ASSESSING THE VIABILITY OF INTEGRATED RENEWABLE ENERGY SYSTEM FOR INSTITUTIONS; CASE OF UCU MUKONO

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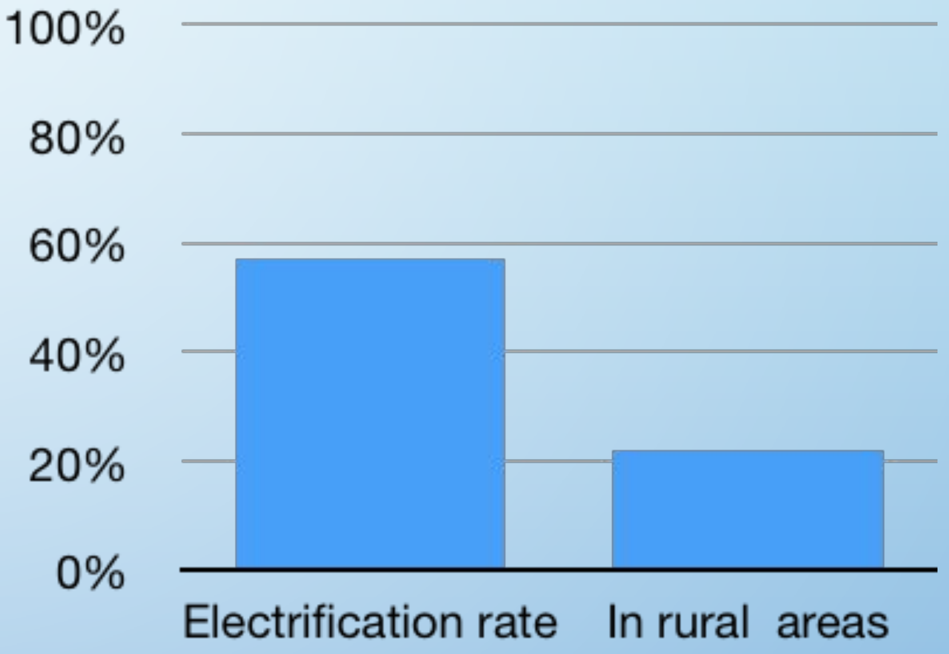
OVERVIEW

- Background/introduction
- Objectives
- Methodology
- Scope
- Results
- Challenges/limitations
- Lessons learned
- Recommendations & Conclusion

INTRODUCTION

- RE accounts for at least 88% of the electricity mix with large-hydropower contributing at least 67%.

- Electricity access in the country is still among the lowest in Africa .



- UCU has a population of 10,000 people. Hence a medium industrial user:
- Tariff ranges of USD 0.12 to USD 0.17 per unit(kwh) of electricity.

CONTINUATION

- Institutions still incur high costs for electrification.
- UCU spends up to UGX 70,000,000 on electricity bill monthly
- UCU heavily depends on firewood (over 95% heating energy demand kitchen)
- Hence need for alternative, available and cheaper resources
- Electrification strategy of Uganda highlights enhancing solar installations, mini-grids to increase electrification in areas without grid

OBJECTIVES

Overall objective

Assess the viability of an integrated renewable energy system for Uganda Christian University

Specific objectives

i. Identify key energy loads with in the University
ii. Assess the potential of renewable energy sources within UCU; Solar, wind, bioenergy
iii. Design an integrated renewable energy system for UCU

SCOPE

ENERGY EFFICIENCY

- Energy efficiency of the of the FEDT block

WIND ENERGY

- Viability of wind energy as a renewable energy source

SOLAR

- Library stand-alone system
- System for UCU sports arena

BIOENERGY

- Briquettes as clean cooking energy fuel.

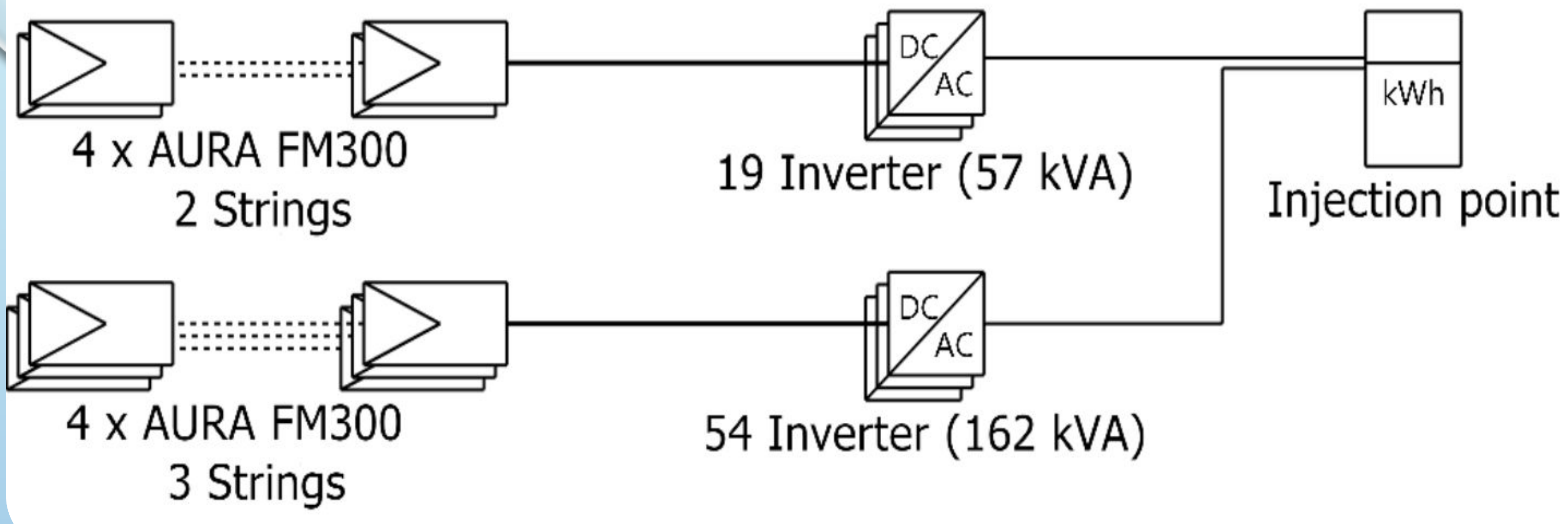
UCU AT A GLANCE: SCOPE

METHODOLOGY

- **Exploratory action research** which allows for three major steps of planning, exploring, reflecting.
- Preliminary assessment through key informants/technical academic and non academic staff, students;
- Survey, observation, experimentation, focus group discussions, interviews with various stakeholders.
- Supporting tools including software like Pvsyst used to design and size solar systems, excel etc. were used :

SIZING AND DESIGNING OF SOLAR STAND-ALONE FOR LIBRARY

Energy demand at library	66kW
Average solar radiation	5.1 $KWH/M^2/DAY$
Structural Stability	Rooftop structurally fit to host system
System Period	20 years
Available panel space	$1309m^2$
Considered Panel Type	300WP
Azimuth angle	10 ° considered



Financing	
Own funds	356,950.00 EUR
Subsidies	30,000.00 EUR
Electricity sale	
Feed-in tariff	0.1733 EUR/kWh
Duration of tariff warranty	20 years
Annual connection tax	0.00 EUR/kWh
Annual tariff variation	0.0 %/year
Feed-in tariff decrease after warranty	0.00 %
Return on investment	
Payback period	6.6 years
Net present value (NPV)	348,079.00 EUR
Internal rate of return (IRR)	18.44 %
Return on investment (ROI)	97.5 %

- **Various activities of the measurement taking process for system design at the library.**

SOLAR SYSTEM FOR UCU SPORTS ARENA

Variations of solar radiation a on a Cloudy day

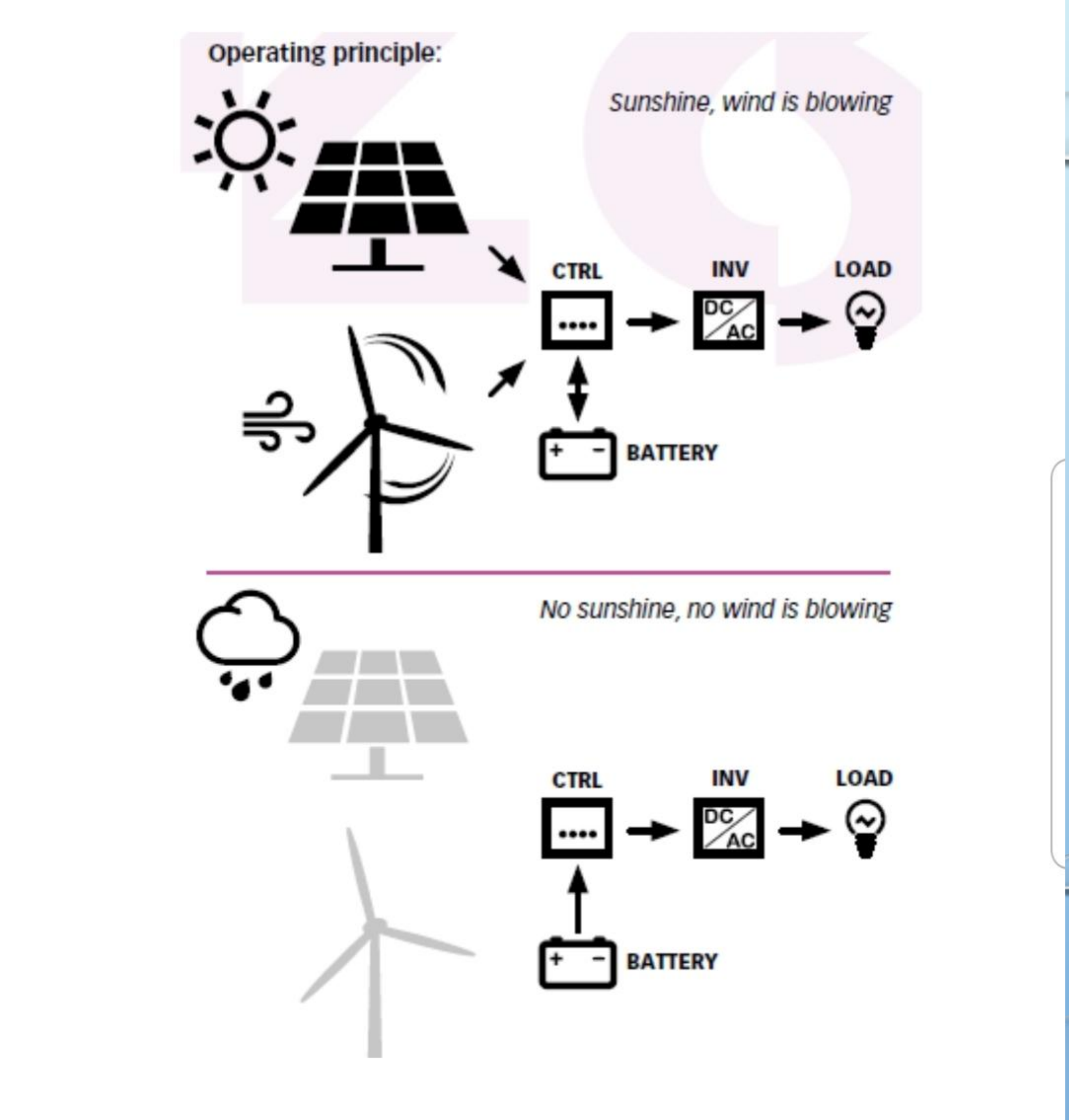
Times of day	8:00 am	10:00 am	12:00 pm	14:00 pm
Solar radiation (W/m^2)	609.2	631.5	914	874
	595.3	830	815	902
	583.4	875	845	878
	595.96	778.83	858	885

Variations of solar radiation a on a Sunny day

Times of day	10:00 am	12:00 pm	14:00 pm
Solar radiation (W/m^2)	932	962	1060
	1002	1011	1038
	1017	1037	1106
	983.67	1003.33	1068

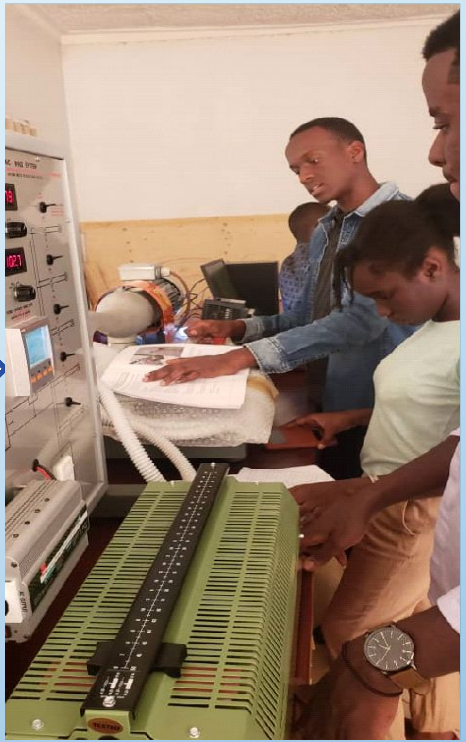
Preliminaries	**Energy Consumption of Sports arena lamps**	226.35 kWh @ month
	Hence electricity costs (800/= @ kWh)	Ush 1,728,000
System Sizing	**No. of 500WP solar panels**	94 panels
	Inverter Wattage	871 watts
	Battery Capacity	2452 Ah
	Key Point:	System sized based on ideal case/scenario

System description/ operating principle



Specifications for resistor part of the combined PV-Wind system

Using the combined PV-Wind system for experiments in the laboratory



Solar radiation meter used to collect radiation data

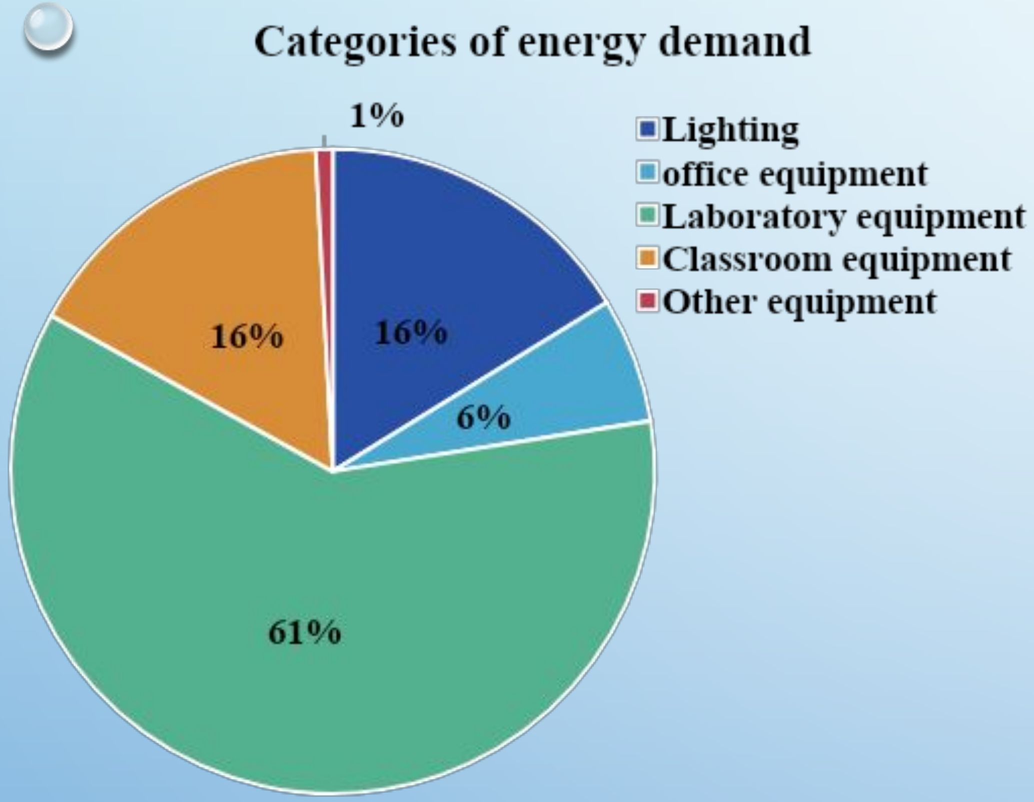
ENERGY EFFICIENCY OF FEDT BLOCK

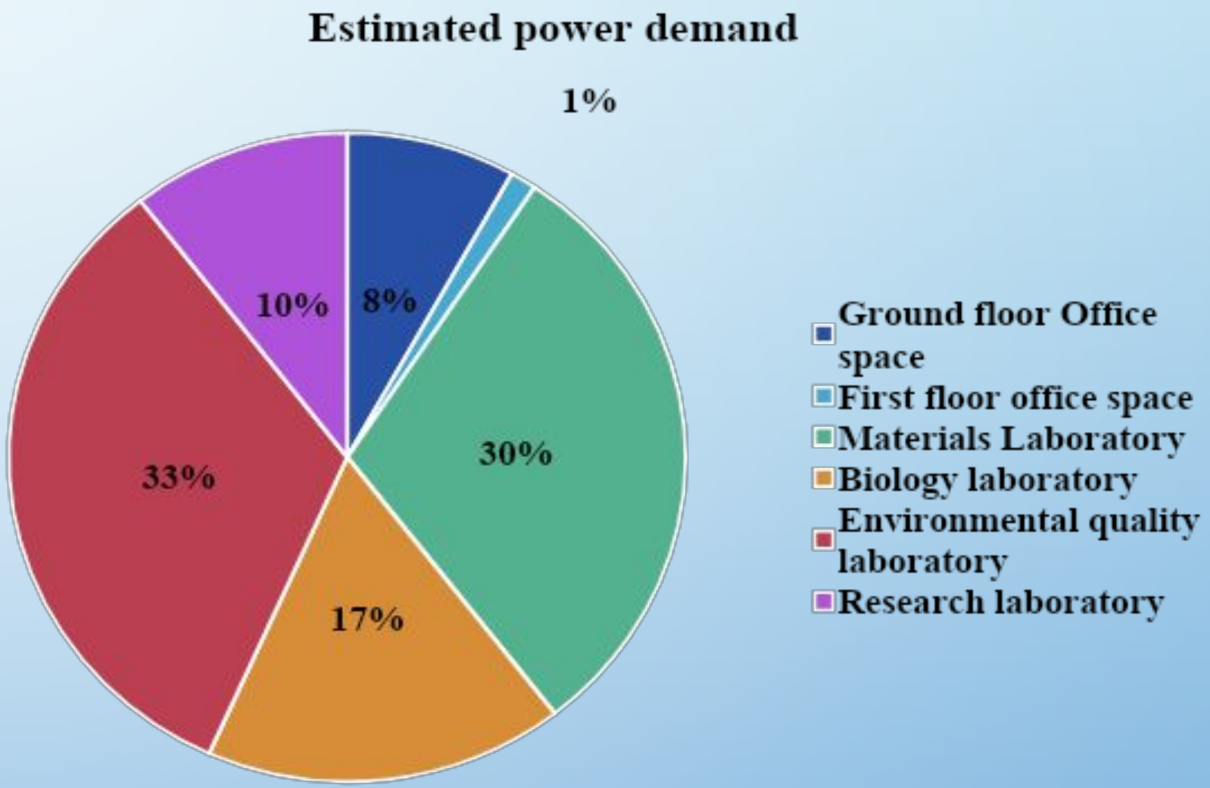
Tools & Materials used

Data analysis software	Equipment		
Microsoft excel	Tape measure	Light Meters	Temperature gun

Energy demand of FEDT	226.35 kWh
Highest demand category	Laboratory equipment
Lowest demand category	Office & other equipment

ENERGY EFFICIENCY OF FEDT BLOCK





Recommendation Solar to cover Lighting demand

During thermography survey

Data sources, laboratories

Collecting data for room dimensioning in CAD

VIABILITY OF WIND ENERGY FOR UCU

MAIN OBJECTIVE; To assess the viability of wind energy as a renewable energy source for UCU, Mukono Mukono

Indoor Wind simulation experiments with the WG-IM/EV model

Startup wind speed

- 3.59m/s, 12.93km/hr

Maximum wind speed

- 49.2 m/s, 177.12km/hr

Rated power

- 400 watts at 12.5m/s

Wind Speeds Siting

Ankrah foundation 1

- Ave.= 14.4-15.9 km/ hr
- Consistency- Medium

Kingdom View Ministry

- Ave. = 4-5 km/hr
- Cons. =High

Ankrah foundation 2

- Ave. = 12.3-14.9 km/hr
- Cons. =High

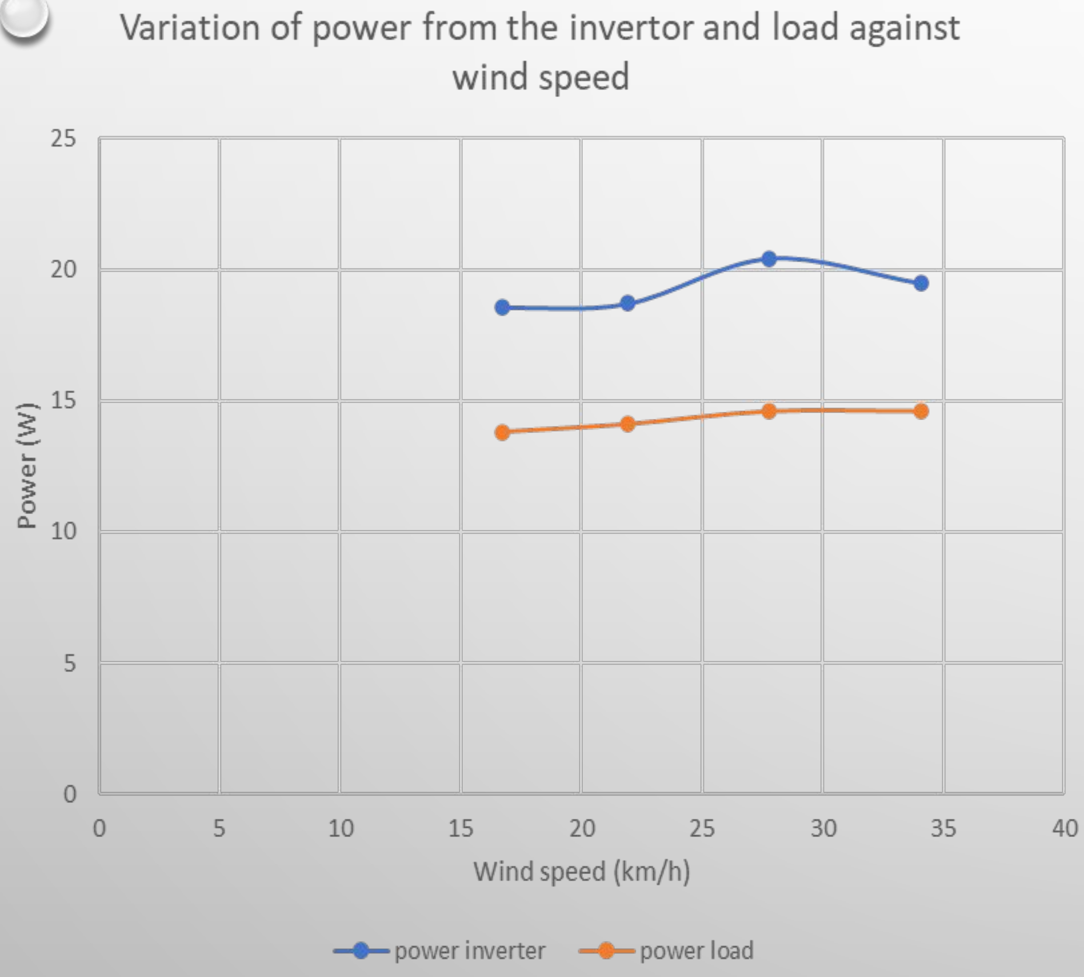
PDR halls of residence

- Ave.= 0-1.8 km/hr
- Cons. =High

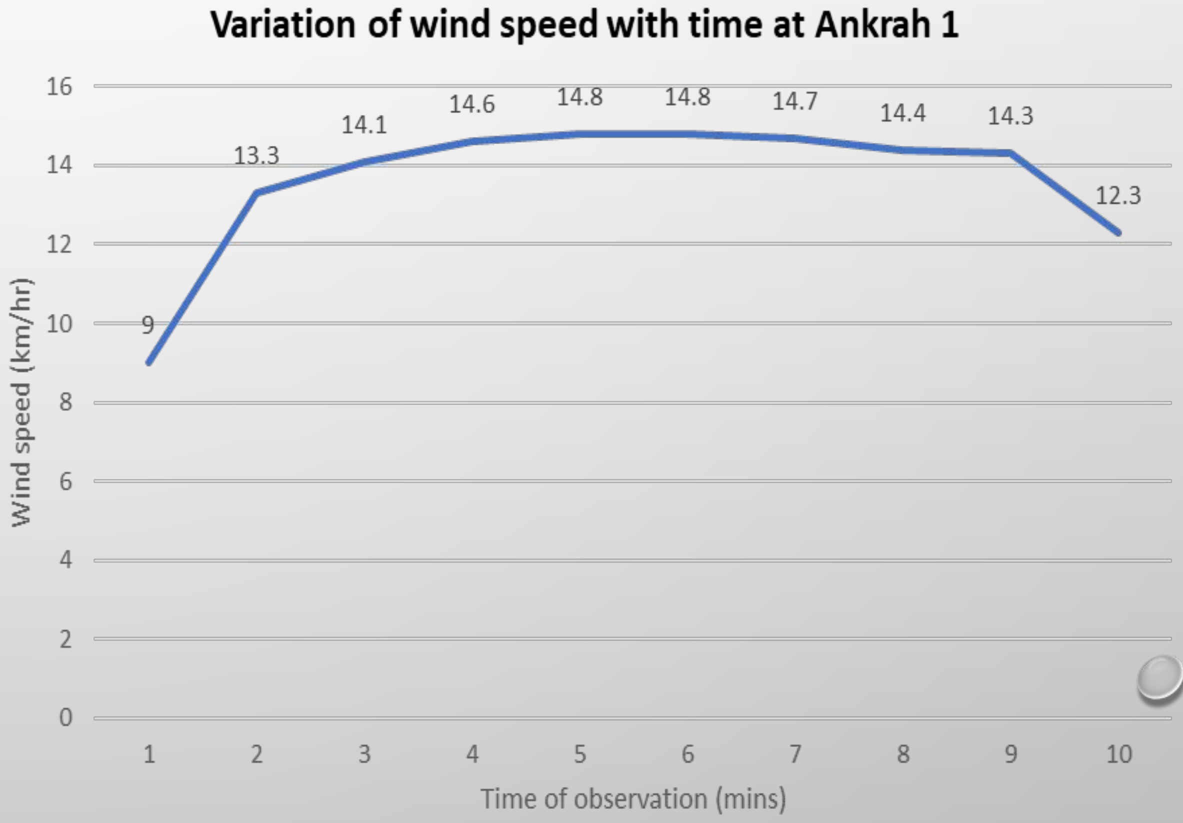
Nsibambi Halls of residence rooftop

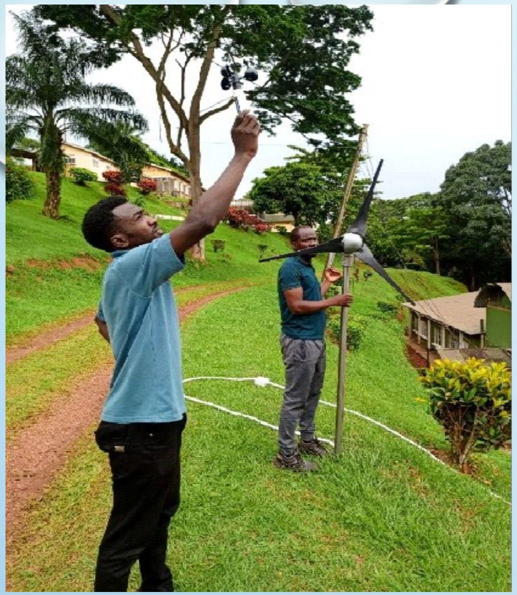
- Ave. = 0-1 km/hr
- Consistency =High

VIABILITY OF WIND ENERGY FOR UCU



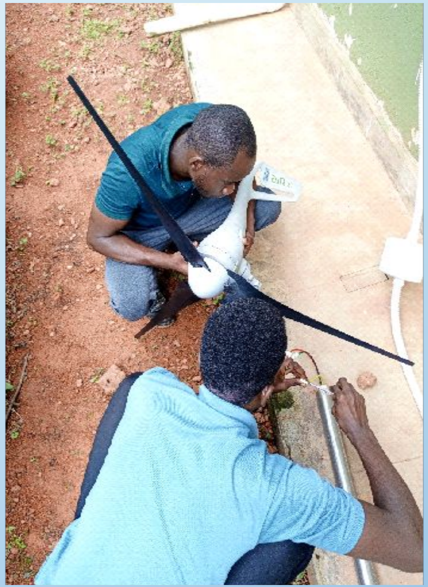
- **Cutoff speed** - At a site





Wind Speeds Siting

Setting up turbine for wind speeds siting



Analysing the system behaviour with wind blowing simulation

BRIQUETTES AS CLEAN COOKING ENERGY

Objectives	Methods	Findings	
Physical characteristics of the briquettes	Property/ test	Value	Standard
	Moisture content (%)	9.2	10-14
	Density(kg/m3)	810	Up to 1000
	Burning time (hrs.)	4-6	N/A
	Water resistance (%)	68.1	32.6-94.8
	Water boiling test (time in minutes)	20.5	50
	Shatter resistance (%)	72.3	N/A
	Ash content (%)	8	3-4
	Calorific value(MJ/kg)(ISO 1928)	26.5 >29.30	
	Clay content (%)	12.5	29.30
Gases emitted from the burning briquettes	Carbon monoxide(ppm)	1107	>9
	Volatile matter	12.6	20-25
	Sulfur content	0.0	0.0
	Fixed carbon	70.2	50-95

BRIQUETTES AS CLEAN COOKING ENERGY

Conclusions;

- At room temperature under normal conditions, the briquette can absorb up to 10% moisture and not be greatly affected in both strength and burning time provided they are not under an immense load.
- The bulk density indicates that the briquette is dense enough to retain heat and burn properly for a long period of time.
- The briquettes of the specified dimensions burn for 4-6 hours having the heat reducing as they burn out with time.
- The ash content obtained is 8%, which is above the standard but is not very far from it. Which still leaves the briquettes to burn at a higher temperature than those with a higher ash content.
- The water boiling test indicates that the heat produced from these briquettes gives the stove a better efficiency.
- The Carbon monoxide gave an average value of 1107ppm which is extremely high and very dangerous to humans when inhaled. This implies that the use of these briquettes must be done outdoors in areas with great aeration.

Briquettes are an affordable clean cooking technology indicate being in line with the SDGs 7 which advocates for affordable and clean energy.

LIMITATIONS/CHALLENGES

- Project time constraints
- Insufficiency of data sources
- Lack of resources to set up private systems
- Unpredictable climate conditions

KEY LESSONS LEARNED

- The available energy resources for UCU
- Cultural (mindset) influence energy consumption and demand
- There's a need for awareness
- The need to access resources for further research (demonstration unit/pilot system)

RECOMMENDATIONS

ENERGY EFFICIENCY

- Solar system for FEDT lighting demand
- Demand analysis of other university buildings

SOLAR

- Set up a pilot systems for further research

BIOENERGY

- Awareness campaigns
- Set up a pilot study for use of briquettes at UCU
- Research on cause and solution to Carbon monoxide emissions
- Further research on other clean cooking energy sources (biogas)

CONCLUSION

- The integrated renewable energy system for UCU will include;
  - ❖ Solar Energy systems
    - ➢ Library stand-alone system
    - ➢ System for UCU sports arena lighting
    - ➢ System for FEDT block lighting
  - ❖ Bioenergy systems for clean cooking
- Wind energy is not viable for UCU
- More process should be undertaken.
- Awareness on efficient and productive energy consumption

THANKYOU

Questions