, S U Offiah, A Agbogu, O V Ekechukwu, I F Okafor and P E Ugwuoke (2023).Extraction and purification of Lawsonia inermis (laali) dyes for applications in dye-sensitized solar cell. IOP Conf. Series: Earth and Environmental Science 1178 (2023) 012007. doi:10.1088/1755-1315/1178/1/012007

19. A C Nkele, S U Offiah, C P Chime and F I Ezema (2023) Review on advanced nanomaterials for hydrogen production. IOP Conf. Series: Earth and Environmental Science 1178 (2023) 012001. doi:10.1088/1755-1315/1178/1/012001

20. G E Orizu, P E Ugwuoke, P U Asogwa and S U Offiah (2023) A review on the inference of doping TiO2 with metals/nonmetals to improve its photocatalytic activities. IOP Conf. Series: Earth and Environmental Science 1178 (2023) 012008. doi:10.1088/1755-1315/1178/1/012008

21. G U Akubue; ID Okeke; AE Ubulom; JC Obiora; KU Uzoigwe, SU Akubue and JA Anyanso, A preliminary investigation of absorber embedded waste crown corks on the performance of passive solar still, May 2023 IOP Conference Series Earth and Environmental Science 1178(1):012003, DOI: 10.1088/1755-1315/1178/1/012003

Published Research Papers, Reports and Findings in Conference Proceedings in 2022

1. Agbo K. E, Walgraeve C, Eze J.I, Vandermeersch L, Ukoha P, Van Langenhove H (2022) Evidence of potential cancer risk associated with cooking fuels in urban kitchens. 5 th International conference/training workshop on Energy for sustainable development in Africa ICTWESD, Nsukka on 17th to 19th May 2022 (oral presentation).

2. Okwe Gerald. I, Okafor I. F, Okebaram Protus N, Akujobi Leonard C. Mitigating the impact of partial shading on grid-tied photovoltaic system using bypass diodes. 5th Proceedings ICTWESDA 2022, at NCERD, University of Nigeria Nsukka, May 17 – 19, 2022, pp. 164 - 169

3. Okwe Gerald. I Okafor I. F, Offiah S.U, Okebaram P.N. Design and Analysis of a Grid -Tied Photovoltaic System for Enhanced Power Supply in Owerri Municipal Using Bluesol The Nigerian Society of Engineers, 2022 Conference, at International Conf. Centre, Abuja. Nov. 14 - 18, 2022.

4. M N Igwebuike , R O Ijeh and I. F Okafor Prediction of wind characteristics of Sokoto station in North-West, Nigeria. 5th Proceedings ICTWESDA 2022, at NCERD, University of Nigeria Nsukka, May 17 – 19, 2022, pp. 164 - 169.

5. Ezema, C. G., Ojike, O. and Okonkwo W. I. Evaluation of an Incinerator For Thermal Decomposition Of Domestic Solid Waste And Hot Water Supply. 5th International Conference and Training Workshop on Energy for Sustainable Development in Africa (ICTWESDA 2022) National Centre for Energy Research and Development, University of Nigeria Nsukka 17th to 19th May, 2022.

6. S U Offiah, E O Onah, C G Ezema, P E Ugwuoke, A B C Ekwealor and F I Ezema. Influence of Aluminum dopants on ZnO nanoparticles for natural dye sensitized solar cells' applications. 5th International Conference and Training Workshop on Energy for Sustainable Development in Africa (ICTWESDA 2022) National Centre for Energy Research and Development, University of Nigeria Nsukka 17th to 19th May, 2022.

7. Chemical Society of Nigeria (Anambra State Chapter) on 29th November to 1st December, 2022. Research Work Presented: **(1)** Mineral Compositions of Plantain (Musa Paradisiaca) Peels and Dry beans (Vigna Unguiculata L): The effects of their combination on cooking time of beans

8. 5th International Conference/Training Workshop on Energy for Sustainable Development in Africa on 17th – 19th May, 2022. Research Work Presented:
(1).Effects of co-digestion and addition of catalyst on the performance of biogas yields.
(2). Assessment of the calorific value, proximate and ultimate analysis of biomass waste resources in Ebonyi state, Nigeria.
(3). Equilibrium isotherm investigation on the sequestration of ciprofloxacin from solution via adsorption onto yam peel powder.
(4) Effects of abattoir effluent and dumpsite on the physicochemical and heavy metal levels of soil and water within Ogbor Hill, Aba.
(5) Physicochemical properties of oil and biodiesel extracted from Thevetianeriifolia seed.

(6) Adsorptive performance of green synthesized zinc oxide nanoparticles for the removal of cadmium (II) and lead (II) ions
(7) Adsorption treatment of fibre cement industry by activated Gossweilerodendroncaesalpinoidea stem waste: kinetic and thermodynamic studies
(8) Assessment of pollution status of river Ajali in Enugu state using water quality index.
(9) Theoretical investigation of the performance of benzimidazole derivatives as mild steel organic corrosion inhibitors in acidic environment.
(10) Development of refractories for pyro-processing (heat-based) industry in Nigeria through the evaluation of mixtures of Enugu Iva-pottery clay, Nsu clay and palm kernel shell waste.
(11) Investigation on the physicochemical properties of Nru clay deposit and its industrial application.

Published Research Papers, Reports and Findings in Conference Proceedings in 2021

1. Okafor I. Francis. Influence of Rim Angles and Heat flux Distribution Boundary on the Heat Transfer of an Absorber Tube for a Parabolic Trough Solar Collector. IOP Conf. Series: Earth and Environmental Science 730 (2021) 012043 (SJR: 0.202).

2. D.R.E. Ewim and I. F. Okafor. Condensation inside smooth and inclined smooth tubes at low mass fluxes: A quick review. IOP Conf. Series: Earth and Environmental Science 730 (2021) 012044. (SJR: 0.202).

3. J C Asogwa, F B Fulani and I. F. Okafor. An Overview of Energy Efficiency and Management; a Case Study of Rural Electrification Agency Building. IOP Conf. Series: Earth Environ. Sci. 730 (2021) 012002. (SJR: 0.202).

4. Agbo K. E, Walgraeve C, Eze J.I, Ugwoke P, Ukoha P, Van Langenhove H (2021). Household indoor concentration levels of NO2, SO2 and O3 in Nsukka, Nigeria. Invited presentation at WHO/UG Workshop on the Accra urban health initiative from 26th to 29th October 2021 (oral presentation).

5. Agbo K. E, Walgraeve C, Eze J.I, Ugwoke P, Ukoha P, Van Langenhove H (2021). Impact of cooking fuels on indoor benzene exposure: Preliminary evidence from Nsukka, Southeast Nigeria. 10th Annual International conference Renewable and Alternative Energy at Nsukka on 23rd to 26th March 2021 (oral presentation).

6.I.Q. Okoye, F.U. Eze, D.I. Ugwu, B.E. Ezema, I.A. Ezugwu, C.G. Ezema and S.I. Attah. Kinase inhibitors in the design of medicinal compounds: A review. 18th Annual Conference of Chemical Society of Nigeria, Enugu State Chapter. Role of Chemistry in Mitigating Covid-19 and other diseases. Department of Pure and Industrial Chemistry 26th-27th July 2021.

7.J. A. Ezugwu, U. C. Okoro, M. A. Ezeokonkwo, B. China Raju, D. I. Ugwu, M.C. Egbujor, B. E. Ezema, C. G. Ezema, E. A Onoabedje, S. I. Attah. Novel Leucine-valine-based dipeptides Antimicrobial and Antimalarial Agents: Synthesis. 2nd International Virtual Conference on Organic Synthesis/Medicinal Chemistry (OSMC). Advances in Organic Medicinal Chemistry. 24th – 29th May, 2021.

8.A C Ofomatah, E O Uzodinma and O Ojike (2021). Spent bio-slurry from ''Adani'' rice husk mixed with graded levels of cow dung in bio-gasification: Heavy metals identification and potentials. IOP Conf. Ser: Earth Environ. Sci. 730 012019. Doi:10.1088/1755-1315/730/1/012019. Pp 1-20. Impact factor: 0.41

9.V. Ezekoye, D Ezekoye, A Ofomatah and A Agbaogu (2021). Comparative study of calorific values and proximate analysis of biogas from different feed stocks. IOP Conf. Ser: Earth Environ. Sci. 730 012018. Doi:10.1088/1755-1315/730/1/012018. Pp 1-17. Impact factor: 0.41

10. Ezekoye Veronica A, Okoro Geraldine I, Ofomatah Anthony, Ezekoye David and Agbaogu Ada (2021). Improving Biogas Yield Using Organic Fraction of Plant and Animal Wastes by Co-digestion. IOP Conf. Ser: Earth Environ. Sci. 730 012037. Doi:10.1088/1755-1315/730/1/012037. Pp 1-11. Impact factor: 0.41

11.U P Onochie, F Onoroh, C Onwurah and A C Ofomatah (2021). The Effect of Elaeis Guineensis Residue on CO2 and SO2 Emissions from Coal Pellets Combustion. IOP Conf. Ser: Earth Environ. Sci. 730 012012. Doi:10.1088/1755-1315/730/1/012012. Pp 1-11. Impact factor: 0.41

12. A C Ofomatah, K E Ugwu and J U Ani (2021). Biogas Production and Storage from Pig Dung Co-Digested with Pineapple Peels. IOP Conf. Ser: Earth Environ. Sci. 730 012004. Doi:10.1088/1755-1315/730/1/012004. Pp 1-9. Impact factor: 0.41

13. A C. Ofomatah, K E. Ugwu and J. U. Ani (2021), Biogas production and storage from pig dung co-digested with pineapple peel, IOP Conf. Series: Earth and Environmental Science 730 (2021) 012004, Doi:10.1088/1755-1315/730/1/012004

14. S.U. Offiah, S.N. Agbo, C.G. Ezema, P.E. Ugwuoke, A.B.C. Ekwealor, A.N.C. Agbogu B.A. Ezekoye and F.I. Ezema (2021).Enhancement of the performance of ZnO based natural dye sensitized solar cells via PVA morphology controlled nanorods. IOP Conf. Series: Earth and Environmental Science 730 (2021) 012033. doi:10.1088/1755-1315/730/1/012033

14. M. Nnaji, A. A. Eze , C C Uzoma and C. E. Nnaji (2021) "Addressing Household Cooking Fuel Options in Nigeria" IOP Conf. Series: Earth and Environmental Science 730 (2021) 012038IOP Publishing doi:10.1088/1755-1315/730/1/012038

15. Chigasa C. uzoma, C. Atama, Kelechi Okpara, Ijeoma Igwe, Moses Nnaji, Chidiebere Adagba and E. Onyekaozuru (2021) Centralised electricity grid and he rural economy of Nigeria. IOP Conference series ,earth and Environmental science.

4th African Conference/Workshop on Applications of Nanotechnology to Energy, Environment, Agriculture and Health organized by Nano Research Group, University of Nigeria, Nsukka at U.N.N from 19th to 23rd July, 2021. **Research Work Presented:** A comparative study of the oil and biodiesel from Annona muricata, hura crepitans and thevetia nerifolia seeds oil.

10th Annual Conference of the Renewable and Alternative Energy Society of Nigeria held at University of Nigeria, Nsukka from 23rd to 26th March, 2021. **Papers Presented: (1)** Biogas Production and Evaluation of Metallic Concentration Potentials of the Spent Sludge from Powdered Rice Husk-Cow Dung Blends for Bio-fertilizer Application. **(2)** A comparative study of the oil and biodiesel produced from Annona muricata seeds, citrus sinensis seeds and jatropha curca seeds.

Published Research Papers, Reports and Findings in Conference Proceedings in 2020

1. Agbo K. E, Walgraeve C, Eze J.I, Ugwoke P, Ukoha P, Van Langenhove H (2020) Rural household energy and implication for indoor BTEX levels in Nigeria. 4 th International Conference/Training Workshop on Energy for Sustainable Development in Africa"11th to 13th November 2020, NCERD, UNN (oral presentation).

2. Onah, B. N., **Okafor, I. F.**, Oyigbo, D. N. and Nnate, K. N. Deployment Of Renewable Energy Technologies for Sustainable Rural Agricultural Development in Nigeria. 4th Proceedings ICTWESDA 2020, at NCERD, University of Nigeria Nsukka, May 17 – 19, 2020, pp. 231 - 241.

3.Ugwu D.I., Eze F.U., Ezema B.E., Ogboo B.C., Eze C.C., Ezugwu J.A., Ugwuja D.I., Ekoh O.C., Attah S.I., and Ezema C.G. Synthesis of Multi-Target Benzene-Sulphonamide Derivatives for the Treatment of Trypanosomiasis. International Virtual Conference on Organic Synthesis/Medicinal Chemistry. Roadmap to drug discovery from synthesis and natural products. August 10-12, 2020.

Published Research Papers, Reports and Findings in Conference Proceedings in 2019

1. Agbo K. E, Walgraeve C, Eze J.I, Ugwoke P, Ukoha P, Van Langenhove H (2019). Urban household energy sources and indoor air NO2 in Southeast Nigeria. 37th Conference of the Solar Energy Society of Nigeria, NASEF 2019, on 4 th to 7 th November p.31 (oral presentation).

2. S U Offiah, S N Agbo, C G Ezema, P E Ugwuoke, A B C Ekwealor, A N C Agbogu, B A Ezeokoye, and F I Ezema. Enhancement of the performance of ZnO based natural dye sensitized solar cells via PVA morphology controlled nanorods. The 37th National Solar Energy Forum 4th -6th November, 2019. Nnamdi Azikiwe University, Awka, Nigeria.

Published Research Papers, Reports and Findings in Conference Proceedings in 2018

1. C. G. Ezema, B. E. Ezema, S. U. Offiah, C.D. Lokhande, P. O. Ukoha, and F. I. Ezema. Comparative Photoelectrochemical (PEC) study of TiO2 using SILAR and hydrothermal methods. The 3rd African

Conference/Workshop on Application of Nanotechnology to Energy to Energy, Environment, Agriculture and Health 15th-18th July, 2018. Princess Alexandra Auditorium, University of Nigeria, Nsukka.

2. S. U. Offiah, S. N. Agbo, C. G. Ezema, A. B. C. Ekwealor, P. Sutta, M. Maaza, P. E. Ugwuoke, R. U. Osuji and F. I. Ezema. Influence of EDTA on SILAR deposited ZnO nanostructures from DSSC applications. The 3rd African Conference/Workshop on Application of Nanotechnology to Energy to Energy, Environment, Agriculture and Health 15th-18th July, 2018. Princess Alexandra Auditorium, University of Nigeria, Nsukka.

3. Ezema B.E., Okafor S.N., Ezema C.G. Synthesis, Molecular Docking and Antimicrobial Studies of Aryl Derivatives of Mono- and Diaza-Benzo[A]Phenoxazin-5-ones. Drug Discovery Africa Inaugural Conference and Workshop 26th -29th September, 2017. Obafemi Awolowo University, Ile-Ife, Nigeria.

Published Research Papers, Reports and Findings in Conference Proceedings in 2017

1.Okafor S.N., Ezema B.E., Ezema C.G. Angular Phenothiazine and Phenoxazine Derivatives: Potent Glucosamine-6-Phosphate Synthase and Lanosterol-14a-Demethylase Inhibitors: Sythesis, In-silico and In-vitro Studies. Drug Discovery Africa Inaugural Conference and Workshop 26th -29th September, 2017. Obafemi Awolowo University, Ile-Ife, Nigeria.

2. C. G. Ezema, B. E. Ezema, S. U. Offiah, C. D. Lokhande, P. O. Ukoha and F. I. Ezema (2017). DSSC Efficiency potential of Laboratory Synthesized 4,4'-[2-hydroxynaphthalene-1,3 diazo]dibenzoic acid. UNN-FZJ Maiden Workshop. 31st July- 2nd August, 2017. NCERD, University of Nigeria, Nsukka.

3.S U Offiah, S N Agbo, C G Ezema, P Sutta, M Malik, P E Ugwuoke, R U Osuji and F I Ezema (2017). Influence of Al-dopants on performance of ZnO dye-sensitized solar cells deposited by SILAR techniques. UNN-FZJ Maiden Workshop. 31st July- 2nd August, 2017. NCERD, University of Nigeria, Nsukka.

4. C. G. Ezema, B. E. Ezema, C. D. Lokhande, P. O. Ukoha and F. I. Ezema (2017). Photoelectrochemical study of TiO2 sensitized with simple synthesized azo dye. Organization for women in science for the developing world, general meeting and scientific conference. 29th May – 1st June, 2017. PAA University of Nigeria, Nsukka.

Published Research Papers, Reports and Findings in Conference Proceedings in 2016

1. Van Poucke R, Nachenius, R.W, Agbo K. E, Hensgen F, Bühle L, Wachendorf M, Ok, Y.S Tack F.M.G, Prins W, Ronsse F, Meers E (2016). Mild hydrothermal conditioning prior to torrefaction and slow pyrolysis of low-value biomass. Asian Pacific Biochar conference, on Oct 19th -23rd, 2016, Gangwon Province, Korea, p.175-175 (oral presentation).

2. I.F. Okafor, J. Dirker and J. P. Meyer. Turbulent Mixed Convection Heat Transfer for Non-Uniform Heat Flux Distributions on a Horizontal Circular Tube, Proceedings,12th International Heat Transfer, Fluid Mechanics and Thermodynamics Conference, 11-13 July 2016,Costa del Sol, Spain

3.C.G. Ezema, B.E. Ezema, C.D. Lokande, P.O. Ukoha, F.I. Ezema. Brookite TiO2 Nanoparticles by Hydrothermal Method for Dye-Sensitized Solar Cell, 2nd African Conference/Workshop (An International Conference on all aspects of nanotechnology), University of Nigeria, Nsukka, 2016.

4.Ezema, B.E., Agada, S.A., Ezema, C.G. 'Magnetically Separable Palladium Catalyzed Hiyama Synthesis of Phenothiazine and Phenoxazine Derivatives' Chemical Society of Nigeria (CSN), Coalcitychem 2016, University of Nigeria, Nsukka.

5.Ezema, B.E., Ezeofor, C.C., Agbo, M.O., Ezema, C.G. 'Phytochemical and antimicrobial studies of the methanol extracts and less polar solvent fraction of Pterocarpus santalinoides leaves' Chemical Society of Nigeria (CSN), Coalcitychem 2016, University of Nigeria, Nsukka.

6.Ezema, B.E., Ezeofor, C.C., Agbo, M.O., Ezema, C.G. 'Phytochemical and antibacterial studies of Eastern Nigeria mistletoe (Loranthus micranthus) parasitic on Pentacletra macrophylla and parkia biglobosa' Chemical Society of Nigeria (CSN), Coalcitychem 2016, University of Nigeria, Nsukka.

7.K. E. Ugwu and P.O. Ukoha (2016), Extraction of toxic organic compounds from sub-bituminous coal samples using binary and ternary solvent systems. Conference proceedings of the 38th International Conference of Chemical Society of Nigeria (CSN) in collaboration with Federation of African Societies of Chemistry (FASC) held between 7th – 11th September 2015 at Abuja, p397-403.

Published Research Papers, Reports and Findings in Conference Proceedings in 2015

1 **I.F. Okafor**, J. Dirker and J. P. Meyer, Laminar Flow Heat Transfer for Asymmetrical Non-Uniform Heat Flux Distributions on Horizontal Circular Tubes, Proceedings, Third Southern African Solar Energy Conference, SASEC 2015.

2. Ayogu, J.I., Ezema, B.E., Agada, S.A., Ezema, C.G., 'Utility of Suzuki-Miyaura Cross-Coupling Reactions in Synthesis of Benzo[a]phenothiazine and Benzo[a]phenoxazine Derivatives and their Antimicrobial Screening' Chemical society of Nigeria (CSN), 9TH Anachem conference (Umunze, 2015).

Published Research Papers, Reports and Findings in Conference Proceedings in 2014

1 I. F. Okafor, J. Dirker and J. P. Meyer, Numerical Study of Heat Transfer Characteristics for Different Solar Flux Distributions on Linear Fresnel Collector Absorber Tubes in Laminar Flow, Proceedings, IHTC 15-9221 August 10-15, 2014, Kyoto, Japan. Begell Digital Library DOI: 10.1615/IHTC15.fcv.009221 pp. 2847-2861 (SJR: 0.318).

2.C. G. Ezema, B. H. Patil, C. D. Lokhande, P. O. Ukoha, B. E. Ezema and F. I. Ezema (2014). Dye sensitized solar cell using simple synthesized azo dye. 3rd National seminar on Physics of materials and

materials based device fabrication. 19th & 20th December, 2014. Shivaji University, Kolhapur, Maharashtra state, India.

3.Ezema, B. E., Ezema, C.G, Ugwu, D.I, and Ayogu, J.I. Synthesis of Heterocyclic Azo Dyes from Quinolin-8-ol, 15TH Annual Conf. (CSN) Enugu state chapter, (2014). Enugu.

Published Research Papers, Reports and Findings in Conference Proceedings in 2013

1. Agbo K.E and Okoye C.O.B, Concentrations of Heavy metal in soils surrounding Municipal solid Waste in Nsukka, Urban, Nigeria. In proceedings of 33rd Annual International Conference of Chemical Society of Nigeria Held in Abeokuta, Nigeria. Pg 73- 83.

2. Agbo K.E and Ukwueze L, (2013). Levels of some trace metals and physicochemical parameters of street dust in Nsukka, Urban, Proceedings of the 35th International Conference/Workshop and Exhibition of the Chemical Society of Nigeria (CSN) – Heartland 2012, held at International Conference Centre, Federal University of Technology, Owerri, Imo State, from 19th to 21st September 2012 (Oral presentation).

3. I. F. Okafor, J. Dirker and J. P. Meyer, Numerical Simulation of Linear Fresnel Collector Absorber Tubes with Non-uniform Circumferential Solar Flux Distributions, Proceedings, Second Southern African Solar Energy Conference, SASEC 2013.

4..International Council for Science (ICSU) Regional Implementation Workshop on Sustainable Energy in sub- Saharan Africa. Nairobi, Kenya, 7th – 8th May 2013.

5.International Council for Science (ICSU) Global-Regional Integration Workshop on Sustainable Energy. Mexican Academy of Sciences Mexico City, 8-9 April 2013.

Published Research Papers, Reports and Findings in Conference Proceedings in 2012

6.Ezema, B.E., Ezema, C.G and Onoabedje, A.E. 'Synthesis of new angular phenothiazine dyestuff', 14TH Annual Conf. (CSN) Enugu state chapter, (2012). University of Nigeria, Nsukka.

7.Ezema Chidimma G. and Ofomatah Anthony C. (2012).Water Purification Using Activated Carbon from Treated Sugarcane Baggasse. Chemical Society of Nigeria, Enugu State Chapter. 14th Annual Conference Book of Abstracts. UBA Hall of Fame, UNN, Nsukka. 19th – 20th June 2012.

8..National Stakeholders Workshop on the Development of Strategies for Sustainable Energy Utilization in Nigeria. Hydro Hotel, Minna, Niger State. 25th – 27th January 2012.

9.C.G. Ezema, S.U. Offiah, P.E. Ugwuoke, P.O. Ukoha, B.E. Ezema and F.I. Ezema (2012). Growth and Characterization of Chemical Bath Deposited PVA/PbS Thin Films. 3rd International Workshop on Renewable Energy for Sustainable Development in Africa. Nondon International Hotels Ltd., Enugu. 5th-10th November, 2012.

10.C.G. Ezema, S.U. Offiah, P.E. Ugwuoke, P.O. Ukoha, B.E. Ezema and F.I. Ezema (2012). Growth and Characterization of Chemical Bath Deposited PVP Capped PbS Thin Films. Solar Energy Society of Nigeria, Benin. 12th-16th November, 2012.

Published Research Papers, Reports and Findings in Conference Proceedings in 2011

1. Agbo K.E and Okoye C.O.B (2011). Concentrations of Heavy metal in soils surrounding Municipal solid Waste in Nsukka, Urban, Nigeria. Proceedings, 33rd Annual International Conference, Workshop and Exhibition of the Chemical Society of Nigeria (Ogun 2010), 20th -24th September 2010 (oral presentation).

2.C.N. Ibeto, C.N. Anyanwu, C.G.Okpara, I.S. Eze, and G.O. Unachukwu. (2011). Assessment of Heavy Metals Concentration of Petrol Samples utilized in Nigeria. Proceedings of the 34th Annual International Conference of the Chem. Soc. of Nig. (Kwara 2011). Main Auditorium Univ. of Ilorin Nig. 19th- 23rd Sept., 2011.

Published Research Papers, Reports and Findings in Conference Proceedings in 2010

1. Agbo K.E Eze J.I and Ugwu K.E (2010). Converting empty fruit bunch to Efficient and sus Energy through Carbonization and Briquetting, Proceedings IWRESDA 2010 held in Abuja (oral presentation).

2. Agbo K.E, and Eze J.I (2010) Briquetting of Palm kernel shell, 2 nd International conference on renewable and alternative energy, FUTO 2010, Owerri Nigeria 16th -20th May 2010 (oral presentation).

3. Agbo K.E, and Eze J.I (2010). Converting Cassava (Manihot Spp) waste from Garri processing industries to energy and Biofertilizer, 2nd International conference on renewable and alternative energy, FUTO 2010, Owerri Nigeria 16th -20th May 2010 (oral presentation).

4. I. F. Okafor, Energy Demand and Supply Projection in the Nigerian Economy, Proceedings of the fifth International Conference on Scientific and Industrial Studies, Vol. 5 (8) pp. 9 – 18 (2010).

5. I. F. Okafor and G.O. Unachukwu, Domestic Cook Stove Development: A new Design Concept for Efficient Performance, Proceedings of the 2nd Internal Workshop on Renewable Energy for Sustainable Development in Africa, pp. 143-150, 10th -29th July, 2010.

6. I. F. Okafor, O. K. Oni and C. J. Obule. Design, Construction and Performance Evaluation of Cylindrical and Square type Briquette Stoves, Proceedings of the 34th Annual Conference and General Meeting of the Nigerian Institute of Food Science and Technology, pp. 46-47, Oct. 18-22, Garden City, 2010.

7. 1.G.U. Akubue; H.O. Njoku; S.U.Offiah & G.O.Unachukwu (2010). Performance Evaluation of Improved Single Slope Solar Still. Proceedings of the 2nd International Workshop on Renewable Energy for Sustainable Development in Africa, IWRESDA 2010, 27th – 29th July, 2010, Pages 167 – 172.

8.Nnaji, C. et al. .Social impacts of Renewable Energy on the South-East Zone of Nigeria. Conference proceedings of 2nd International Workshop on Renewable Energy for Sustainable Development in Africa organized by National Centre for Energy Research and Development, University of Nigeria, Nsukka in collaboration with ENEA Research Centre, Italy, held at Reiz Continental Hotel, Abuja, 27-29th July 2010.Pp. 225-238.

9.Nnaji, C. et al. Climate Change and Socio-Economic Development in Nigeria". Conference Proceedings on Climate Change and the Nigerian Environment, held at the University of Nigeria, pp. 205-215.

PATENTS, INVENTIONS AND TECHNOLOGICAL ADVANCEMENT

Patented R&D products

(i) Hexagonal Type Domestic Charcoal Stove for Improved Thermal Efficiency Performance and Indoor Air Pollution Emission Reduction, CRP: 010474, Date: 12/02/2025

(ii) Energy and exhaust system improvement device, CRP: 007118, Date: 21/09/2021

Inventions and Technological Advancement

(i) Automated Roof mounted domestic solar water heating system.

(ii) Model solar powered thermoelectric refrigerator for domestic use.

(iii) Active hybrid solar thermal crop dryer for preservation and combating post-harvest losses.

(iv) Biogas production and utilization system for domestic heating

(v) Biomass-coal blend briquettes fuel for domestic and industrial heating

(vi) Biomass dual fuel (charcoal or firewood) energy efficient domestic cook stoves.

(vii) Design, fabrication and realization of coal and biomass briquetting machines, biomass solid fuels optimization and mass production of biomass briquettes

(viii) Design, fabrication and installation of a thermosyphon solar water heating system for residential uses

(xi) Design, fabrication and performance evaluation of a Rocket type institutional energy efficient wood cookstove with chimney.

(xii) Design and fabrication of a hybrid solar thermal crop dryer for combating post-harvest losses encountered by farmers.

(xiii) The Green Energy Model Building designed and fabricated, with the following:

- Solar PV system for electricity generation for powering TV, fan etc.
- Solar thermal water heater with a flat plate collector for hot water production
- Solar PV powered water pumping system, hot water storage tank
- Temperature control system with solenoid valves for controlling hot water storage into tank

- Wind turbine system for harvesting wind energy to augment PV system especially in the night when solar radiation is not available and other accessories

COMPLETED AND ON-GOING RESEARCH PROJECTS

S/N	Research and Development Projects	Completed /on-going
1	Production and characterization of biodiesel from cascabela thevetia, castor oil and their blend	2025
2	Design and Simulation of Photovoltaic system for Improved Electricity supply in Owerri Urban Using Spewise Approach	2024
3	Production of biodiesel from waste cooking oil.	
4	Improving biodiesel yield and production rate with nanoparticles	
5	Survey of Biomass (Fuelwood and Charcoal) Fuel Consumption Using Surveys & Benchmark Model In the South-South and South-East Zones of Nigeria. Electricity Consumption Profile of Urban Households in Nsukka, Enugu State.	
6	Studies on the environmental impact of using fossil based fuels in vehicles	
7	Sourcing of coal samples were sourced from various coal mines including Ribadu, Inyi, Owukpa, Onyeama, Okaba, Ogwashi-Uku, Amansiodo, Okobo-Enjema, Ogboyega and an international anthracite coal from the United Kingdom	
8	Yield Analyses and Socio-economic Impact Assessment of Photovoltaic and Photovoltaic supported Food and Energy Hybrid Systems in Tropical Nigerian-Beninese Climate	2023
9	Impact assessment of fuel stations on borehole VOCs water quality.	
10	Determinants Of Solar Energy Demand In Households In Nsukka Area, Enugu State	
11	Biodiesel production and characterization from Hildegarde barteri and fluted pumkin seed oil with their blends	
12	Biodiesel production and characterization from Hura crepitans and telfairia occidentalis seed oil with their blends	
13	Utilization of agro-based residues for briquette production	
14	Production of biogas from blends of wild pawpaw trunk and cow dung	
15	Characterization of lignite and coals in the vicinity of Southeast region	

16	Production of liquid coal with water - Coal Water Slurry (CWS) as alternative fuel source for running engines and facilities	2023
17	Design of Laboratory Scale Solar and Wind Simulators, Development of Solar Powered Hybrid incubators for Rural Farmers, Design and fabrication of heat powered fume extractor using thermopile application	
18	Design and development of both passive and active solar dryers with auxiliary air heater and energy storage system for efficient drying and preservation of different agricultural products.	**2022**
19	Evaluation of an incinerator for thermal decomposition of domestic solid waste and hot water supply	
20	Heat extraction from rooftop of existing building structures for industrial heat processes application, design and development of a single axis solar tracking system for solar concentrators using an integrated comparator circuit	
21	Assessment of the effect of household energy use on indoor air pollution in Southeast Nigeria,	
22	Ambient and indoor air quality assessment of Nsukka metropolis,	
23	Design and Development of a medium Size Solar Thermal Powered Poultry Chick Brooding System	**2021**
24	Greenhouse Type Solar Dryer for Drying peppers, tomatoes, Vegetables, Plantain chips; gives better quality product than open air drying	
25	Design, fabrication and performance evaluation mini-size laboratory Kiln for firing clay body use for producing the insulating body part of the energy efficient biomass cook stoves, by National Stove Eligibility Laboratory section of NCERD.	
26	Design and development of wind turbine model energy harvesting systems	
27	Assessment of Wind characteristics in some location across Nigeria	
28	Development of solar cooling system for food preservation and comfort cooling thermoelectrice device	
29	Studies and production of biogas scrubber for removal of CO2, CO and H_2S and moisture contents from biogas to improve combustion efficiency and reduce emissions to the environment.	**2020**

30	Fabrication of Water scrubbing Unit for Biogas scrubbing and bottling in CNG Cylinder.	
31	The Socio-Economic Impact Assessment Of Solar Photovoltaic(PV) Systems Within Nsukka Local government Area of Enugu State.	
32	Fabrication of biogas pressure pump from locally available materials.	
33	Survey of Household energy sources in Southeast Nigeria 2019, Funded by BOF Ghenty University	
34	Synthesis, Characterization and Comparative analysis of Samples of Dye Sensitized Solar cells using natural and synthetic dyes with TiO2 films.	
35	$10m^3$ Biogas production plants (2 in number) (fixed type and floating type) with cow dung/water hyacinths, at National Centre Energy Efficiency and Environment University of Benin, Edo State, constructed by Energy Research Centre, UNN, for Cooking in the Restaurant/practical demonstration	**2019**
36	Design, production, and characterization of fixed dome type metal biodigester for generation of biogas from blends of household wastes and animal dungs for promoting adoption of biogas technology and clean cooking solution among households	
37	Solar Powered Water Distiller for domestic water treatment and salt production.	
38	Design and Development of Solar Thermal water Heating systems for domestic, institutions and industrial applications	
39	Comparative study of fresh stockfish drying under passive and active solar dryer and open- sun environment.	2018
40	Energy Utilization and Energy Efficiency performance in Economic Sectors in ECOWAS	
41	Development of a hybrid thermal photocatalytic solar treatment system for potable water use in households	
42	Assessment of briquetting of carbonized Empty Fruit Bunch, EFB and Palm kernel shells.	
43	Fast pyrolysis of the eight (8) biomass samples for production of Bio-char, bio-oil and non-condensable gases	2017
44	$10m^3$ Biogas production plants (fixed type) with cow dung/water hyacinths, at National Centre Energy Efficiency and Environment University of Benin, Edo State, constructed by Energy Research Centre, UNN, for Cooking in the	

	Restaurant/practical demonstration	
45	Characterization of eight (8) woody Biomass samples for fast pyrolysis experiments.	
46	Monitoring the concentrations of air pollutants (NO_2, SO_2, O_3 and VOCs) linked to cooking fuels among households in Nsukka Urban and surrounding rural areas	
47	Kinetic Modelling of Biogas Production from Blends of Animal Manure	2016
48	Photoelectrochemical solar cells based on dyes-sensitization of nanocrystalline TiO2	
49	Study on improvement of onset of flammable gas production from pumpkin stalk-cow dung blend	
50	Comparison of preservation of fresh amaranthus and pumpkin vegetables in open air and solar refrigerator environment.	
51	Characterization of the liquid and solid products of the fast pyrolysis experiments based on the eight (8) biomass samples	2015
52	Briquetting of blends of coal with biomass materials (bio-coal briquettes)as alternative fuel source for domestic and industrial uses	
53	Biogas energy production from blending maize bracts with old cabbage leaf wastes.	
54	Development of Digital Resource Preservation Programme for Effective Service Delivery in Federal University Libraries in Nigeria	
55	Assessment of energy contents of pyrolyzed waste woods and sawdust for energy application, INTERREG IVB, EU	
56	Design and development of biodiesel reactor for production of biodiesel from various vegetable oils to facilitate the integration of biodiesel into energy-mix in Nigeria.	
57	Production and Characterization of biochar from selected biomass streams, for energy and soil application, 2015. Funded by VLIR-OUS, Belgium Government.	
58	Biodiesel production from some locally available oil feedstock	

59	Design and Fabrication of an automatic power Changeover	2014
60	Installation of PV Streetlights at the VC's Lodge, UNN	
61	Biomass/Coal Blend Briquetting Machines for producing optimized solid fuel as alternative fuel to fuel wood for domestic and industrial uses	**2013**
62	Small and large Size Biogas digesters for energy recovery from variety organic wastes for domestic cooking and electricity generation.	
63	Determinants of Household Energy Choices for Cooking in Rural Areas: Evidence from Enugu State, Nigeria	
64	Integrated PV in buildings. PhD work of Dr. C.U. Ikedi (University of Nottingham, UK, July 2012)	2012
65	Analysis of Factors Determining Firewood Use for Cooking by Rural Households in Nsukka Area of Enugu State	
66	Production and Characterization of Biodiesel Fuel of Cocos Nucifera (Coconut) Oil and its Blend from Nsukka, Nigeria	
67	Performance Evaluation of Nozzle Type Improved Wood Cook Stove	
68	Preparation of Environmental Friendly Bio-coal Briquette from Groundnut Shell and Maize Cob Biomass Waste: Comparative Effects of Ignition Time and Water Boiling Studies	
69	Design and Fabrication of a 1 KVA inverter by Electronics Laboratory.	2011
70	Analysis and survey on the application of solar dryer in Eastern Nigeria	
71	Anaerobic Digestion of Municipal Solid Waste for Energy Generation: Prospects and Challenges in Nigeria	
72	Measured Performances of an Augmented [Double-Exposure Absorber-Plate] Single-Slope Solar Still	
73	Determination of Impact of dumpsites on surrounding soils in Nsukka, Enugu State,	2010
74	Production and Characterization of charcoal briquettes from palm kernel shells	
75	Performance Assessment of a Solar Water Heater Process Water Purification in Food Processing Industries	

76	Social impacts of Renewable Energy on the South-East Zone of Nigeria	

ONGOING RESEARCH AND DEVELOPMENT PROJECTS

S/N	**Research and Development Projects**	Status
1	Completing the setting-up of the solar PV module production line for research and technical skills acquisition for local production, cost reduction and easy diffusion of solar PV technology in Nigeria, with an Annex at Akpugo, Nkanu LGA, Enugu State	Ongoing
2	Design and setting-up of biogas production pilot plants at NCERD for popularizing the technology of biogas bottling and electricity generation.	Ongoing
3	Design and development of commercial size solar thermal powered poultry chick brooding system with PCM heat storage system for rural farmers to boost production and efficient performance of poultry farming.	Ongoing
4	Design, development and dissemination of biomass blend briquetting machines for mass production and commercialization of smokeless briquette fuel to promote access to clean energy, abate the growing rate of deforestation and climate change mitigation.	Ongoing
5	Design and setting-up of the biodiesel fuel production pilot plant at NCERD, for biodiesel fuel production from non-edible seed oils for research and facilitation of the integration of biodiesel into energy-mix in Nigeria.	Ongoing
6	Design, development and dissemination of multi-purpose agro-product hybrid solar thermal dryer with an auxiliary air heater for efficient preservation and combating post-harvest losses encountered by farmers.	Ongoing
7	Research on natural dye sensitized solar cells: Development of dye-sensitized solar cells (DSSCs) Investigation of Starch as Polymer host and its Application in DSSCs) Preparation and Characterization of Dye-sensitized Nanocrystalline solar cells using starch polymer electrolytes.	Ongoing
8	Development of Household Scale Solar Assisted Water Treatment System.	Ongoing
9	Design, Construction and Performance Analysis of Double Exposure Single Slope Solar Still with Nano-enhanced Phase Change Materials, Detailed Performance Evaluation of Nano-coated, Nano-enhanced Energy Storage Material on Single Slope Solar Still.	Ongoing

10	Design and evaluation of biomass based pulverizing machine for thermo-conversion feedstock	Ongoing
11	Optimization of Anaerobic Digestion of Organic Fraction of Municipal Solid Waste, of SW for biogas production.	Ongoing

COLLABORATIONS WITH LOCAL AND INTERNATIONAL INSTITUTIONS

S/N	Date	Title of Research/ Collaboration	Name of Collaborators	Outcomes of Research/ Collaboration in addressing Public Policy Issues.
1	2022 - till date	Fabrication of a perovskite solar cell/fabrication of solar panels	National Centre for Energy Research Development (NCERD) and University of Nigeria Nsukka Nano Research Laboratory	Capacity building and Development of solar PV module fabrication skills for renewable energy electricity generation. This is in line with the policy issues on the development and domesticating of renewable energy technology in Nigeria
2	2022- Till date	Yield Analyses and Socio-economic Impact Assessment of Photovoltaic and Photovoltaic supported Food and Energy Hybrid Systems in Tropical Nigerian-Beninese Climate	Sunfarming GmbH, Erkner (Germany) - NCERD, University of Nigeria, Nsukka (Nigeria) - Center for Atmospheric Research (CAR) - National Space Re-search and Development Agency (NASRDA), Abuja (Nigeria) - University of Abomey-Calavi, (Benin Republic)	Installation of 20kWp AgriPV system, 20kWp system at the medical centre (hospital), 11kWp at the Nano research laboratory, a 5kWp solar home system and a 1kWp PV-powered charging station. Post-harvest losses of fruits and vegetables and prospects for use of solar energy for conservation of agricultural products. Use of a forced convection solar dryer for the reduction of post-harvest Losses. Photosynthesis dynamics and regulation sensed in the frequency domain, Plant Physiology.

				Crop production and growth analysis under controlled micro-climate within an AgriPV system. This is in line with policy issues on access to sustainable energy, climate change mitigation and food security
3	2023-Till date	Forecasting Energy Generation and Consumption of a Solar Photovoltaic Electric Vehicle Charging Station Using Deep Learning Techniques	NCERD and Africa Centre Of Excellence for Sustainable Power and Energy Development (ACE-SPED) University Of Nigeria, Nsukka. National Automotive Design and Development Commission (NADDC) Electric Vehicle Charging Station, UNN	Developed a universal RE forecasting methodology for both generation and consumption at any given solar photovoltaic (SPV) infrastructure with energy storage. Estimated energy generated based on real-time conditions obtained from an existing SPV standalone facility in the South-eastern part of Nigeria. It supports policy issues on sustainable alternative energy for road transportation and pollutants emission reduction
4	2024	(i) Elemental composition of biocoal briquettes and its effect on the environment (ii) Properties of biocoal briquettes from mesoporous coals and rice husk and their effects on environmental pollution	NCERD and Prof. C.N. Ibeto (Department of Pure and Industrial Chemistry, University of Nigeria, Nsukka)	This research work revealed that the level of hazardous elements in coals varied after conversion of different coals and biomass feed-stock to biocoal briquette fuels. It provided information on the sources of toxic elements in biocoal briquette fuels and their control to minimize adverse environmental and health impacts. It supports the policy issues on promoting clean energy utilization and pollutant emissions reduction.

5	2023	Biosorption of potassium ion using bean seeds and its energy saving application	NCERD and Dr. J.U. Ani (Department of Pure and Industrial Chemistry, University of Nigeria, Nsukka)	This work revealed that the energy used, cooking time and cost could be reduced in cooking beans with plantain peel, due to sorption of potassium. It supports the policy issues relating to clean cooking solution, efficient fuel utilization and conservation.
6	2023	Chemical composition and fuel potentials of *Irvingia gabonensis s*eed	NCERD and Mmesoma Ugwueke (Department of Pure and Industrial Chemistry, University of Nigeria, Nsukka)	It was found that *Irvingia gabonensis* biodiesel has the qualities that complied with specifications for biodiesel applications. It indicates need for policy issues that regulates specifications for biodiesel in the country, quality and the plant sources for biodiesel production for food security.
7	2022	The Socio-Economic Impact Assessment of Solar Photovoltaic(Pv) Systems within Nsukka Local Government Area of Enugu State	NCERD and Onyia, C. C.and Obetta, A.E (Department of Agricultural Economics, UNN)	This work revealed that solar energy plays a great role in promoting the socio-economic life of dwellers in Nsukka local government area of Enugu State, Nigeria. It supports the policy issues on promoting access to clean energy and economic growth in the rural areas.
8	2023	Decomposition effects of energy and CO_2 intensities in the Nigerian economy: A logarithmic mean weight divisia index (LMDI) analysis.	NCERD and Monica Maduekwe (ECREEE, Praia, Cape Verde)	The work revealed that energy use and CO_2 emission have increased to some extent between 1980 and 2019. It supports the policy issues on climate change and mitigating green house gas emissions.

9	2024	Energy Access Constraints to COVID-19 Lockdown in Nigeria	NCERD and Institute for International Law of Peace and Armed Conflict (IFHV) Ruhr University Bochum, Germany	Evidences show great impediments to the COVID-19 response in Nigeria due to the dire lack of access to stable electricity during the lockdown to curtail the pandemic spread.
10	2022 - till date	Training and Manpower Development in Solar PV Installation and maintenance (SPVI).	NCERD and (1) Nigeria Energy Support Programme (NESP), Supported by the European Union and German Government. 2)Council for the Regulation of Engineering in Nigeria (COREN)	Capacity building, Empowerment and COREN Certification of some youth, fresh graduates, artisans in Solar PV Installation & Supervision.This supports the policy issues in promoting capacity building, skill acquisitions and integration of renewable energy technology in Nigeria
11	2022	Effect of household Energy Use on indoor air quality in Southeast, Nigeria	NCERD and Prof Herman Van Langenhove and Prof. Christophe Walgraeve (Ghent University).	Inventory of household energy type in Southeast Nigeria. The barriers against the adoption of clean cookstoves in the region were identified. Determination of the impact of various household energy sources on indoor air pollution in the area. Determination of exposure and health risk implications of emissions from cooking fuel types in the region. This is in line with the clean cooking policy issues.
12	2023	Determination of volatile organic compounds (VOC) concentration in boreholes in the vicinity of fuel storage facilities	NCERD and Dr Hillary Abugu (Dept. of Pure and Industrial Chemistry, UNN)	Fuel (filling stations) storage tanks may be a point source of VOCs in borehole water. Therefore, fuel storage facilities must be located away from underground water sources

				to avoid contamination. This supports public health protection policy issues.
13	2024	Application of nanoparticles for producing biodiesel from non-edible oils.	NCERD and Prof Pius O. Ukoha (Department. of Pure and Industrial Chemistry, UNN)	The synthesized zinc oxide and iron oxide nanoparticles increased biodiesel yield, reduced the reaction time, and improved the fuel properties of biodiesel produced from Used frying oil. This paves the way for developing a protocol for low-cost biodiesel production from non-edible oils. This is in line with the public policy of access to clean and affordable energy.
14	2019	SOLTrain West Africa (ECOWAS solar thermal demonstration programme coordinated by ECREEE) held at NCERD, UNN	NCERD, Dr. O. Nweke, ECOWAS coordinated by ECREEE	Capacity building and Development on solar thermal device device fabrication and testing skills . This is in line with the policy issues on the development and domesticating of renewable energy technology in Nigeria

S/N	**Date**	**Title of Research**	**Names of Collaborators**	**Outcomes of Research/ Collaboration**
1	2024	Assessment of the compatibility of biomass‐coal blends for cleaner energy utilization and sustainable development	Ofomatah A.C (NCERD) Onochie U.P (DELSU)	Published in Biomass Conversion and Biorefinery
2	2024	Effect of binder on the optimization ratio of the physiochemical properties of biomass-coal pellets	Ofomatah A.C (NCERD) Onochie U.P (DELSU)	Presented at 6th international conference/training workshop (ICTWESDA 2024)

3	2023	Potentials of Biomass Waste Resources with Respect to their Calorific Value, Proximate and Ultimate Analysis for Energy Utilization.	Ofomatah A.C (NCERD), Onochie U.P DELSU	Published in IOP Conference Series
4	2023	Development of refractories for the pyro-processing (heatbased) industry in Nigeria through the evaluation of mixtures of Enugu Iva-Pottery clay, Nsu-clay and palm kernel shell waste	Ofomatah A.C (NCERD), Agbo S PRODA	Published in IOP Conference Series
5	2023	The effects of catalyst and co-digestion on the performance of biogas yield.	Ofomatah A.C (NCERD)Ezekoye, V UNN, Physics Dept	Published in IOP Conference Series
6	2022	Bioavailability and health risk assessment of potentially toxic elements in salty water environment of Okposi, Southeastern Nigeria.	Kenechukwu E. Ugwu and Anthony C. Ofomatah	Published in *SN Applied Sciences*
11	2021	Microplastics pollution indices of bottled water from South Eastern Nigeria	C.N Ibeto, C.E Enyoh, A.C Ofomatah, L.A Oguejiofor, T. Okafocha and V. Okanya	Published in *International Journal of Environmental Analytical Chemistry*.
12	2021	Impedance studies of biosynthesized $Na_{0.8}Ni_{0.33}Co_{0.33}Mn_{0.33}0_2$ applied in an aqueous sodium-ion battery	Assumpta Chinwe Nwanya, Miranda M. Ndipingwi, Ofomatah Anthony. Fabian I. Ezema, Malik Maaza and Emmanuel Iwuoha	Published in *Int. J Energy Res*.
13	2021	Spent bio-slurry from ‘’Adani’’ rice husk mixed with graded levels of cow dung in bio-gasification: Heavy metals identification and potentials	A C Ofomatah, E O Uzodinma and O Ojike	Published in IOP conference series *Earth Environ. Sci*
14	2021	Comparative study of calorific values and proximate analysis of biogas from different feed stocks	V. Ezekoye, D Ezekoye, A Ofomatah and A Agbaogu, UNN	Published in IOP conference series *Earth Environ. Sci*
15	2021	Improving Biogas Yield Using Organic Fraction of Plant and Animal Wastes by Co-digestion.	Ezekoye Veronica A, Okoro Geraldine I, Ofomatah Anthony, Ezekoye David and Agbaogu Ada, UNN	Published in *IOP Conf. Ser: Earth Environ. Sci*
16	2021	The Effect of Elaeis Guineensis Residue on CO2 and SO2 Emissions from Coal Pellets Combustion.	U P Onochie, F Onoroh, C Onwurah and A C Ofomatah, UNN	Published in *IOP Conf. Ser: Earth Environ. Sci*

17	2021	Biogas Production and Storage from Pig Dung Co-Digested with Pineapple Peels	A C Ofomatah, K E Ugwu and J U Ani, UNN	Published in *IOP Conf. Ser: Earth Environ. Sci*
18	2020	Detection and Determination of Associated Metals from Charcoal by Atomic Absorption Spectroscopy	Ugwu K and Ofomatah A.C and UNN	Published in *IOP Conf. Ser: Earth Environ. Sci*
19	2020	Feed Analyses of Proximate Composition and Heavy Metals: A Case Study of Some Poultry Feeds Distributed in Aba, Southeastern, *Nigeria*	O.L. Alum; C.E. Eledalachi1; E.M. Orji1; H.O. Abugu; A.C. Ofomatah and N.C Isienyi, UNN	Published in *Pacific Journal of Science and Technology*
20	2020	Methane Production Enhancement and Comparative Study of Biodegradation of Some Plants and Animal Wastes	Veronica Ezekoye, Peter Offor, Anthony Ofomatah, Agbogu Ada and Ezekoye David, UNN	Published in *Indian Journal of Biochemistry and Biophysics (IJBB).*
21	2019	Synthesis and Characterization of Biodiesel from Citrus Sinensis Seed Oil.	Veronica Ezekoye, Rita Adinde, David Ezekoye and Anthony Ofomatah, and UNN	Published in *Scientific African*
22	2019	Characterization and Analysis of Biodiesel Produced from Lonchocarpus Sericeus Seed Oil	Ezekoye, V, Adinde, R, Ezekoye, D and Ofomatah, A and UNN	Published in Proceedings of the 2nd Biennial General Meeting and Scientific Conference, *Women in Science*.
23	2019	Application of response surface methodology for optimization of dissolved solids adsorption by activated charcoal.	J.U Ani, U.C Okoro, L.E Aneke, O.D Onukwuli, I.O Obi, K.G Akpomie and A.C Ofomatah and UNN	Published in *Applied Water Science*.
24	2017	Contamination levels, toxicity profiles, and emission sources of polycyclic aromatic hydrocarbons (PAHs) in the soils of an emerging industrial town and its environs in the Southeastern Nigeria	Ofomatah, A.C and Okoye, C.O.B	Published in *Environ Monit Assess*
25	2017	Biogas Optimization Potentials of Cow Dung, Pig Dung and Poultry Droppings with Sugar cane bagasse and Watermelon Peel	A.C Ofomatah and E.E Obasi and UNN	Published in *FUW Trends in Science and Technology Journal*
26	2017	Methane emissions and volatile fatty acid production from manure excreted by cattle fed diets containing lipids	L.C Ugwuowo, A.G Ezekwe, A.O Ani , S.I Eze, C.N Anyanwu and	Published in the *J. Anim. Plant Sci*

			A. Ofomatah and UNN	
27	2016	Biodegradation with heterogeneous catalyst in the production of biogas from wheat wastes, rice husk and spent grains	Ezekoye Veronica, Ezekoye Benjamin, Ofomatah Anthony, Onah Daniel and Peter Offor and UNN	Published in *Int.J. Phy. Sc*
28	2015	The effect of soaking time on biogas yield of ash-treated and untreated bagasse.	Ofomatah A.C, Ezema C.G and David U.G And UNN	Published in *J. Ren and Alt. Energy Tech*.
29	2015	Evaluation of combustion potentials of biogas produced from blends of pig dung and cabbage leaves waste	Uzodimma E.O, Ezenwa M.C and Ofomatah A.C And UNN	Published in *J. Ren and Alt. Energy Tech*
30	2015	The efficacy of palm oil sludge in reducing ruminal methanogenesis using rumen simulation technique	L.C Ugwuowo, A.G Ezekwe, A.O Ani , S.I Eze, C.N Anyanwu and A. Ofomatah, UNN	Published in *Afr J.Biotechnol*
31	2015	Production and Analyses of Biodiesel from Gmelina Seed Oil (*G*melina *a*rborea)	Ofomatah A.C, Ezema C.G and Idoko C, UNN	Published in *Nig. Journal of Solar Energy*
32	2013	Evaluation of Liquid Charcoal as an Alternative to Diesel Oil	Ugwu K.E, Ofomatah A.C and Eze S.I	Published in *Nig. Journal of Solar Energy*
33	2013	Bioethanol Production from Acid Pre-Treated Banana (Musa aluminata) Peels.	Ibeto C.N, Ofoefule A.U, Ofomatah A.C and Ugwoke P.E, UNN	Published in *Nig. Journal of Solar Energy*
34	2013	Biodigestion of cassava peels blended with pig dung for methane generation.	Oparaku N.F, Ofomatah A.C and Okoroigwe E.C UNN	Published in *Afr. J. Biotechnol*
35	2013	Biodegradation of agricultural waste and pig dung in anaerobic digester. *Int.J. Phy. Sc*.	Oparaku N.F and Ofomatah A.C, and UNN	Published in *Int.J. Phy. Sc*
36	2013	Influence of solid concentration on the flow characteristics and settling rate of coal-water slurries.	Kenechukwu Emmanuel Ugwu, Anthony Chibuzo Ofomatah and Samson Ifeanyi Eze and UNN	Published in *JENR*
37	2013	Evaluation of properties of coal slurry from different solvents.	Ugwu K.E and Ofomatah A.C, and UNN	Published in *Int.J. Phy. Sc*
38	2013	Production and evaluation of activated carbon from palm kernel shells(PKS)	Okoroigwe E.C, Ofomatah A.C, Oparaku	Published in *Int.J. Phy. Sc*

		for economic and environmental sustainability	N.F and Unachukwu G.O and UNN	
39	2013	The effects of cow dung inoculum and palm head ash-solution treatment on biogas yield of bagasse	Ofomatah A.C and Okoye C.O.B, UNN	Published in *Int.J. Phy. Sc*
40	2012	Bagasse and poultry droppings as feedstock for biogas production.	Ugwu K.E, Ofomatah A.C and Okoye C.O.B, UNN	Published in *IJPAC*
41	2012	Production and storage of biogas from ash-treated and untreated bagasse	Ofomatah Anthony Chibuzo, Ibeto Cynthia Nkolika, Okoye Chukwuma Obiajulu Benedict and Unachukwu Godwin Ogechi, UNN	Published in *Int.JCR*.
42	2012	Production and Characterization of biodiesel fuel of cocos nucifera (coconut) oil and its blend from Nsukka, Nigeria	C.G Ezema, A.C Ofomatah and B.E Ezema, UNN	Published in *Int. J. Chem.*
43	2011	Effect of ash on the optimization of biogas production from blends of bagasse and cow dung.	A.C Ofomatah, C.O.B Okoye and G.O Unachukwu, UNN	Published in *J. Chem Soc. Nigeria*
44	**2020**	"Energy Challenge and the Nigerian Economy	Nnaji, M.; Eze, A.A.; Uzoma, C. C.; Nnaji, C. E. & Madueme S.I, Prof. Jude Chukwu. Department of Economics, university of Nigeria, Nsukka. 2. Chimere Iheonu, University of South Africa, Johannesburg	Published in Nigerian Journal of Solar Energy, Vol.31, Issue1, pp. 31-34
45	**2020**	Foreign Direct Investment, Financial Deepening, Energy Innovations and Environmental Quality in Selected African Economies The Socio-Economic Impact Assessment Of Solar Photovoltaic(PV) Systems Within Nsukka Local government Area of Enugu State	Chukwu, Jude Okechukwu, Chimere O. Iheonu and Chibueze, E. Nnaji, 1.Prof. Jude Chukwu. Department of Economics, university of Nigeria, Nsukka. 2. Chimere Iheonu, University of South Africa, Johannesburg	Published in Nigerian Journal of Social Sciences, Vol.14, Issue 2,pp. 1-8

46	**2021**	Centralised electricity grid and he rural economy of Nigeria. Addressing Household Cooking Fuel Options in Nigeria.	Chigasa C. uzoma, C. Atama, Kelechi Okpara, Ijeoma Igwe, Moses Nnaji, Chidiebere Adagba and E. Onyekaozuru Monica Maduekwe/ ECREEE, Praia, Cape Verde	Published in IOP Conference series ,earth and Environmental science.

5. OTHER RELEVANT CONTRIBUTIONS TO THE ENERGY SECTOR

Design and Fabrication Work at Mechanical Workshop Section (2012- date)

- Design, construction and performance evaluation of a passive indirect solar air heater built with auxiliary paraffin oil blend as heat storage medium for drying woodslab for continuous drying during off-sun hours.
- Design and fabrication of institutional rocket type energy efficient wood cookstove with chimney for use by Vaneta Industry Ltd, Auchi Okene, Edo State and one customized 20 liters pot for blending biomass feedstock for biogas production.
- Design, construction and testing of hybrid photovoltaic/thermal solar water heater for improved output power performance of PV system
- Design, construction and performance evaluation of anactive mixed mode solar dryer with three rack trays and vertical chimney powered by solar PV system for drying fruits and vegetables.
- Design, construction and performance evaluation of anactive mixed mode solar dryer with three rack trays and horizontal chimney powered by solar PV system for drying fruits and vegetables
- Design, fabrication and performance evaluation mini-size laboratory Kiln for firing clay body use for producing the insulating body part of the energy efficient biomass cook stoves, by National Stove Eligibility Laboratory section ofNCERD.
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Research Work at the Solar Photovoltaic Laboratory Section (2013- date)

- Enhancement of the performance of ZnO based naturaldye sensitized solar cells via PVA morphology controlled nanorods.
- Comparative photo-response performances of dye sensitized solar cells using dyes from hibiscus rosa- sinensis, helianthus annuus, mimosa pudica, luffa cylindrical and lonchocarpus cyanescens
- Influence of annealing temperature on the performance of TiO_2 based Dye sensitized solar cells.
- Effects of Cr dopants on the performance of ZnO based Dye sensitized solar cells.
- Fabrication and evaluation of the photoelectrical performance of dye sensitized solar cells using dye from Bougainvillea glabra flower and TiO_2, ZnO and TiO_2/ZnOphotoelectrodes.

- Electrical drafting, load analysis, installation of electrical appliances and maintenance at NCERD.
- Design, application and maintenance of photovoltaic systems and Electrical drafting at NCERD.
- Developing a semi simulating insolation PV Lab.atNCERD.
- Investigating the effects varying PV parameters on the optimal performance of the system at NCERD.
- Techno Economic evaluation of PV system at point of consumption at NCERD, work is still ongoing.
- Evaluation of the outcome of the non-investment in distributed generation of distribution network done fort Electrical Engineering, University of Nigeria, Nsukka at NCERD.
- Evaluation and understudying the effect of dust by volumeon PV module by self-simulating insolation, done for Mechanical Engineering, University of Nigeria, Nsukka atNCERD.
- Performance evaluation studies of All in One Street Light at NCERD.
- Developing model for PV sizing at NCERD.
- Modelling of Embedded Power System to ImproveVoltage Profile at NCERD, work still ongoing.

Completed Field Work and Research Projects (2015 - date)

- Completion of Survey on "Indoor air pollution andHousehold energy use", focused on determining the prevalence of various cooking energy sources and penetration of renewable and clean energy fuels aswell as air pollution among households in South East Nigeria. A total of randomly selected 1698 householdswere included from 2017 – Oct. 2019.

- Monitoring the concentrations of air pollutants (NO_2, SO_2, O_3 and VOCs) linked to cooking fuels among households in Nsukka Urban and surrounding ruralareas from June 2018 – Sept. 2019.

- Monitoring of two solar water heating systems at Sunshine hotels Enugu, from January – September, 2019, conducted under the auspices of SOLTrain West Africa (ECOWAS solar thermal demonstration programme coordinated by ECREEE), by Solar/Geothermal Unit of NCERD.

- Inspection, performance evaluation and maintenance of solar powered street lights, solar powered water bore holes for rural community sustainable water supply in Enugu, Imo, Abia, Ebonyi, Anambra, Rivers and Edo States.

- Installation, Performance monitoring and maintenance of solar powered street lights installed in the premises of NCERD complex, and Nsukka campus of University of Nigeria and solar PV system for powering laboratory and office equipment at the NCERD Biomass and Admin buildings.

- Installation of Solar-electric vaccine refrigeration system at the University of Nigeria Nsukka Medical Centre

- Installation of Solar-electric for powering TVs, lighting and scientific equipment at the University of Nigeria, Nsukka Medical Center
- Installation of the Laboratory Emissions Monitoring System (LEMS) at the National Stove Eligibility Laboratory, University of Nigeria, Nsukka, 2015.
- Design and construction of $10m^3$ capacity biogas system at Achalla Nru Village in Nsukka Local Government Area.
- Design and construction of $10m^3$ capacity biogas plant at Energy Research Centre, University of Nigeria Nsukka
- Bio-waste to Energy Conversion: Thermalperformance investigations and analysis of pulverized wood sawdust waste and water hyacinth blend intosolid biomass briquette fuel for domestic and industrial uses as alternative fuel source to fuel wood, conducted by Energy Management and Environment Unit, NCERD.
- Determination of concentrations of polycyclic aromatic hydrocarbons (PAHs) in extracts of coals mined at Onyeama, Enugu State and at Okobo, Kogi State, conducted by Fossil Energy Unit, NCERD. PAHs are harmful to the environment and the health ofpeople due to their high degree of mutagenicity and carcinogenicity.
- Preliminary studies on the preparation of coal-water slurries, conducted by Fossil Energy Unit, NCERD. Coal-water slurries preparation from different ratios of coal to water to evaluate necessary parameters towardsmaking use of coal-water mixture in engines.
- Review of environmental issues in coal processing and utilization, and the mitigation of coal environmental impacts, conducted by Fossil Energy Unit, NCERD.
- Production of biogas from organic waste such as:

  (a) Albino Rat dung only; Albino rat dung with plantain peels; Albino rat dung with clay; Albino rat dung KOH; Albino rat dung plantain peel with NaOH
  (b) Water hyacinth; plantain peels; cow dung ;water hyacinth with plantain peel; water hyacinth with cow dung ; cow dung with plantain peel; water hyacinth with plantain peel with cow dung.
  (c) Goat dung; pig dung; sheep dung; carpet grass; chicken broilers;
  (d) Generating electricity or mechanical power from biogas production
  (e) Cooking test comparative studies: biogas,NNPC gas, charcoal, and kerosene.
  (f) Investigating the effect of bigester shape inbiogas production yield.

RESEARCH WORK OUTPUT IN THE BIOMASS LAB SECTION

ENERGY COMMISSION OF NIGERIA
NATIONAL CENTRE FOR ENERGY RESEARCH AND DEVELOPMENT
UNIVERSITY OF NIGERIA, NSUKKA

The research results of the under-listed research work (2010 - date) are disseminated through conferences, exhibitions and publications in the conference proceedings, national and international peer-reviewed journals.

Research Work Carried out in the Biomass Lab Section 2025

1. Drying of various samples with solar drier.
2. Data Collection from weather station.
3. Ashing/Ash Content Determination of cashew nut shell using muffle furnace.
4. PH reading and adjustment of reagents with pH metre.
5. Free fatty acid determination of pear oil by titrimetry.
6. Moisture content determination of wood samples using oven.

Research Work Carried out in the Biomass Lab Section 2024

1. Sulphur Content Determination by gravimetry.
2. Ultimate Analyses of Coal Samples
3. Determination of the proximate composition of digester slurry and biomass.
4. Extraction of oil from various seeds for biodiesel production.
5. Production of biodiesel from oil seeds.
6. Characterization of oil and biodiesel samples.
7. Digestion of biomass waste samples for heavy metals determination.
8. Analyses of Effluents
9. Proximate Analyses of plant samples.
10. Soil Analyses
11. Determination of Total Solids on waste samples using oven.
12. Carbon Content Determination on coal sample.

Research Work Carried out in the Biomass Lab Section 2023

1. Determination of Brix Value using Abbe refractometre.
2. Metal analyses using atomic absorption spectrophotometre.
3. Sulphur Content Determination by gravimetry.
4. Ultimate Analyses of Coal Samples
5. Determination of Total Solids on waste samples using oven.
6. Carbon Content Determination on coal sample.
7. Density/specific gravity measurement on crude oil using density bottle.
8. Microscopic Examination of slurry using a microscope.
9. Water Analyses
10. Refractive Index Determination using Abbe refractometre.
11. Determination of Brix Value using Abbe refractometre.
13. Metal analyses using atomic absorption spectrophotometre.

Research Work Carried out in the Biomass Lab Section 2022

1. Production of hand sanitizers for covid-19
2. Production of disinfectants for covid-19
3. Production of hand wash for covid-19
4. Water Analyses
5. Refractive Index Determination using Abbe refractometre.

6. Determination of Brix Value using Abbe refractometre.
7. Determination of Total Solids on waste samples using oven.
8. Carbon Content Determination on coal sample.
9. Density/specific gravity measurement on crude oil using density bottle.
10. Microscopic Examination of slurry using a microscope.
11. Water Analyses
12. Refractive Index Determination using Abbe refractometre.

Research Work Carried out in the Biomass Lab Section 2021

1. Production of hand sanitizers for covid-19
2. Production of disinfectants for covid-19
3. Production of hand wash for covid-19
4. Proximate Analyses on coal samples.
5. Crude fat determination of cashew nut sample using soxhlet apparatus.
6. Gas analysis of biogas samples with gas analyser.
7. Autoclaving of samples using autoclave.
8. Volatile matter determination on waste samples using oven and furnace respectively.
9. Determination of Total Solids on waste samples using oven.
10. Carbon Content Determination on coal sample.
11. Density/specific gravity measurement on crude oil using density bottle.
12. Microscopic Examination of slurry using a microscope.

Research Work Carried out in the Biomass Lab Section 2020

1. Production of hand sanitizers for covid-19
2. Production of disinfectants for covid-19
3. Production of hand wash for covid-19
4. Determination of Calorific Value of coal samples using bomb calorimetre
5. Carbonization of palm kernel shells using muffle furnace.
6. Determination of the absorbance and transmittance of nano particles with ultra-violet visible Spectrophotometre.
7. Scanning for the determination of wavelength of maximum absorption with ultra-violet visible Spectrophotometre.
8. Weighing of coal samples for digestion using ohaus weighing balance.
9. Characterization of coal samples.
10. Drying of various samples with solar drier.
11. Data Collection from weather station.
12. Ashing/Ash Content Determination of cashew nut shell using muffle furnace.

Research Work Carried out in the Biomass Lab Section 2019

1. Determination of Brix Value using Abbe refractometre.
2. Metal analyses using atomic absorption spectrophotometre.
3. Sulphur Content Determination by gravimetry.
4. Ultimate Analyses of Coal Samples
5. Determination of the proximate composition of digester slurry and biomass.
6. Extraction of oil from various seeds for biodiesel production.
7. Characterization of coal samples.

8. Drying of various samples with solar drier.
9. Data Collection from weather station.
10. Ashing/Ash Content Determination of cashew nut shell using muffle furnace.
11. PH reading and adjustment of reagents with pH metre.
12. Free fatty acid determination of pear oil by titrimetry.

Research Work Carried out in the Biomass Lab Section (2018)

1. Data Collection from weather station.
2. Ashing/Ash Content Determination of cashew nut shell using muffle furnace.
3. PH reading and adjustment of reagents with pH metre.
4. Free fatty acid determination of pear oil by titrimetry.
5. Moisture content determination of wood samples using oven.
6. Proximate Analyses on coal samples.
7. Determination of Brix Value using Abbe refractometre.
8. Metal analyses using atomic absorption spectrophotometre.
9. Sulphur Content Determination by gravimetry.
10. Ultimate Analyses of Coal Samples
11. Determination of the proximate composition of digester slurry and biomass.
12. Extraction of oil from various seeds for biodiesel production.

Research Work Carried out in the Biomass Lab Section (2017)

1. Determination of Calorific Value of coal samples using bomb calorimetre
2. Carbonization of palm kernel shells using muffle furnace.
3. Determination of the absorbance and transmittance of nano particles with ultra-violet visible Spectrophotometre.
4. Scanning for the determination of wavelength of maximum absorption with ultra-violet visible Spectrophotometre.
5. Weighing of coal samples for digestion using ohaus weighing balance.
6. Soil Analyses
7. Characterization of coal samples.
8. Drying of various samples with solar drier.
9. Data Collection from weather station.
10. Ashing/Ash Content Determination of cashew nut shell using muffle furnace.
11. PH reading and adjustment of reagents with pH metre.
12. Free fatty acid determination of pear oil by titrimetry.

Research Work Carried out in the Biomass Lab Section (2016)

1. Characterization of coal samples.
2. Drying of various samples with solar drier.
3. Data Collection from weather station.
4. Ashing/Ash Content Determination of cashew nut shell using muffle furnace.
5. PH reading and adjustment of reagents with pH metre.
6. Free fatty acid determination of pear oil by titrimetry.
7. Moisture content determination of wood samples using oven.
8. Proximate Analyses on coal samples.
9. Crude fat determination of cashew nut sample using soxhlet apparatus.

10. Gas analysis of biogas samples with gas analyser.
11. Autoclaving of samples using autoclave.
12. Volatile matter determination on waste samples using oven and furnace respectively.

Research Work Carried out in the Biomass Lab Section (2015)

1. Determination of Total Solids on waste samples using oven.
2. Carbon Content Determination on coal sample.
3. Density/specific gravity measurement on crude oil using density bottle.
4. Microscopic Examination of slurry using a microscope.
5. Water Analyses
6. Refractive Index Determination using Abbe refractometre.
7. Determination of Brix Value using Abbe refractometre.
8. Metal analyses using atomic absorption spectrophotometre.
9. Sulphur Content Determination by gravimetry.
10. Ultimate Analyses of Coal Samples
11. Determination of the proximate composition of digester slurry and biomass.
12. Extraction of oil from various seeds for biodiesel production.

Research Work Carried out in the Biomass Lab Section (2014)

1. Sulphur Content Determination by gravimetry.
2. Ultimate Analyses of Coal Samples
3. Determination of the proximate composition of digester slurry and biomass.
4. Extraction of oil from various seeds for biodiesel production.
5. Production of biodiesel from gmelina seed oil.
6. Characterization of gmelina seed oil and biodiesel samples.
7. Digestion of biomass waste samples for heavy metals determination
8. Production of biodiesel from oil seeds.
9. Characterization of oil and biodiesel samples.
10. Digestion of biomass waste samples for heavy metals determination.
11. Analyses of Effluents
12. Proximate Analyses of plant samples.

Research Work Carried out in the Biomass Lab Section (2013)

1. Proximate Analyses on coal samples.
2. Crude fat determination of cashew nut sample using soxhlet apparatus.
3. Gas analysis of biogas samples with gas analyser.
4. Autoclaving of samples using autoclave.
5. Volatile matter determination on waste samples using oven and furnace respectively.
6. Determination of Total Solids on waste samples using oven.
7. Carbon Content Determination on coal sample.
8. Density/specific gravity measurement on crude oil using density bottle.
9. Microscopic Examination of slurry using a microscope.
10. Water Analyses
11. Refractive Index Determination using Abbe refractometre.
12. Determination of Brix Value using Abbe refractometre.

Research Work Carried out in the Biomass Lab Section (2012)

1. Determination of Calorific Value of coal samples using bomb calorimetre
2. Carbonization of palm kernel shells using muffle furnace.
3. Determination of the absorbance and transmittance of nano particles with ultra-violet visible Spectrophotometre.
4. Scanning for the determination of wavelength of maximum absorption with ultra-violet visible Spectrophotometre.
5. Weighing of coal samples for digestion using ohaus weighing balance.
6. Characterization of coal samples.
7. Drying of rice rusk with solar drier.
8. Data Collection from weather station.
9. Ashing/Ash Content Determination of cashew nut shell using muffle furnace.
10. PH reading and adjustment of reagents with pH metre.
11. Free fatty acid determination of pear oil by titrimetry.
12. Moisture content determination of wood samples using oven.

Research Work Carried out in the Biomass Lab Section (2011)

1. Crude fat determination of cashew nut sample using soxhlet apparatus.
2. Gas analysis of biogas samples with gas analyser.
3. Autoclaving of samples using autoclave.
4. Volatile matter determination on waste samples using oven and furnace respectively.
5. Determination of Total Solids on waste samples using oven.
6. Carbon Content Determination on coal sample.
7. Density/specific gravity measurement on crude oil using density bottle.
8. Microscopic Examination of slurry using a microscope.
9. Water Analyses
10. Refractive Index Determination using Abbe refractometre.
11. Determination of Brix Value using Abbe refractometre.
12. Sulphur Content Determination by gravimetry.

Research Work Carried out in the Biomass Lab Section (2010)

1. Determination of Calorific Value of coal samples using bomb calorimetre
2. Carbonization of palm kernel shells using muffle furnace.
3. Determination of the absorbance and transmittance of nano particles with ultra-violet visible Spectrophotometre.
4. Scanning for the determination of wavelength of maximum absorption with ultra-violet visible Spectrophotometre.
5. Weighing of coal samples for digestion using ohaus weighing balance.
6. Drying of rice rusk with solar drier.
7. Data Collection from weather station.
8. Ashing/Ash Content Determination of cashew nut shell using muffle furnace.
9. PH reading and adjustment of reagents with pH metre.
10. Free fatty acid determination of pear oil by titrimetry.
11. Moisture content determination of wood samples using oven.

12. Proximate Analyses on coal samples.

Impact of the research on the economy or specific industries.

S/N	year	Title of Research	Outcomes of Research/ Impact of the research on the economy
	2010	The Role of Renewable Energy Resources in Poverty Alleviation and Sustainable Development in Nigeria	Reveals the importance of renewable energy resources in industrialization, employment creation, income generation even in the rural communities and drastic reduction of poverty in the country.
	2011	Electricity Generation, Economic Growth and the Need for Alternative Source of Power in Nigeria	Reiterates the importance of renewable energy resources for stimulating economic growth and alternative source of power.
	2012	Determinants of Household Energy Choices for Cooking in Rural Areas: Evidence from Enugu State, Nigeria	analyzed the factors determining rural energy choices for cooking in rural areas in Enugu State and suggest the need for policy makers to consider socio-economic factors while addressing issues associated with household energy consumption
	2013	Electricity Supply, Fossil Fuel Consumption, CO_2 Emissions and Economic Growth: Implications and Policy Options for Sustainable Development in Nigeria	Revealed that a holistic energy planning and investment in energy infrastructure is needed to drive economic growth
	2014	Demographic Variables, Energy Intensity, Environmental Degradation and Economic Growth Nexus in the Nigerian Economy	The study opens up a new policy insight to control the environment by using energy efficient technologies. Access to alternative and affordable renewable energy systems and cleaner fuels can also play a pivotal role in improving environmental quality.
	2016	The Energy Intensity of Economic Sectors in MINT Countries: Implications for Sustainable Development	*The results suggest that a policy framework that emphasizes the utilization of energy efficient technologies especially electricity infrastructural development aimed at energy service availability, accessibility and affordability will help to trigger desirable economic development and ensure rapid sustainable development of MINT (Mexico, Indonesia, Nigeria, Turkey) economies.*
	2020	Foreign Direct Investment, Financial	The findings suggest that FDI has the

		Deepening, Energy Innovations and Environmental Quality in Selected African Economies	capacity of attracting environmentally friendly technologies. Financial deepening can lead to the provision of the needed funds for the change from fossil fuel based production to the use of renewable energy sources for production activities.
	2021	A Policy Analysis of Grid Rural Electrification in Nigeria since 1981	Highlights the importance of renewable energy in complementing rural electricity efforts for improving the socio-economic life of rural dwellers
	2022	The Socio-Economic Impact Assessment of Solar Photovoltaic(Pv) Systems within Nsukka Local Government Area of Enugu State	The research revealed that solar energy plays a great role in promoting the socio-economic life of dwellers in Nsukka local government area of Enugu State, Nigeria.
	2023	Decomposition effects of energy and co2 intensities in the Nigerian economy: A logarithmic mean weight divisia index (LMDI) analysis.	The outcomes revealed that energy use and CO2 emission have increased to some extent between 1980 and 2019.
	2024	Energy Access Constraints to COVID-19 Lockdown in Nigeria	*Evidences show great impediments to the COVID-19 response in Nigeria due to the dire lack of access to stable electricity during the lockdown to curtail the pandemic spread.*