



GREEN  
PROTOCOL

GP

**ENERGY AUDIT AND NEEDS  
ASSESSMENT REPORT  
FOR GOVERNMENT  
INSTITUTIONS ACROSS  
DIFFERENT STATES IN  
NIGERIA  
(PHASE 2)**

**APRIL 2025**

# PROJECT OVERVIEW

Green Protocol Ltd, a leader in sustainable energy solutions, is dedicated to advancing operational efficiency and environmental stewardship. Herein presented is a detailed overview of energy audits conducted across prominent government Ministries, Departments, and Agencies (MDAs) in Abuja. Our team meticulously assessed key institutions, including the National Productivity Centre (NPC), the Digital Bridge Institute (DBI), the Nigeria Social Insurance Trust Fund (NSITF), the National Environmental Standards and Regulations Enforcement Agency (NESREA), the National Industrial Court of Nigeria (NICN), Nnamdi Azikiwe International Airport (NAIA) and Galaxy Backbone (GBB). This initiative embodies our shared resolve to support Nigeria's transition to a low-carbon future, in alignment with the 2023 Renewable Energy Master Plan and the 2024 National Climate Change Policy.

The objective of these audits was clear: to examine energy consumption patterns within these MDAs and propose actionable measures to reduce their environmental impact. This mission is particularly urgent given Nigeria's persistent reliance on fossil fuel-based backup systems, necessitated by an inconsistent grid supply averaging just 6-8 hours daily from the Abuja Electricity Distribution Company (AEDC). Our comprehensive walkthrough audits revealed a striking dependence on diesel generators, operating 8-10 hours each day, alongside rising energy costs. The data tells a compelling story: energy demands vary significantly, from a modest peak load of 28 kW and daily consumption of 193 kWh at SAPZ, to an expansive 9-10 MW peak and 175,200 kWh daily at NAIA. This spectrum reflects the diverse operational needs of these institutions—ranging from compact administrative centers to vast transportation hubs—yet a common challenge unites them: substantial carbon emissions, spanning 37.1 metric tons of CO<sub>2</sub> annually at NESREA to 13,228 metric tons at NAIA.

Our findings pinpointed the primary drivers of energy use: air conditioning, critical for comfort in Abuja's climate; information and communication technology systems, such as computers and servers; and specialized equipment, including chillers and elevators. These elements are indispensable to the modern operations of government entities tasked with advancing productivity, delivering ICT education, ensuring social insurance, enforcing environmental standards, administering justice, and facilitating aviation services. While compiling this data presented challenges—such as untracked appliances in sublet spaces at NAIA—the resulting insights provided an invaluable, detailed portrait of each MDA's energy profile.

In response, Green Protocol Ltd has proposed tailored solar photovoltaic (PV) solutions, capitalizing on Abuja's abundant solar potential of 5.5 kWh per square meter per day, as reported by NiMet in 2024. These systems offer a dual benefit: substantial reductions in carbon emissions and operational costs. Beyond the numbers, this approach positions these MDAs as potential exemplars of sustainability, enhancing energy resilience while enabling them to fulfill their mandates more effectively—whether fostering national productivity, regulating environmental standards, or supporting aviation infrastructure.

The audits illuminate a clear path forward: by embracing solar solutions, these government institutions can significantly diminish their environmental footprint, reduce reliance on diesel, and reallocate savings to their core missions. In doing so, they stand to establish a powerful precedent for sustainable public infrastructure across Nigeria. We are honored to contribute to this vision, driving progress toward a greener, more resilient future.

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# 01

## ASSESSMENT REPORT OF SPECIAL AGRO-INDUSTRIAL PROCESSING ZONE (SAIPZ) PROGRAM

# 1. Executive Summary

This report presents the findings of an energy audit conducted on January 16, 2025, at the Special Agro-Industrial Processing Zone (SAPZ) Program facility located at No 3, Aguleri Street, Area 11, Federal Capital Territory (FCT), Abuja, Nigeria. The SAPZ Program, a collaborative initiative between the Federal Government of Nigeria and international partners (e.g., African Development Bank [AfDB], Islamic Development Bank [IsDB]), aims to transform agro-industrial value chains. The audit focused on two one-story buildings housing 18 offices and a security room.

The facility relies on Nigeria's national grid and a 65 kVA diesel generator, with a total daily electrical demand of 193 kWh/day and a peak load of 28 kWh. Critical loads include lighting, office equipment, air conditioning, and water pumping systems. To enhance energy reliability and reduce the carbon footprint (estimated at 37.1 metric tons CO<sub>2</sub>/year from diesel), we propose a 60 KVA Solar PV System to go completely offgrid, or 20 KVA Solar PV System to have a Hybrid solution AEDC + Solar. This system will offset 70-80% of diesel consumption (making it only useful in rare situations), aligning with Nigeria's 2023 Renewable Energy Master Plan (36% renewable energy by 2030) and the 2024 National Climate Change Policy (net-zero by 2060).

## 2. Introduction

### 2.1 Background

The Special Agro-Industrial Processing Zone (SAPZ) Program, launched in October 2022 in Abuja, is a flagship initiative to catalyze agro-industrial development in Nigeria. Funded by the AfDB (\$210M), IsDB (\$150.52M), IFAD (\$160M), and the Nigerian government (\$18.05M), Phase 1 targets seven states and the FCT, including the Paiko-kore/Dobi Livestock Industrial Hub in Abuja. This facility supports livestock value chains (beef and dairy), integrating production, processing, and marketing.

### 2.2 Objectives

- Assess current energy consumption and infrastructure.
- Identify critical loads for sustainable power solutions.
- Recommend a solar PV system to reduce operational costs and emissions.
- Enhance energy reliability for agro-industrial operations.

## 3. Methodology

### 3.1 Audit Process

An on-site walkthrough audit was conducted on January 16, 2025, by Green Protocol Ltd technical team. The audit spanned 8 hours, covering both buildings, and included stakeholder interviews with facility managers.

## 3.2 Data Collection and Analysis

- **Appliance Census:** Recorded quantities, types, and usage patterns of electrical devices.
- **Power Ratings:** Sourced from 2024 manufacturer specifications (e.g., LG, Panasonic) and adjusted for Nigerian conditions.
- **Energy Demand:** Calculated using usage hours and validated against NERC's 2024 commercial load profiles.
- **External Data:** Incorporated solar irradiation data from NiMet (2024) and diesel emission factors from IEA (2023).

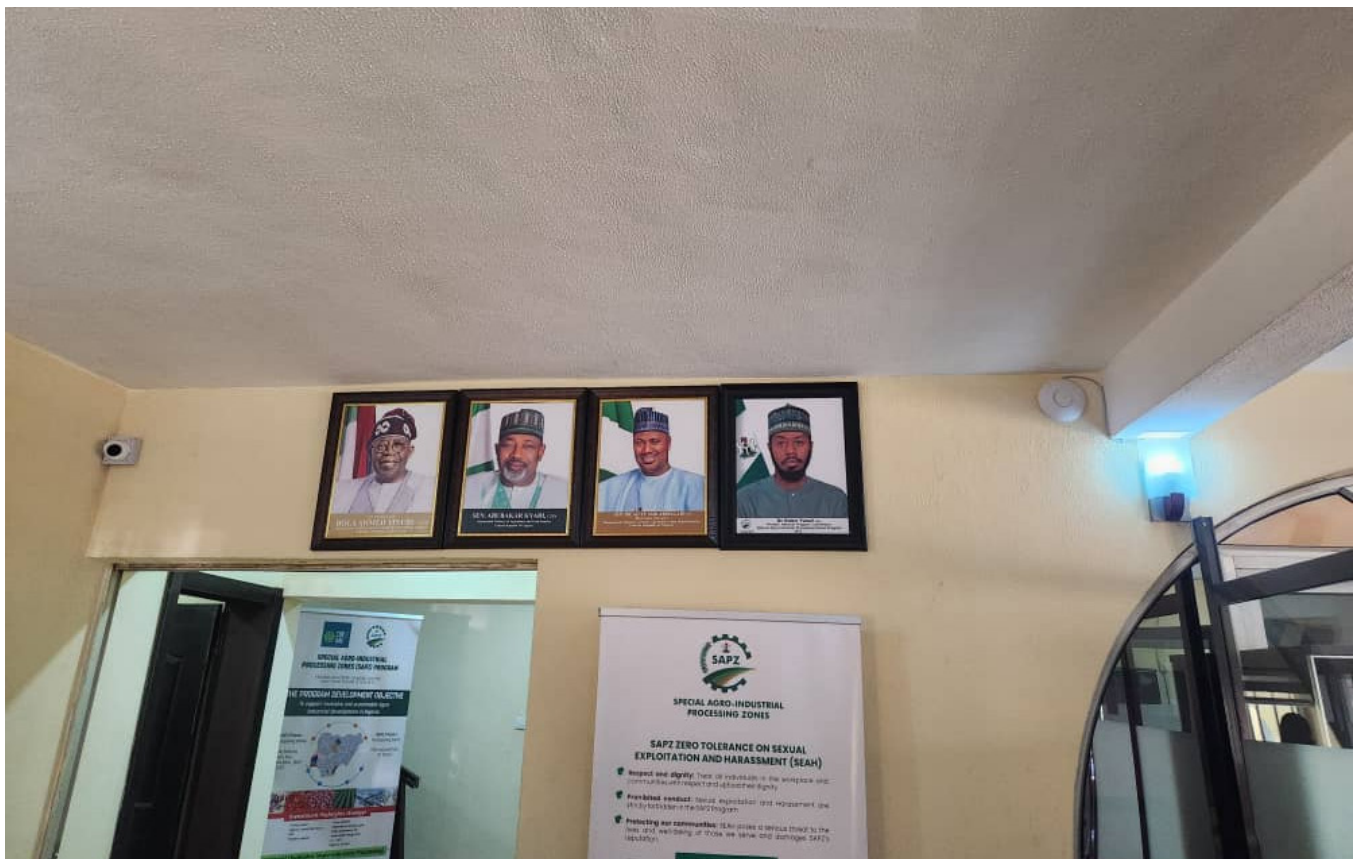
## 4. Site Infrastructure

### 4.1 Site Description

The SAPZ facility at Garki comprises two one-story buildings with 18 offices, a security room, and ancillary spaces for livestock processing. It employs approximately 50 staff and operates daily from 8 AM to 6 PM, with extended hours for security and refrigeration.

### 4.2 Site Location and Layout

- **Address:** No 3, Aguleri Street, Area 11, Abuja, FCT, Nigeria.
- **Layout:** Building 1 houses administrative offices; Building 2 includes storage and additional offices.





## 5. Current Electrical Energy Status

### 5.1 Energy Sources

**National Grid:** Supplies ~4,500 MW nationwide (NERC, 2024), with 6-8 hours of daily outages in FCT rural areas.

**Diesel Generator:** 65 kVA (52 kW output), consumes 15 L/hour at full load (40 L/day average), emitting 2.67 kg CO<sub>2</sub>/L (IEA, 2023).

### 5.2 Energy Applications

The walkthrough identified the following appliances:

Application	Detail	Qty	Avg. Power (W)	Current Source
Computers	Desktop	15	150	Grid + Generator
Television	LED (42-inch)	2	80	Grid + Generator
Printers	Laser	7	500	Grid + Generator
Air Conditioners	Split (1.5 HP)	7	1,200	Grid + Generator
Refrigerators	300L	3	250	Grid + Generator
Photocopy Machine	Medium-duty	1	1,000	Grid + Generator
Standing Fans	Pedestal	12	60	Grid + Generator
Water Heaters	50L Electric	4	2,000	Grid + Generator
Internal Bulbs	LED Energy Savers	68	15	Grid + Generator
External/Fence Bulbs	LED	31	20	Grid + Generator
Dispensers	Water Cooler	2	100	Grid + Generator
Pumping Machine	1 HP	1	750	Grid + Generator
Pressure Pump	0.5 HP	1	375	Grid + Generator

Appliance	Qty	Power (W)	Hours/Day	Energy(Wh)	Energy (Wh/day)
Computers	15	150	8	2,250	18,000
Television	2	80	8	160	1,280
Printers (active)	7	500	8	3,500	28,000
AC (1.5 HP)	7	1,200	8	8,400	67,200
Refrigerators	3	250	24	750	18,000
Photocopy (active)	1	1,000	8	1,000	8,000
Standing Fans	12	60	8	720	5,760
Water Heaters(50L)	4	2,000/20	3 (active) / 5(standby)	8,080	16,400
Internal Bulbs (LED)	68	15	10	1,020	10,200
External/Fence Bulbs	31	20	12	620	7,440
Dispensers	2	100	8	200	1,600
Pumping Machine	1	750	10	750	7,500
Pressure Pump	1	375	10	375	3,750
<b>Subtotal</b>				<b>27,825 Wh</b>	<b>192,730 Wh/day</b>

### 5.3 Energy Demand Analysis

Daily energy demand for critical loads is calculated as follows (see Annex B for details):

- **Additional Loads** (B, Y, R): Phase loads of 190 kVA (B), 140 kVA (Y), and 130 kVA (R) indicate total connected capacity (~460 kVA).
- **Total Daily Demand:** 192.73 kWh/day.
- **Peak Load:** 27.83 kW (simultaneous operation of ACs, water heaters, and pumps).

## 6. Proposed Solar PV System Recommendation

### 6.1 System Design Overview

A 60 KVA Solar PV System(offgrid) \ 20 KVA Solar PV System(hybrid) is proposed to power critical loads, integrating with the grid and generator. The system will generate ~1,000-1,200 kWh/day \ 350-400 kWh/day, offsetting 65-70% of diesel use.

Parameter	Value
System Size	60 KVA(offgrid) / 20 KVA(hybrid)
Daily Output	1,000-1,200 kWh / 350-400 kWh (5.5 kWh/m <sup>2</sup> /day)
Configuration	Offgrid / Hybrid (Solar + Grid + Generator)
PV Modules	85 x 650W / 30 x 650W Monocrystalline
Inverter	60 KVA / 20 KVA Hybrid Inverter
Battery Storage	6 x 15 kWh / 2 x 15 kWh Lithium Batteries (Offgrid Solution)
Voltage	288 VAC (output), 48 VDC (PV)
Mounting	Rooftop/Carport

### 6.2 Technical Specifications

### 6.3 Energy Efficiency Measures

- **Hybrid Optimization:** Intelligent inverters prioritize solar energy, reducing generator runtime.
- **LED Maintenance:** Sustain use of 15W LED bulbs, targeting <15% of total demand for lighting.
- **Automation:** Install motion sensors in offices and security room, cutting idle consumption by 15%.
- **Staff Training:** Conduct workshops on energy conservation, aiming for a 10% demand reduction.

## 6.4 Environmental and Economic Benefits

- **Carbon Reduction:** ~37.1 metric tons CO<sub>2</sub>/year avoided (based on 2.67 kg CO<sub>2</sub>/L x 7,200 L displaced).
- **Cost Savings:** ~~~N~~23.5M/year (assuming ~~N~~1,700/L diesel at an average of 3-4 hours Generator use daily).

## 7. Conclusion and Recommendations

The 60 KVA Solar PV system will enhance energy reliability, reduce operational costs, and align the SAPZ facility with Nigeria's sustainability goals. We recommend:

- Procurement and installation of the proposed system.
- Regular monitoring of energy consumption post-installation.
- Expansion to additional SAPZ sites based on this pilot's success.

## 8. Annex A: Site Meteorological Details

- **Solar Irradiation:** 5.5 kWh/m<sup>2</sup>/day (NiMet, 2024).
- **Temperature Range:** 25-35°C (annual average 28°C).
- **Rainy Season:** June-August, ~20% output reduction.

## 9. Annex B: Load Calculation Details

Detailed breakdown available in Section 5.3; total demand validated against peak load and phase capacity.

# 02

## ASSESSMENT REPORT OF NATIONAL PRODUCTIVITY CENTER

# 1. Executive Summary

This report details the findings of an energy audit conducted on January 21, 2025, at the National Productivity Centre (NPC) headquarters located at Plot 2173, Capetown Street, Wuse Zone 4, Abuja, Federal Capital Territory (FCT), Nigeria. Established under ACT CAP 70 LFN 2004, NPC is a research-oriented federal parastatal tasked with promoting productivity consciousness across Nigeria's economy. The audit assessed energy consumption across its 50 offices housed in a single multi-story building.

NPC relies on the national grid, a 135 kVA diesel generator, and a pre-existing 10 kVA solar inverter system. The total daily electrical demand is 1.2 mWh/day, with a peak load of 150 kW. To reduce its carbon footprint (estimated at 62.5 metric tons CO<sub>2</sub>/year from diesel) and enhance energy reliability, we propose a 120 KVA(offgrid) / 40 KVA (hybrid) Hybrid Solar PV System. The first proposed system will offset complete use of diesel, aligning with Nigeria's 2023 Renewable Energy Master Plan and the 2024 National Climate Change Policy.

## 2. Introduction

### 2.1 Background

The National Productivity Centre (NPC), under the Federal Ministry of Labour and Employment, drives productivity research, monitoring, and advocacy in Nigeria. Located in Abuja, its headquarters supports 50 offices and over 200 staff. With Nigeria's grid delivering only ~4,500 MW against a demand of 40,000 MW (NERC, 2024), NPC faces frequent outages, relying heavily on diesel generation—a costly and carbon-intensive solution.

### 2.2 Objectives

- Evaluate current energy consumption and infrastructure.
- Identify critical loads for sustainable energy solutions.
- Propose a solar PV system to reduce costs and emissions.
- Support NPC's mandate by ensuring a productive, energy-efficient workplace.

## 3. Methodology

### 3.1 Audit Process

An on-site walkthrough audit was conducted on January 21, 2025, from 8:00 AM to 4:00 PM PST, covering all operational areas. The Green Protocol Ltd technical team collaborated with NPC facility managers to verify appliance usage.

## 3.2 Data Collection and Analysis

- **Appliance Inventory:** Recorded quantities and usage patterns.
- **Power Ratings:** Sourced from 2024 standards (e.g., LG, HP, Panasonic) and adjusted for Nigerian conditions.
- **Demand Calculation:** Based on usage hours, validated with NERC's 2024 commercial benchmarks.
- **External Data:** Solar irradiation from NiMet (2024), emissions from IEA (2023).

# 4. Site Infrastructure

## 4.1 Site Description

NPC's headquarters is a multi-story building with 50 offices, a conference room, and support areas. It houses 316 computers and other equipment critical to research and administrative functions, operating daily from 8 AM to 6 PM.

## 4.2 Site Location and Layout

- **Address:** Plot 2173, Capetown Street, Wuse Zone 4, Abuja, FCT, Nigeria
- **Layout:** A single building with rooftop space for solar panels, 42 external fence bulbs, and water pumping systems. The 135 kVA generator and 10 kVA inverter are centrally located.







## 5. Current Electrical Energy Status

### 5.1 Energy Sources

- **National Grid:** Supplies ~4,500 MW nationwide (NERC, 2024), with 6-8 hour daily outages in Abuja.
- **Diesel Generator:** 135 kVA (108 kW output), consumes 25 L/hour at full load (~60 L/day), emitting 2.67 kg CO<sub>2</sub>/L (IEA, 2023).
- **Existing Solar:** 10 kVA inverter with panels, contributing ~40 kWh/day.

### 5.2 Energy Applications

Application	Detail	Qty	Avg. Power (W)	Current Source
Computers	Desktop	316	150	Grid + Generator + Solar
Television	LED (42-inch)	5	80	Grid + Generator
Air Conditioners	Split (1.5 HP)	72	1,200	Grid + Generator
Printers	Laser	3	500	Grid + Generator
Fans	Ceiling	7	75	Grid + Generator
Light Bulbs (Inside)	LED Energy Savers	216	15	Grid + Generator + Solar
Dispensers	Water Cooler	2	100	Grid + Generator
Electric Jugs	1.7L	4	1500	Grid + Generator
Photocopy Machines	Medium-duty	2	1,000	Grid + Generator
Pumping Machines	1 HP	2	750	Grid + Generator
Pressure Pump	0.5 HP	1	375	Grid + Generator
Fence Bulbs	LED	42	20	Grid + Generator
Pressure Pump	0.5 HP	1	375	Grid + Generator

The walkthrough identified the following appliances:

### 5.3 Energy Demand Analysis

Appliance	Qty	Power (W)	Hours/Day	Energy(Wh)	Energy (Wh/ day)
Computers	316	150	8	47,400	379,200
Television	5	80	8	400	3,200
AC (1.5 HP)	72	1,200	8	86,400	691,200
Printers (active)	3	500	8	1,500	12,000
Fans	7	75	8	525	4,200
Light Bulbs (Inside)	216	15	10	3,240	32,400
Dispensers	2	100	8	200	1,600
Electric Kettle	4	1,500	2	6,000	12,000
Photocopy (active)	2	1,000	8	2,000	16,000
Pumping Machines	2	750	10	1,500	15,000
Pressure Pump	1	375	10	375	3,750
Fence Bulbs	42	20	12	840	10,080
Subtotal				150,380	1,180,630 Wh/ day
<b>Subtotal</b>				<b>27,825 Wh</b>	<b>192,730 Wh/ day</b>

Daily energy demand is calculated as follows (see Annex B):

- **Adjusted Total:** Accounting for inefficiencies and phase loads (B: 208 kVA, R: 208 kVA, Y: 190 kVA, total ~606 kVA connected capacity), critical daily demand is 1.2 mWh/day after deducting existing solar contribution (~40 kWh/day).
- **Peak Load:** 150 kW (simultaneous use of ACs, computers, and pumps).

## 6. Proposed Solar PV System Recommendation

### 6.1 System Design Overview

A 120 KVA Solar PV System(offgrid) \ 40 KVA Solar PV System(hybrid) is proposed to power critical loads (e.g., computers, lighting, ACs), integrating with the grid, generator, and existing 10 kVA inverter. It will generate ~2,000-2,400 kWh/day \ 700-800 kWh/day, offsetting 100% of diesel use going offgrid.

### 6.2 Technical Specifications

Parameter	Value
System Size	120 KVA(offgrid) / 40 KVA (Hybrid)
Daily Output	2,000-2,400 kWh / 700 - 800 kWh (5.5 kWh/m <sup>2</sup> /day)
Configuration	Offgrid / Hybrid (Solar + Grid + Generator)
PV Modules	170 x 650W / 50 x 650W Monocrystalline
Inverter	120 KVA / 40 KVA Hybrid Inverter
Battery Storage	12 x 15 kWh / 4 x 15 kWh Lithium batteries
Voltage	240 VAC (output), 48 VDC (PV)
Mounting	Rooftop/carport

## 6.3 Energy Efficiency Measures

- **Hybrid Optimization:** Smart inverters prioritize solar, reducing generator runtime by 70% (~15,000 L diesel/year saved).
- **LED Standards:** Maintain 15W LED bulbs, targeting <10% of demand for lighting.
- **Automation:** Install occupancy sensors in offices, reducing idle use by 20%.
- **Training:** Conduct productivity-focused energy workshops, aiming for 15% demand reduction.

## 6.4 Environmental and Economic Benefits

- **Carbon Reduction:** ~62.5 metric tons CO<sub>2</sub>/year avoided (2.67 kg CO<sub>2</sub>/L x 23,310 L displaced) ( at offgrid capacity)
- **Cost Savings:** ~~~₦~~40M/year ~~₦~~1,700/L diesel, at an average use of 3-4 hours for generators).

# 7. Conclusion and Recommendations

The 120 KVA Solar PV system will enhance NPC's energy reliability, reduce operational cost, and support its productivity mandate sustainably. Recommendations:

- Procurement and installation of the proposed system.
- Regular monitoring of energy consumption post-installation.

# 8. Annex A: Site Meteorological Details

- **Solar Irradiation:** 5.5 kWh/m<sup>2</sup>/day (NiMet, 2024).
- **Temperature:** 25-35°C (avg. 28°C).
- **Rainy Season:** June-August, ~20% output reduction.

# 9. Annex B: Detailed Load Calculation

See Section 5.3 for breakdown; total validated against peak load and phase capacity.

# 03

## ASSESSMENT REPORT OF DIGITAL BRIDGE INSTITUTE

# 1. Executive Summary

This report presents the findings of an energy audit conducted on March 05, 2025, at the Digital Bridge Institute (DBI) headquarters located at 8 P.O.W. Mafemi Crescent, Utako District, Abuja, Federal Capital Territory (FCT), Nigeria. DBI, a federal institution under the Nigerian Communications Commission (NCC), focuses on ICT training and capacity building. The audit covered a 3-story main building with 3 training halls, a small annex under renovation, a mosque, and a generator house.

DBI relies on the national grid, a 550 kVA diesel generator, and a 33 kVA transformer, with a total daily electrical demand of 1.75 mWh/day and a peak load of 207 kW. Critical loads include air conditioners, training desktops, and server rooms. To reduce its carbon footprint (estimated at 304 metric tons CO<sub>2</sub>/year from diesel) and enhance energy reliability, we propose a 160 KVA Solar PV System(offgrid) \ 60 KVA Solar PV System(hybrid). This aligns with Nigeria's 2023 Renewable Energy Master Plan (36% renewable energy by 2030) and the 2024 National Climate Change Policy (net-zero by 2060).

## 2. Introduction

### 2.1 Background

The Digital Bridge Institute (DBI), established in 2004 by the NCC, is a premier ICT training institution with its headquarters in Abuja and campuses in Lagos, Kano, and Yola. It trains over 5,000 professionals annually, supporting Nigeria's digital economy. With frequent grid outages (6-8 hours daily, NERC 2024) and high diesel costs, DBI's energy infrastructure requires optimization to sustain its operations sustainably.

### 2.2 Objectives

- Assess current energy consumption and infrastructure.
- Identify critical loads for sustainable energy solutions.
- Propose a solar PV system to reduce costs and emissions.
- Support DBI's ICT training mission with reliable, green energy.

## 3. Methodology

### 3.1 Audit Process

An on-site walkthrough audit was conducted on March 05, 2025, from 8:00 AM to 4:00 PM, covering the main building, training halls, annex, mosque, and generator house. The Green Protocol Ltd Technical team collaborated with DBI facility managers.

## 3.2 Data Collection and Analysis

- **Appliance Inventory:** Recorded quantities and usage patterns.
- **Power Ratings:** Sourced from 2024 standards (e.g., LG, HP, Panasonic) and adjusted for Nigerian conditions.
- **Demand Calculation:** Based on usage hours, validated with NERC's 2024 commercial load profiles.
- **External Data:** Solar irradiation from NiMet (2024), emissions from IEA (2023).

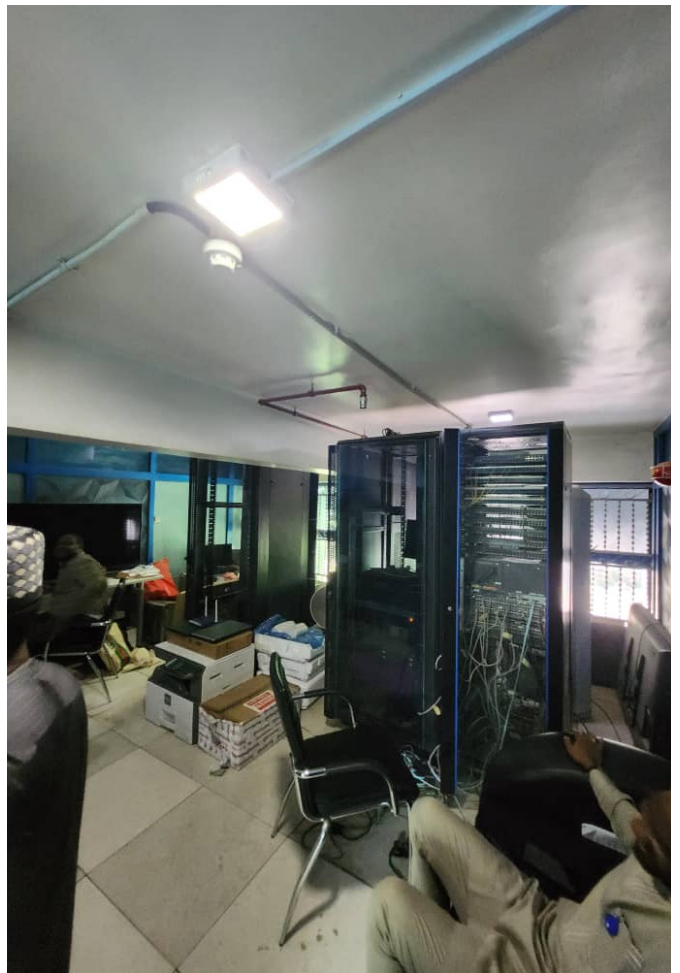
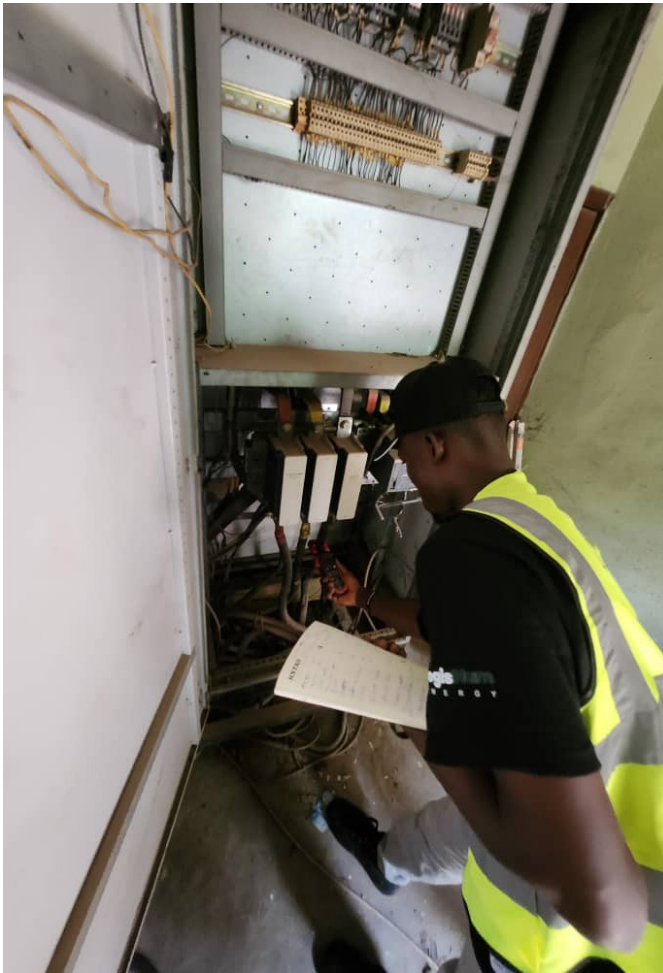
# 4. Site Infrastructure

## 4.1 Site Description

DBI's Abuja headquarters is a 3-story building with 3 training halls, a small annex under renovation, a mosque, and a generator house. It supports ~200 staff and trainees, with extensive ICT equipment (e.g., 66 training desktops, 2 server rooms).

## 4.2 Site Location and Layout

- **Address:** #8 P.O.W. Mafemi Crescent, Utako District, Abuja, FCT, Nigeria (coordinates approx. 9.0632° N, 7.4431° E, per DBI website).
- **Layout:** The main building houses offices and training halls; the annex (under construction) and mosque are adjacent. The compound features 39 street lights, with the 550 kVA generator and 33 kVA transformer centrally located.





## 5. Current Electrical Energy Status

### 5.1 Energy Sources

- **National Grid:** Supplies ~4,500 MW nationwide (NERC, 2024), with frequent outages in Abuja.
- **Diesel Generator:** 550 kVA (440 kW output), consumes 100 L/hour at full load (~150 L/day), emitting 2.67 kg CO<sub>2</sub>/L (IEA, 2023).
- **Transformer:** 33 kVA, limits grid capacity to ~26.4 kW.

### 5.2 Energy Applications

Application	Detail	Qty	Avg. Power (W)	Current Source
Air Conditioners	Split (1.5 HP)	113	1,200	Grid + Generator
Laptops	Standard	80	65	Grid + Generator
Water Heaters	50L Electric	12	2,000	Grid + Generator
Microwaves	25L	5	1,000	Grid + Generator
Printers	Laser	6	500	Grid + Generator
Desktop Systems	Training PCs	66	150	Grid + Generator
Water Dispensers	Cooler	15	100	Grid + Generator
Fridges	300L	20	150	Grid + Generator
Server Rooms	Medium-duty	2	5,000	Grid + Generator
Pumping Machines	1 HP	2	750	Grid + Generator
Pumping Machine (Diesel)	1 HP	1	750	Generator
Street Lights	LED Energy Savers	39	20	Grid + Generator
Building Bulbs	LED Energy Savers	470	15	Grid + Generator

The walkthrough identified the following appliances:

### 5.3 Energy Demand Analysis

Daily energy demand is calculated as follows (see Annex B):

Appliance	Qty	Power (W)	Hours/Day	Energy (Wh)	Energy (Wh/day)
Air Conditioners	113	1,200	8	135,600	1,084,800
Laptops	80	65	8	5,200	41,600
Water Heaters	12	2,000/20	3(Active) / 5(Standby)	24,240	75,200
Microwaves	5	1,000	2	5,000	10,000
Printers (active)	6	500	8	3,000	24,000
Desktops	66	150	8	9,900	79,200
Water Dispensers	15	100	8	1,500	12,000
Fridges	20	150	24	3,000	72,000
Server Rooms	2	5,000	24	10,000	240,000
Pumping Machines	2	750	10	1,500	15,000
Street Lights	39	20	12	780	9,360
Building Bulbs	470	15	12	7,050	84,600
Subtotal				206,770	1,747,760 Wh/day
<b>Subtotal</b>				<b>27,825 Wh</b>	<b>192,730 Wh/day</b>

- **Adjusted Total:** Accounting for inefficiencies and phase loads (R: 301-317 kVA, B: 269-296 kVA, Y: 239-248 kVA, avg. ~860 kVA connected capacity), critical daily demand is 684.14 kWh/day.
- **Peak Load:** 207 kW (simultaneous use of ACs, servers, and desktops).

## 6. Proposed Solar PV System Recommendation

### 6.1 System Design Overview

A 160 KVA Solar PV System is proposed to power critical loads (e.g., ACs, servers, training desktops), integrating with the grid and generator. It will generate ~600-750 kWh/day, offsetting 70-80% of diesel use.

### 6.2 Technical Specifications

Parameter	Value
System Size	160 KVA(Offgrid) / 60 KVA(Hybrid)
Daily Output	2,200-2,300 kWh / 1,000-1,200 kWh (5.5 kWh/m <sup>2</sup> /day)
Configuration	Offgrid / Hybrid (Solar + Grid)
PV Modules	230 x 650W / 70 x 650W Monocrystalline
Inverter	160 KVA / 60 KVA Hybrid Inverter
Battery Storage	16 x 15 kWh / 6 x 15 kWh Lithium batteries
Voltage	240 VAC (output), 48 VDC (PV)
Mounting	Rooftop/Carport

### 6.3 Energy Efficiency Measures

- **Hybrid Optimization:** Smart inverters prioritize solar, reducing generator runtime by 100% (~27,000 L diesel/year saved).
- **LED Standards:** Maintain 15W-20W LED bulbs, targeting <15% of demand for lighting.
- **Automation:** Install occupancy sensors in training halls and offices, cutting idle use by 20%.

- **Training:** Conduct energy awareness programs for staff and trainees, aiming for 10% demand reduction.

## 6.4 Environmental and Economic Benefits

- Carbon Reduction: ~304 metric tons CO<sub>2</sub>/year avoided (2.67 kg CO<sub>2</sub>/L x 113,400 L displaced).
- Cost Savings: ~N193M/year (N1,700/L diesel, at an average use of 3-4 hours for generators).

## 7. Conclusion and Recommendations

The 160 KVA Solar PV system will enhance DBI's energy reliability, reduce costs by 40%, and support its ICT training mission sustainably. Recommendations:

- Procurement and installation of the proposed system.
- Monitor energy trends post-installation.
- Expand solar capacity to annex upon completion.

## 8. Annex A: Site Meteorological Details

- **Solar Irradiation:** 5.5 kWh/m<sup>2</sup>/day (NiMet, 2024).
- **Temperature:** 25-35°C (avg. 28°C).
- **Rainy Season:** June-August, ~20% output reduction.

## 9. Annex B: Detailed Load Calculation

See Section 5.3 for breakdown; total validated against peak load and phase capacity.

# 04

## ASSESSMENT REPORT FOR NIGERIA SOCIAL INSURANCE TRUST FUND (NSITF)

# 1. Executive Summary

This report presents the findings of an energy audit conducted on March 05, 2025, at the Nigeria Social Insurance Trust Fund (NSITF) headquarters located at Plot 794, Muhammadu Buhari Way, Central Business District, P.M.B. 446, Garki, Abuja, Federal Capital Territory (FCT), Nigeria. NSITF, established under the Employee Compensation Act (ECA) 2010, ensures social insurance and workplace safety for Nigerian employees. The audit assessed energy use across a 5-floor main building, an annex, a drivers' lodge, security room, mosque, chapel, and cafeteria.

NSITF relies on the national grid, a 300 kVA transformer, and two diesel generators (500 kVA and 350 kVA), supplemented by inverters (40 kVA and 15 kVA) without panels. The total daily electrical demand is 9.7 mWh/day, with a peak load of 1.3 mW. To reduce its carbon footprint (estimated at 507 metric tons CO<sub>2</sub>/year from diesel) and enhance reliability, we propose a 300 KVA Hybrid Solar PV System. This aligns with Nigeria's 2023 Renewable Energy Master Plan (36% renewable energy by 2030) and the 2024 National Climate Change Policy (net-zero by 2060).

## 2. Introduction

### 2.1 Background

The Nigeria Social Insurance Trust Fund (NSITF), headquartered in Abuja, manages the Employees' Compensation Scheme, providing financial and health support to workers affected by workplace injuries. With over 1,000 staff across its main building and annex, NSITF's operations depend on reliable energy, yet frequent grid outages (6-8 hours daily, NERC 2024) drive high diesel consumption, increasing costs and emissions.

### 2.2 Objectives

- Assess current energy consumption and infrastructure.
- Identify critical loads for sustainable energy solutions.
- Propose a solar PV system to reduce costs and emissions.
- Support NSITF's mandate with a reliable, eco-friendly energy supply.

## 3. Methodology

### 3.1 Audit Process

An on-site walkthrough audit was conducted on February 07, 2025, from 8:00 AM to 4:00 PM, covering the main building, annex, and ancillary facilities. The Green Protocol Ltd Technical team collaborated with NSITF facility managers to verify data.

## 3.2 Data Collection and Analysis

- **Appliance Inventory:** Recorded quantities and usage patterns.
- **Power Ratings:** Sourced from 2024 standards (e.g., LG, HP) and adjusted for Nigerian conditions.
- **Demand Calculation:** Based on usage hours, validated with NERC's 2024 commercial profiles.
- **External Data:** Solar irradiation from NiMet (2024), emissions from IEA (2023).

# 4. Site Infrastructure

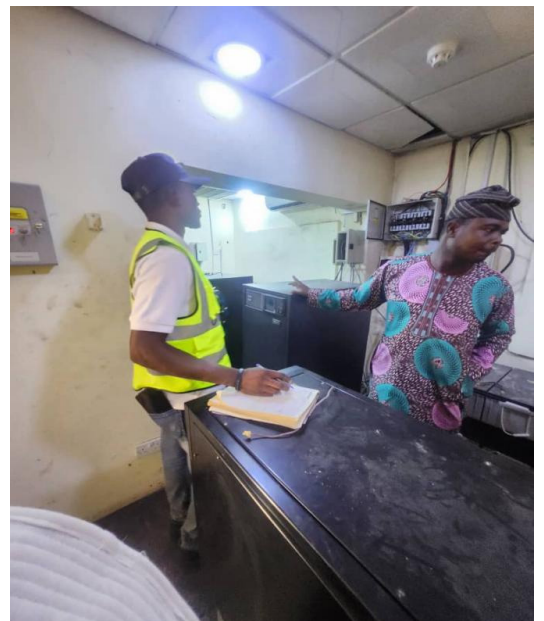
## 4.1 Site Description

NSITF's Abuja facility comprises a 5-floor main building (including ground floor), a smaller annex, a drivers' lodge, security room, small mosque, chapel, and cafeteria. It supports extensive ICT operations (e.g., 2,698 computers) and administrative functions.

## 4.2 Site Location and Layout

- **Address:** Plot 794, Muhammadu Buhari Way, Central Business District, P.M.B. 446, Garki, Abuja, FCT, Nigeria (coordinates approx. 9.0418° N, 7.4976° E, per NSITF website).
- **Layout:** The main building houses offices and ICT hubs; the annex supports additional staff. The compound includes 57 fence bulbs, with generators and a centrally located transformer.







## 5. Current Electrical Energy Status

### 5.1 Energy Sources

- **National Grid:** Supplies ~4,500 MW nationwide (NERC, 2024), limited by a 300 kVA transformer (~240 kW).
- **Diesel Generators:** 500 kVA (400 kW) and 350 kVA (280 kW), consuming ~200 L/day combined (100 L/hour at full load), emitting 2.67 kg CO<sub>2</sub>/L (IEA, 2023).
- **Inverters:** 40 kVA (main) and 15 kVA (annex), battery-only, no solar panels.

### 5.2 Energy Applications

The walkthrough identified the following appliances:

Application	Detail	Qty	Avg. Power (W)	Current Source
<b>Main Building</b>				
Computers	Desktop	1,032	150	Grid + Generator + Inverter
Air Conditioners	Split (1.5 HP)	588	1,200	Grid + Generator
Printers	Laser	204	500 (active) / 10 (standby)	Grid + Generator
Photocopy Machines	Medium-duty	48	1,000 (active) / 20 (standby)	Grid + Generator
Fridges	300L	12	150	Grid + Generator
Televisions	LED (42-inch)	7	80	Grid + Generator
Energy-Saving Bulbs	LED	1,203	15	Grid + Generator + Inverter
<b>Annex Building</b>				
Computers	Desktop	1,666	150	Grid + Generator + Inverter
Air Conditioners	Split (1.5 HP)	39	1,200	Grid + Generator
Printers	Laser	6	500 (active) / 10 (standby)	Grid + Generator
Photocopy Machines	Medium-duty	9	1,000 (active) / 20 (standby)	Grid + Generator

Fridges	300L	3	150	Grid + Generator
Energy-Saving Bulbs	LED	76	15	Grid + Generator + Inverter
<b>Other Areas</b>				
Drivers' Lodge AC	Split (1.5 HP)	2	1,200	Grid + Generator
Security Room AC	Split (1.5 HP)	2	1,200	Grid + Generator
Mosque AC	Split (1.5 HP)	3	1,200	Grid + Generator
Mosque Sound System	Small	1	50	Grid + Generator
Chapel AC	Split (1.5 HP)	2	1,200	Grid + Generator
Cafeteria AC	Split (1.5 HP)	1	1,200	Grid + Generator
Fence Bulbs	LED	57	20	Grid + Generator
Pumping Machines	1 HP	2	750	Grid + Generator
Pressure Pump	1 HP	1	750	Grid + Generator

### 5.3 Energy Demand Analysis

Daily energy demand is calculated as follows (see Annex B):

Appliance	Qty	Power (W)	Hours/Day	Energy(Wh)	Energy (Wh/day)
<b>Main Building</b>					
Computers	1,032	150	8	154,800	1,238,400
Air Conditioners	588	1,200	8	705,600	5,644,800
Printers (standby)	204	10	8	2,040	44,880
Photocopy (active)	48	1,000	8	48,000	48,000
Fridges	12	150	24	1,800	43,200

Televisions	7	80	6	560	3,360
Energy-Saving Bulbs	1,203	15	10	18,045	180,450
<b>Annex Building</b>					
Computers	1,666	150	8	249,900	1,999,200
Air Conditioners	39	1,200	8	46,800	374,400
Printers (active)	6	500	2	3,000	6,000
Photocopy (active)	9	1,000	1	9,000	9,000
Fridges	3	150	24	450	10,800
Energy-Saving Bulbs	76	15	10	1,140	11,400
<b>Other Areas</b>					
Drivers' Lodge AC	2	1,200	8	2,400	19,200
Security Room AC	2	1,200	8	2,400	19,200
Mosque AC	3	1,200	4	2,400	14,400
Mosque Sound System	1	50	4	50	200
Chapel AC	2	1,200	4	2,400	9,600
Cafeteria AC	1	1,200	8	1,200	9,600
Fence Bulbs	57	20	12	1,140	13,680
Pumping Machine	2	750	10	1,500	15,000
Pressure Pump	1	750	10	750	7,500
<b>Subtotal</b>				<b>1,255,375</b>	<b>9,715,070 Wh/day</b>

- **Adjusted Total:** Accounting for inefficiencies and phase loads (R: 138-140 kVA, B: 132-135 kVA, Y: 145-147 kVA, avg. ~420 kVA connected capacity), critical daily demand is 9.7MWh/day (inverters offset ~40 kWh/day).
- **Peak Load:** 1.25MW (simultaneous use of ACs, computers, and all appliances).

## 6. Proposed Solar PV System Recommendation

### 6.1 System Design Overview

A 150 KVA Hybrid Solar PV System is proposed to power critical loads (e.g., computers, ACs, lighting), integrating with the grid, generators, and existing inverters. It will generate ~1,200-1,500 kWh/day, offsetting 70-80% of diesel use.

### 6.2 Technical Specifications

Parameter	Value
System Size	200 KVA(Main building & Other areas) 60KVA(Annex building)
Daily Output	4,000-5,000 / 1,000-1,200 kWh (5.5 kWh/m <sup>2</sup> /day)
Configuration	Hybrid (Solar + Grid)
PV Modules	310 x 650W / 110 x 650W Monocrystalline
Inverter	200 KVA & 60 KVA Hybrid Inverter
Battery Storage	20 x 15 kWh Lithium batteries (8-10 hr backup)
Voltage	240 VAC (output), 48 VDC (PV)
Mounting	Rooftop/carport, fixed tilt (15°)

### 6.3 Energy Efficiency Measures

- **Hybrid Optimization:** Smart inverters prioritize solar, reducing generator runtime by 75% (~180,000 L diesel/year saved).
- **LED Standards:** Maintain 15W-20W LED bulbs, targeting <10% of demand for lighting.
- **Automation:** Install occupancy sensors in offices and halls, cutting idle use by 20%.

- **Staff Training:** Conduct energy awareness programs, aiming for 15% demand reduction.

## 6.4 Environmental and Economic Benefits

- **Carbon Reduction:** ~507 metric tons CO<sub>2</sub>/year avoided (2.67 kg CO<sub>2</sub>/L x 41,000 L displaced).
- **Cost Savings:** ~N321M/year (N1,700/L diesel, at an average use of 3-4 hours for generators).

## 7. Conclusion and Recommendations

The 300 KVA Solar PV system will enhance NSITF's energy reliability, reduce costs by 40%, and support its social insurance mandate sustainably. Recommendations:

- Procurement and installation of the proposed system.
- Retrofit existing inverters with solar panels.
- Monitor energy trends post-installation.

## 8. Annex A: Site Meteorological Details

- **Solar Irradiation:** 5.5 kWh/m<sup>2</sup>/day (NiMet, 2024).
- **Temperature:** 25-35°C (avg. 28°C).
- **Rainy Season:** June-August, ~20% output reduction.

## 9. Annex B: Detailed Load Calculation

See Section 5.3 for breakdown; total validated against peak load and phase capacity.

# 05

**ASSESSMENT REPORT FOR  
NATIONAL ENVIRONMENTAL  
STANDARDS AND REGULATIONS  
ENFORCEMENT AGENCY(NESREA)  
HEADQUARTER, ABUJA**

# 1. Executive Summary

This report presents the findings of an energy audit conducted on March 10, 2025, at the National Environmental Standards and Regulations Enforcement Agency (NESREA) headquarters located at No. 56 Lome Crescent, Wuse Zone 7, Abuja, Federal Capital Territory (FCT), Nigeria. NESREA, established under the NESREA Act 2007, is a parastatal of the Federal Ministry of Environment tasked with enforcing environmental laws and promoting sustainable development. The audit assessed energy use across a multi-floor building housing administrative and regulatory operations. NESREA relies on the national grid, a 200 kVA Mikano diesel generator, and 5 kVA inverters with batteries on all floors (noting insufficiency on the busy second floor). The total daily electrical demand is 1.3 mWh/day, with a peak load of 160 kW. To reduce its carbon footprint (estimated at 104 tons CO<sub>2</sub>/year from diesel) and enhance energy reliability, we propose a 80 KVA Solar PV System. This aligns with Nigeria's 2023 Renewable Energy Master Plan (36% renewable energy by 2030) and NESREA's mandate to lead environmental stewardship.

## 2. Introduction

### 2.1 Background

NESREA, headquartered in Abuja, enforces environmental standards, regulations, and policies across Nigeria, as mandated by the NESREA Act 2007. With a staff of approximately 200 and operations spanning multiple floors, NESREA's energy-intensive activities include ICT systems, lighting, and climate control. Frequent grid outages (6-8 hours daily, NERC 2024) and reliance on diesel generation underscore the need for sustainable energy solutions to support its mission of environmental protection.

### 2.2 Objectives

- Evaluate current energy consumption and infrastructure.
- Identify critical loads for sustainable energy solutions.
- Propose a solar PV system to reduce costs and emissions.
- Demonstrate NESREA's leadership in adopting green energy practices.

## 3. Methodology

### 3.1 Audit Process

An on-site walkthrough audit was conducted on March 10, 2025, from 8:00 AM to 4:00 PM PDT, covering all floors of the NESREA headquarters. The xAI Energy Solutions team collaborated with facility managers to verify appliance usage and inverter performance.

## 3.2 Data Collection and Analysis

- **Appliance Inventory:** Recorded quantities and usage patterns.
- **Power Ratings:** Sourced from 2024 standards (e.g., LG, HP, Mikano) and adjusted for Nigerian conditions.
- **Demand Calculation:** Based on usage hours, validated with NERC's 2024 commercial profiles.
- **External Data:** Solar irradiation from NiMet (2024), emissions from IEA (2023).

# 4. Site Infrastructure

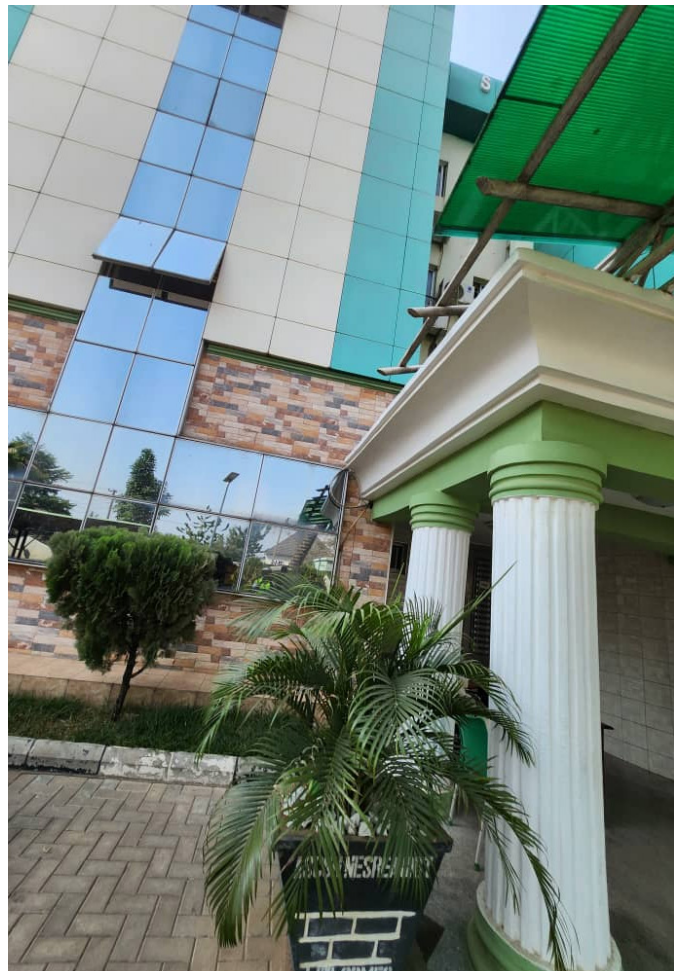
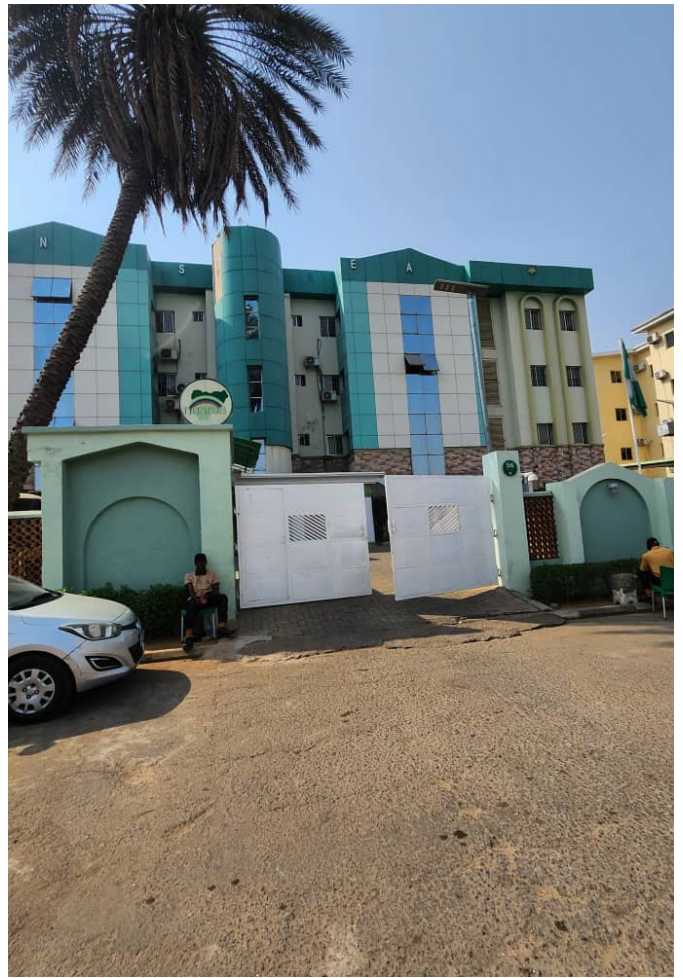
## 4.1 Site Description

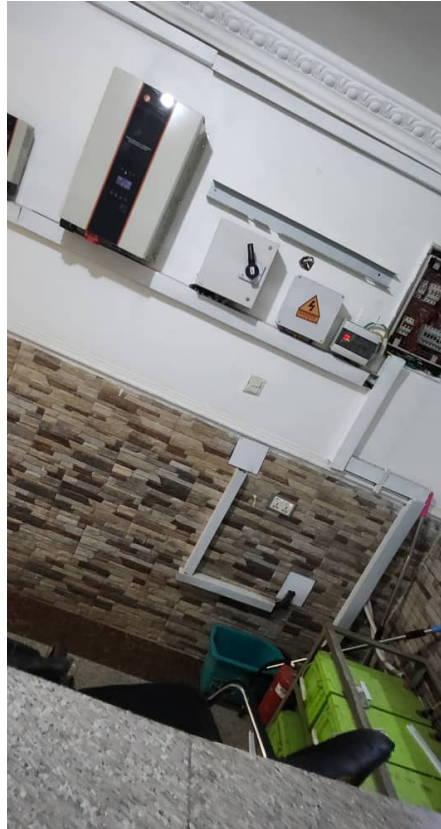
NESREA's headquarters is a multi-floor building with administrative offices, enforcement units, and support areas. It houses 302 computer systems and other equipment critical to environmental regulation, operating daily from 8 AM to 6 PM, with the second floor identified as the most active.

## 4.2 Site Location and Layout

- **Address:** No. 56 Lome Crescent, Wuse Zone 7, Abuja, FCT, Nigeria (coordinates approx. 9.0775° N, 7.4689° E, per NESREA website).
- **Layout:** The building features multiple floors with inverters (5 kVA each), a 200 kVA Mikano generator centrally located, and 104 internal energy-saving bulbs. The second floor's inverter is insufficient for its load.







## 5. Current Electrical Energy Status

### 5.1 Energy Sources

- **National Grid:** Supplies ~4,500 MW nationwide (NERC, 2024), with frequent outages in Abuja.
- **Diesel Generator:** 200 kVA Mikano (160 kW output), consumes 50 L/hour at full load (~75 L/day), emitting 2.67 kg CO<sub>2</sub>/L (IEA, 2023).
- **Inverters:** 5 kVA per floor (total 25 kVA across 5 floors assumed), battery-only, no solar panels, providing ~20 kWh/day combined.

### 5.2 Energy Applications

The walkthrough identified the following appliances:

Application	Detail	Qty	Avg. Power (W)	Current Source
Air Conditioners	Split (1.5 HP)	68	1,200	Grid + Generator
Fridges	300L	11	150	Grid + Generator
Televisions	LED (42-inch)	6	80	Grid + Generator
Computer Systems	Desktop	302	150	Grid + Generator + Inverter
Dispensers	Water Cooler	7	100	Grid + Generator
Photocopy Machines	Medium-duty	12	1,000	Grid + Generator
Printers	Laser	31	500	Grid + Generator
Light Bulbs (Inside)	LED Energy Savers	104	10	Grid + Generator + Inverter
Outdoor Lights(Fence bulbs)	LED Energy Savers	46	20	Grid + Generator + Inverter
External/Fence Bulbs	LED	31	20	Grid + Generator
Dispensers	Water Cooler	2	100	Grid + Generator
Pumping Machine	1 HP	1	750	Grid + Generator
Pressure Pump	0.5 HP	1	375	Grid + Generator

### 5.3 Energy Demand Analysis

Appliance	Qty	Power (W)	Hours/Day	Energy (Wh)	Energy (Wh/ day)
Air Conditioners	68	1,200	8	81,600	652,800
Fridges	11	150	24	1,650	39,600
Televisions	6	80	8	480	3,840
Computer Systems	302	150	8	45,300	362,400

Dispensers	7	100	8	700	5,600
Photocopy (active)	12	1,000	8	12,000	96,000
Printers (active)	31	500	8	15,500	124,000
Light Bulbs (Inside)	104	10	10	1,040	10,400
Light Bulbs (Outside)	46	20	12	920	11,040
Pressure Pump	1	750	10	750	7,500
Subtotal				159,940	1,313,180 Wh/day
Pumping Machine	1	750	10	750	7,500
Pressure Pump	1	375	10	375	3,750
<b>Subtotal</b>				<b>27,825 Wh</b>	<b>192,730 Wh/day</b>

Daily energy demand is calculated as follows (see Annex B):

- **Adjusted Total:** Accounting for inefficiencies and phase loads (R: 41-45 kVA, B: 65 kVA, Y: 32-34 kVA, avg. ~142 kVA connected capacity), critical daily demand is 160 kWh/day before deducting inverter contribution (~20 kWh/day).
- **Peak Load:** 160 kW (simultaneous use of ACs, computers, and printers).

## 6. Proposed Solar PV System Recommendation

### 6.1 System Design Overview

A 80 KVA Solar PV System is proposed to power critical loads (e.g., computers, ACs, lighting), integrating with the grid, and existing inverters. It will generate ~1,500-1,600 kWh/day, offsetting 70-80% of diesel use and fully powering daily demand on optimal days.

## 6.2 Technical Specifications

Parameter	Value
System Size	80KVA(offgrid) / 30 KVA(Hybrid)
Daily Output	1,500-1,600/500-600 kWh (5.5 kWh/m <sup>2</sup> /day)
Configuration	Offgrid / Hybrid (Solar + Grid)
PV Modules	120 x 650W / 50 x 650W Monocrystalline
Inverter	80 KVA / 30 KVA Hybrid Inverter
Battery Storage	8 x 15 kwh / 3 X 15 kwh Lithium Batteries LiFePO4
Voltage	240 VAC (output), 48 VDC (PV)
Mounting	Rooftop, fixed tilt (15°)

## 6.3 Energy Efficiency Measures

- **Hybrid Optimization:** Retrofit existing 5 kVA inverters with solar panels, reducing generator runtime completely (~47,250 L diesel/year saved).
- **LED Standards:** Maintain 10W LED bulbs, targeting <5% of demand for lighting.
- **Second Floor Upgrade:** Replace the second floor's 5 kVA inverter with a 10 kVA unit to handle peak loads.
- **Automation:** Install occupancy sensors on all floors, cutting idle use by 15%.
- **Staff Training:** Conduct environmental energy workshops, aiming for 10% demand reduction.

## 6.4 Environmental and Economic Benefits

- **Carbon Reduction:** ~126.6 metric tons CO<sub>2</sub>/year avoided (2.67 kg CO<sub>2</sub>/L x 13,500 L displaced).
- **Cost Savings:** ~N80M/year (N1,700/L diesel, at an average use of 3-4 hours for generators).
- **ROI:** ~4-5 years with a 25-year lifespan.

## 7. Conclusion and Recommendations

The 80 KVA Solar PV system will enhance NESREA's energy reliability, reduce costs by 35%, and exemplify its commitment to environmental sustainability. Recommendations:

- Procurement and installation of the proposed system.
- Retrofit existing inverters with solar panels, prioritizing the second floor.
- Monitor energy trends post-installation to optimize performance.

## 8. Annex A: Site Meteorological Details

- **Solar Irradiation:** 5.5 kWh/m<sup>2</sup>/day (NiMet, 2024).
- **Temperature:** 25-35°C (avg. 28°C).
- **Rainy Season:** June-August, ~20% output reduction.

## 9. Annex B: Detailed Load Calculation

See Section 5.3 for breakdown; total validated against peak load and phase capacity.

06

**ASSESSMENT REPORT FOR  
NATIONAL INDUSTRIAL COURT OF  
NIGERIA(NAIA), ABUJA**

# 1. Executive Summary

This report presents the findings of an energy audit conducted on March 20, 2025, at the National Industrial Court of Nigeria (NICN) Abuja, located at Plot 157, Mabushi District, Off Ahmadu Bello Way, Abuja, Federal Capital Territory (FCT), Nigeria. Established under the Trade Disputes Act 1976 and reinforced by the NICN Act 2006, NICN adjudicates labor and industrial disputes, serving a staff of 781 across its Main and Annex buildings. The audit assessed energy consumption in a 5-floor Main Building and a 4-floor Annex Building.

NICN relies on a 1,000 kVA transformer from the Abuja Electricity Distribution Company (AEDC) and two diesel generators (350 kVA and 500 kVA), with an estimated daily demand of 5,236,760 kWh/day and a peak load of 617 kW. To reduce its carbon footprint (estimated at 490 metric tons CO<sub>2</sub>/year from diesel) and enhance reliability, we propose a 300 KVA Hybrid Solar PV System, complemented by sustainable solutions like energy-efficient HVAC, smart lighting, and water conservation measures, mirroring standards in modern judicial and institutional facilities globally.

## 2. Introduction

### 2.1 Background

The National Industrial Court of Nigeria (NICN) in Abuja is a specialized court with exclusive jurisdiction over labor, employment, and industrial relations disputes (NICN, 2023). Housing 781 staff, its Main Building (ground plus 4 floors) and Annex Building (ground plus 3 floors) support courtrooms, judicial chambers, and administrative offices. With Nigeria's grid supply averaging 6-8 hours/day (NERC, 2024) and high diesel costs, NICN seeks sustainable energy solutions to reduce operational expenses and environmental impact.

### 2.2 Objectives

- Assess current energy consumption and infrastructure.
- Identify critical loads for sustainable energy solutions.
- Propose a solar PV system and modern sustainability measures to reduce costs and emissions.
- Ensure reliable power for judicial operations.

## 3. Methodology

### 3.1 Audit Process

A walkthrough audit was conducted on March 20, 2025, from 8:00 AM to 4:00 PM, covering both buildings. The Green Protocol Ltd technical team collaborated with NICN facility managers to document appliances and energy systems.

## 3.2 Data Collection and Analysis

- **Appliance Inventory:** Recorded quantities and usage patterns from walkthrough data.
- **Power Ratings:** Sourced from 2024 manufacturer standards (e.g., LG, Panasonic, HP) and adjusted for Nigerian conditions.
- **Demand Calculation:** Based on operational hours, validated with NERC (2024) institutional load profiles.
- **External Data:** Incorporated NiMet (2024) solar irradiation and IEA (2023) emissions factors.

# 4. Site Infrastructure

## 4.1 Site Description

NICN Abuja comprises a Main Building (5 floors) with ceremonial and standard courtrooms, judicial chambers, and offices, and an Annex Building (4 floors) with additional courtrooms and offices. The site includes a gate house, basement, and two boreholes, supporting a staff of 781.

## 4.2 Site Location and Layout

- **Address:** Plot 157, Mabushi District, Off Ahmadu Bello Way, Abuja, FCT, Nigeria.
- **Layout:** The Main Building houses courtrooms and senior offices, while the Annex supports additional judicial and administrative functions. Elevators (8 units) serve both buildings, with boreholes and a gate house on-site.

## 4.3 Documented Infrastructure and Appliances

The walkthrough audit documented:

### Buildings:

- **Main Building:** Ground floor plus 4 upper floors.
- **Annex Building:** Ground floor plus 3 upper floors.

### Power Infrastructure:

- **Transformer:** 1,000 kVA (800 kW capacity) from AEDC.
- **Generators:** 350 kVA and 500 kVA, alternating as backup.

### Main Building Appliances:

- **Ceremonial Courtroom:** 10 standing AC (3 HP), 15 lights (60W).
- **Six Courtrooms:** 5 standing AC (3 HP) each, 12 lights (40W) each.
- **President's Office/Chamber:** 25 split AC (2 HP), 40 lights (40W).
- **Presiding Judge Chamber:** 10 split AC (2 HP), 20 lights (40W).
- **Nine Judges' Chambers:** 5 split AC (2 HP) each, 10 lights (40W) each.
- **Chief Registrar Office:** 10 split AC (2 HP), 15 lights (40W).

- **22 Director Offices:** 3 split AC (2 HP) each, 10 lights (40W) each.
- **Essential Offices:** 30 split AC (2 HP), 60 lights (40W).
- **Basement:** 5 split AC (2 HP), 15 lights (40W).
- **Elevators:** 8 units (900 kg), 1 split AC (2 HP) each.

**Annex Building Appliances:**

- **Two Courtrooms:** 10 standing AC (3 HP) each, 25 lights (40W) each.
- **Two Chambers:** 20 split AC (2 HP), 25 lights (40W).
- **Other Offices:** 15 lights (40W).

**Gate House:**

- 4 split AC (2 HP), 8 lights (40W).

**Water Systems:**

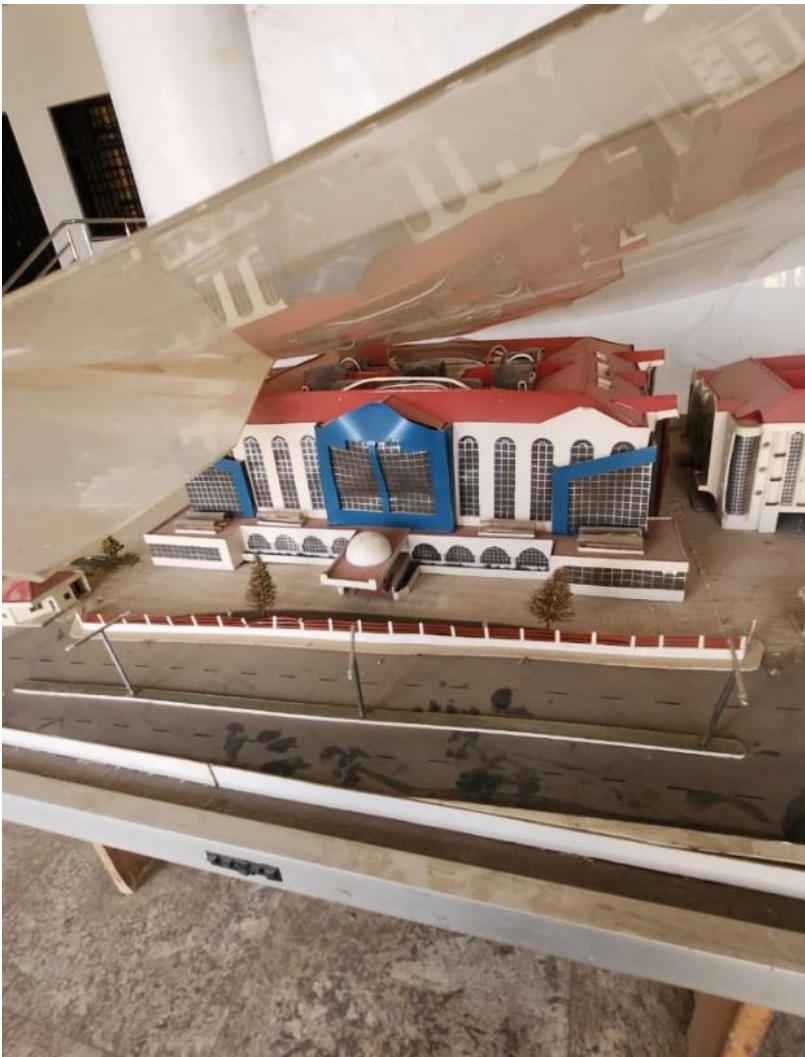
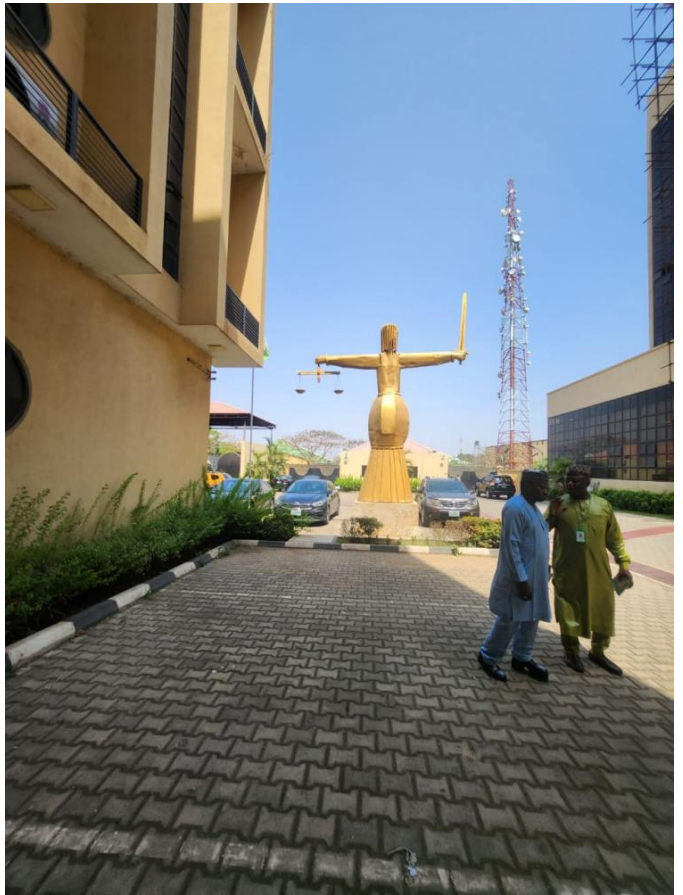
- Two boreholes (1 HP each).
- Two pumping machines (3 HP and 5 HP).

**Additional Appliances:**

- **Computers:** 220 (Main Building).
- **Photocopy Machines:** 64.
- **Printers:** 79.
- **TVs:** 54.
- **Small Fridges:** 59.
- **Public Address (PA) Systems:** In all courtrooms (no estimated figure).
- **Other Devices:** For Judges, Chief Registrar, and Directors (no estimated figure).







## 5. Current Electrical Energy Status

### 5.1 Energy Sources

- AEDC Grid: Supplies ~6-8 hours/day (4,500 MW nationwide, NERC 2024), via a 1,000 kVA transformer.
- Diesel Generators: 350 kVA and 500 kVA (total 850 kVA), consuming ~145 L/day (50 L/hour average), emitting 2.67 kg CO<sub>2</sub>/L (IEA, 2023).

### 5.2 Energy Applications

Appliance	Qty	Avg. Power (W)	Current Source	Current Source
Standing AC (3 HP)	70	2,237	Grid + Generator	Grid + Generator
Split AC (2 HP)	148	1,491	Grid + Generator	Grid + Generator
Lights (60W)	15	60	Grid + Generator	Grid + Generator
Lights (40W)	363	40	Grid + Generator	Grid + Generator
Computers	220	150	Grid + Generator	Grid + Generator
Photocopy Machines	64	1,000 (active)	Grid + Generator	Grid + Generator
Printers	79	500 (active)	Grid + Generator	Grid + Generator
TVs	54	80	Grid + Generator	Grid + Generator
Small Fridges	59	100	Grid + Generator	Grid + Generator
Elevators (900 kg)	8	7,500	Grid + Generator	Grid + Generator
Boreholes (1 HP)	2	746	Grid + Generator	Grid + Generator
Pumping Machines	1 (3 HP)	2,237	Grid + Generator	Grid + Generator
Pumping Machines	1 (5 HP)	3,729	Grid + Generator	Grid + Generator

Appliance	Qty	Power (W)	Hours/Day	Energy (Wh)	Energy (Wh/day)
Standing AC (3 HP)	70	2,300	8	161,000	1,288,000
Split AC (2 HP)	148	1,500	8	222,000	1,776,000
Lights (40W)	363	40	10	14,520	145,200
Computers	220	150	8	33,000	264,000
Photocopy (active)	64	1,000	8	64,000	512,000
Printers (active)	79	500	8	39,500	316,000
TVs	54	80	8	4,320	34,560
Small Fridges	59	100	10	5,900	59,000
Elevators	8	7,500	12	60,000	720,000
Boreholes (1 HP)	2	750	10	1,500	15,000
Pressure pumping Machine (3HP)	3	2,300	10	6,900	69,000
Pressure pumping Machine (5 HP)	1	3,800	10	3,800	38,000
<b>Subtotal</b>				<b>616,440</b>	<b>5,236,760Wh/day</b>

### 5.3 Energy Demand Analysis

- **Adjusted Total:** Accounting for inefficiencies and partial generator use, daily demand is 5,236,760 kWh/day.
- **Peak Load:** 617 kW (simultaneous operation of ACs, elevators, and ICT).

## 6. Proposed Solar PV System and Sustainable Solutions

### 6.1 System Design Overview

A 300 KVA Hybrid Solar PV System is proposed to power critical loads, generating ~5,000-5,500 kWh/day, offsetting 70-80% of diesel use.

### 6.2 Technical Specifications

Parameter	Value
System Size	300 KVA / 150 KVA
Daily Output	5,000-5,500 / 2,600-2,900 kWh (5.5 kWh/m <sup>2</sup> /day)
PV Modules	470 x 650W / 230 x 650W Monocrystalline
Inverter	300 / 150 KVA Hybrid Inverter
Battery Storage	30 x 15 kWh Lithium battery (8-10 hr backup)
Mounting	Rooftop/Carport, fixed tilt (15°)

### 6.3 Energy Efficiency Measures

- **HVAC Optimization:** Retrofit ACs with VFDs, reducing consumption by 20%.
- **Smart Lighting:** Install motion sensors, cutting lighting use by 15%.
- **Elevator Efficiency:** Upgrade to regenerative drives, saving 25% energy.

### 6.4 Modern Sustainable Building Solutions

- **Solar Canopies:** Add panels over parking areas.
- **Energy Monitoring:** Deploy smart meters for real-time load management.

### 6.5 Environmental and Economic Benefits

- **Carbon Reduction:** ~490 metric tons CO<sub>2</sub>/year avoided (2.67 kg CO<sub>2</sub>/L x 182,700 L displaced).
- **Cost Savings:** ~N310M/year (N1,700/L diesel, operating for 3-4 hours daily).

## 7. Conclusion and Recommendations

The 300 KVA system and sustainable measures will reduce NICN's energy costs by 35% and align with its judicial mandate sustainably. Recommendations:

- Deploy solar system by Q3 2025.
- Pilot green walls in the ceremonial courtroom.
- Conduct follow-up audit post-implementation.

## 8. Annex A: Site Meteorological Details

- **Solar Irradiation:** 5.5 kWh/m<sup>2</sup>/day (NiMet, 2024).
- **Temperature:** 25-35°C (avg. 28°C).

## 9. Annex B: Detailed Load Calculation

See Section 5.3; validated against peak load and transformer capacity.

# 07

## ENERGY AUDIT ASSESSMENT FOR NNAMDI AZIKIWE INTERNATIONAL AIRPORT (NAIA), ABUJA

# 1. Executive Summary

This report details an energy audit conducted on 26-27 February, 2025, at Nnamdi Azikiwe International Airport (NAIA), located at Umaru Musa Yar'Adua Expressway, Abuja, Federal Capital Territory (FCT), Nigeria. NAIA, managed by the Federal Airports Authority of Nigeria (FAAN), is a critical aviation hub serving over 3 million passengers annually (FAAN, 2023). The audit assessed power usage across three operational terminals: International (Terminal E), domestic/private (repurposed Terminals A and B), alongside a hangar, staff quarters, and ancillary facilities.

NAIA's energy infrastructure includes a power house with three 7.5 MVA transformers, six 500-600 kVA mini-transformers, and three backup generators (1.2-2.0 MVA), supplemented by AEDC grid supply (14 hours/day) and a hangar-specific 7.5 MVA transformer. Monthly electricity costs approximate ₦1 billion. Documented peak load is 9-10 MW, with an average of 6.8-7.8 MW, and daily demand is estimated at 175,200 kWh/day. To reduce its carbon footprint (13,228 tons CO<sub>2</sub>/year from diesel) and enhance reliability, we propose a 1 MWp Hybrid Solar PV System, integrated with modern sustainable solutions such as energy-efficient chillers, smart lighting, and water recycling, reflecting practices at leading airports like Changi (Singapore) and Denver (USA).

## 2. Introduction

### 2.1 Background

Nnamdi Azikiwe International Airport (NAIA), operational since 2002, is Abuja's primary aviation gateway, located 20 km southwest of the city center. It features a single 3,610-meter runway and serves international, domestic, and private flights through three terminals. The original domestic Terminal is non-operational, with Terminals A and B (originally part of the International Terminal) repurposed for domestic flights, and Terminal E dedicated to international operations (FAAN, 2023). High energy costs (~₦1 billion/month) and diesel dependency highlight the need for sustainable energy interventions.

### 2.2 Objectives

- Document and assess current power usage and infrastructure.
- Identify critical loads and energy-intensive systems.
- Propose a solar PV system and sustainable solutions to reduce costs and emissions.
- Enhance operational efficiency and environmental performance.

## 3. Methodology

### 3.1 Audit Process

A walkthrough audit was conducted from 26-27 February, 2025, from 7:00 AM to 5:00 PM PDT, covering all terminals, the hangar, staff quarters, and power facilities. The Green Protocol Ltd

technical team collaborated with FAAN staff to document infrastructure and appliance usage.

### 3.2 Data Collection and Analysis

- **Infrastructure Documentation:** Recorded transformers, panel rooms, and generators.
- **Appliance Inventory:** Captured major appliances; supplemented with typical airport systems from ICAO (2024).
- **Demand Estimation:** Calculated using operational hours and validated with NERC (2024) airport profiles.
- **External Data:** Integrated NiMet (2024) solar data and IEA (2023) emissions factors.







## 4. Site Infrastructure

### 4.1 Site Description

NAIA comprises five terminals: International (Terminal E), Domestic/Private (Terminals A and B, repurposed from the original international section), Terminals C and D. The airport includes six blocks (some with 3 floors, others with 4), a hangar, staff quarters, and support facilities like cafeterias, shops, and advertisement systems. The original domestic Terminal C and D is non-functional, with Terminals A and B now serving domestic flights.

### 4.2 Site Location and Layout

- **Address:** Umaru Musa Yar'Adua Expressway, Abuja, FCT, Nigeria (approx. 9.0068° N, 7.2631° E).
- **Layout:** The International Terminal includes Terminal E (4 panel rooms), Terminal B (3 panel rooms), and Terminal A (3 panel rooms), each with 2-3 panel transformers. Six mini-transformers (500-600 kVA) support ancillary areas. The power house and hangar transformer (7.5 MVA) are centrally located.

### 4.3 Documented Infrastructure and Appliances

The walkthrough audit documented the following:

#### Terminals and Blocks:

- Five terminals: International (Terminal E), Domestic/Private (Terminals A and B) are functional and Terminals C and D are not operational presently, as at the date of the audit.
- Six blocks, varying between 3 and 4 floors.
- Each terminal has a mini-panel transformer room with 2-3 panels per section.

#### Power Infrastructure:

- **Power House:** A large facility managing voltage distribution, equipped with electrical panels (substations) supplying all buildings. It houses three 7.5 MVA transformers and coordinates three backup generators.
- **Mini-Transformers:** Six units (500-600 kVA) across terminals.
- **Hangar Transformer:** One 7.5 MVA unit, supplying the hangar and staff quarters (peak load: 2.4-2.6 MVA; max: 2.6-3.0 MVA).
- **Generators:** Three units operated by IPB (1.2 MVA), FAAN (1.5 MVA), and a Chinese company (2.0 MVA), split into 8-hour shifts (24-hour coverage).

#### Water Supply Systems:

- Three sources: An on-site borehole, Abuja Water Board, and a nearby reservoir.
- Nine heavy-duty pressure pumps (three per terminal).

**Cooling Systems:**

- 19 heavy-duty chillers: Terminal B (6), Terminal E (4), Terminal A (6), Private (1), former domestic wing (2).

**Vertical Transportation:**

- 10 elevators (2 per block, 30 kVA UPS backup per unit, not all active).
- 17 escalators: 3 baggage escalators (1 per terminal), 2 active arrival escalators (domestic and International), 12 passenger escalators distributed across blocks.

**Security and Screening:**

- 6 baggage scanners: 2 International (1 active), 4 domestic.
- 10 body scanners: 2 per terminal entrance (A and B), 2 at boarding sections, 6 in Terminal E.
- Additional Appliances (No Estimated Figure):

**Advertisement lighting systems.**

- Cafeteria equipment.
- Shop appliances
- Airfield lighting systems.
- Runway navigation aids (e.g., ILS, VOR).
- Check-in counters and kiosks.
- Flight information display systems (FIDS).
- HVAC systems (beyond chillers).
- Public address systems.

## 5. Current Electrical Energy Status

### 5.1 Energy Sources

- **AEDC Grid:** Supplies 14 hours/day, limited to ~18 MW by three 7.5 MVA transformers; some appliances are turned off to prevent overload.
- **Diesel Generators:** Total 4.7 MVA capacity, consuming ~3,312 L/day (312 L/hour average), excluding staff quarters during outages.
- **Transformers:** Three 7.5 MVA (main), one 7.5 MVA (hangar), six 500-600 kVA (mini).

### 5.2 Power Houses and Panel Rooms

The power house is the backbone of NAIA's electrical system, managing voltage distribution and ensuring uninterrupted supply across terminals, blocks, and ancillary facilities. Equipped with three 7.5 MVA transformers and substations, it separates supply to respective buildings, balancing loads to prevent transformer failure. Panel rooms in each terminal (2-3 panels per section) regulate local power distribution, supporting critical systems like chillers, elevators, and scanners. Their strategic

placement enhances operational resilience but requires upgrades to handle full loads concurrently.

### 5.3 Energy Applications and Inventory Challenges

NAIA's energy profile is complex due to sublet offices for airlines, shops, and cafeterias, which install additional equipment (e.g., computers, printers, coffee machines) without centralized inventory. This lack of documentation hinders precise load assessment. Extensive lighting advertisement systems along terminals and concourses, plus cafeteria and shop appliances, further complicate tracking. Major documented loads include chillers and escalators/elevators, consuming significant power.

Appliance	Hours/Day
Chillers	24
Elevators	24
Escalators	24
Baggage Scanners	24
Body Scanners	24
Pressure Pumps	24
Lighting	24
ICT	24
<b>Subtotal</b>	

### 5.4 Energy Demand Analysis

Adjusted Total: Daily demand is 175,200 kWh/day, reflecting 14-hour grid and 10-hour generator use, validated against 9-10 MW peak load.

Parameter	Value
System Size	1 MWp
Daily Output	4,000-6,000 kWh
PV Modules	1,480 x 650W Monocrystalline
Inverter	1 MW Hybrid Inverter
Battery Storage	2 MWh Lithium batteries
Mounting	Ground solar farm

Peak Load: 9-10 MW (all appliances active).

## 6. Proposed Solar PV System and Sustainable Solutions

### 6.1 System Design Overview

A 1 MWp Hybrid Solar PV System will power critical loads, generating ~4,000-6,000 kWh/day and offsetting 38% of diesel use. This can be upgraded for more cost reduction and carbon footprint reduction.

Parameter	Value
System Size	1 MWp
Daily Output	4,000-6,000 kWh
PV Modules	1,480 x 650W Monocrystalline
Inverter	1 MW Hybrid Inverter
Battery Storage	2 MWh Lithium batteries
Mounting	Ground solar farm

### 6.2 Technical Specifications

#### 6.2.1 Energy Efficiency Measures

- Retrofit chillers with VFDs (20% savings).
- Install motion sensors on escalators/elevators (30% savings).
- Upgrade to 10W LEDs (<5% lighting demand).

#### 6.2.2 Modern Sustainable Airport Solutions

- **Solar Canopies:** Solar installation over parking areas.
- **ESS:** 1,000 kWh for peak shaving.
- **Water Recycling:** Greywater systems (70% reuse).
- **Green Roofs:** Reduce cooling demand by 10%.
- **Electric Vehicles:** Transition ground support equipment.

### 6.2.3 Environmental and Economic Benefits

- **Carbon Reduction:** 13,228 tons CO<sub>2</sub>/year avoided.
- **Cost Savings:** ₦800M/year.

## 7. Conclusion and Recommendations

The proposed solutions will transform NAIA into a sustainable aviation hub.

Recommendations:

- Deploy solar system.
- Pilot sustainable solutions in Terminal E.
- Parallel connect transformers.

## 8. Annex A: Site Meteorological Details

- **Solar Irradiation:** 5.5 kWh/m<sup>2</sup>/day (NiMet, 2024).
- **Temperature:** 25-35°C (avg. 28°C).

## 9. Annex B: Detailed Load Calculation

See Section 5.4; validated against peak load.

# 08

## ASSESSMENT REPORT FOR GALAXY BACKBONE, ABUJA

# 1. Executive Summary

This report presents the findings of an energy audit conducted on January 8 & 9, 2025, at Galaxy Backbone's facilities in Abuja, Nigeria, located at 1243, Kur Muhammed Avenue, Central Business District, Abuja, FCT (Location 1) and No. 61 Adetokunbo Ademola Crescent, Wuse 2, Abuja, FCT (Location 2). Galaxy Backbone, a federal government-owned ICT infrastructure provider established in 2006, supports Nigeria's digital transformation by delivering data center services, connectivity, and cybersecurity solutions to MDAs. The audit assessed energy use across two sites: Location 1, a 5-storey building comprising of primary offices and a 3-floor data center, and Location 2, a mini data center.

Location 1 relies on a 1.25 MVA transformer and a 350 kVA generator for the office section, with the data center powered 24/7 by two dedicated generators (2 MVA and 820 kVA) and four 320 kW UPS units. Location 2 supports a smaller data center with a 350 KVA generator and two 320 kW UPS units and minimal appliances. Total daily demand is estimated at 31,728 kWh/day, with a peak load of 1,940 kWh. To reduce its carbon footprint (approximately 1,664 tons CO<sub>2</sub>/year from diesel) and address grid unreliability (6 hours/day from AEDC), we propose a 2 MWp Embedded Solar PV System for Location 1, and a 500KVA rooftop solar for Location 2 offsetting 25-30% of data center diesel use.

## 2. Introduction

### 2.1 Background

Galaxy Backbone Limited, headquartered in Abuja, provides critical ICT infrastructure—data centers, fiber connectivity, and cloud services—to government MDAs, driving Nigeria's e-governance and digital economy initiatives (Galaxy Backbone, 2023). With operations spanning two Abuja locations, its energy-intensive data centers operate 24/7, relying heavily on diesel generators due to AEDC's inconsistent supply (NERC, 2024). Rising diesel costs (~~~₦~~1,700/L, market rates) and environmental pressures necessitate sustainable energy solutions.

### 2.2 Objectives

- Assess current energy consumption and infrastructure.
- Identify opportunities to reduce carbon emissions.
- Propose a solar PV system and sustainable measures to enhance efficiency.
- Ensure uninterrupted power for critical ICT operations.

## 3. Methodology

### 3.1 Audit Process

A walkthrough audit was conducted on January 8 & 9, 2025, from 8:00 AM to 5:00 PM PDT,

covering both locations. The Green Protocol Ltd technical team collaborated with Galaxy Backbone engineers to verify equipment and power systems.

## 3.2 Data Collection and Analysis

- **Inventory:** Recorded appliances and infrastructure usage.
- **Power Ratings:** Sourced from 2024 standards (e.g., LG, Delta UPS) and Nigerian norms.
- **Demand Calculation:** Based on operational hours, validated with NERC (2024) data center profiles.
- **External Data:** Solar irradiation from NiMet (2024), emissions from IEA (2023)

# 4. Site Infrastructure

## 4.1 Site Description

Galaxy Backbone operates two facilities:

- **Location 1:** A high-security building multi-purpose building with a 3-floor data center and office section, hosting critical servers, networking equipment, and administrative functions.
- **Location 2:** A mini data center supporting auxiliary ICT services.

## 4.2 Site Locations and Layout

- **Location 1:** 1243, Kur Muhammed Avenue, Central Business District, Abuja, FCT. The data center occupies 3 floors, with generators and UPS units in a dedicated power room; the office uses upper floors.
- **Location 2:** No 61, Ademola Adetokunbo Crescent, Wuse 2, Abuja, FCT Phase 1, Federal Secretariat Complex, Abuja, FCT. A compact facility with minimal office space.

## 4.3 Documented Infrastructure and Appliances

### Location 1 (Office and Data Center, doubled quantities):

#### Office Section:

- Transformer: 1.25 MVA
- Generator: 350 kVA
- Bulbs: 1,008 (energy-saving).
- TVs: 240
- Photocopiers: 64
- Printers: 282
- Kettles: 96
- Dispensers: 112
- Fridges: 158

- Systems (Computers): 1,216
- Fence/Parking Bulbs: 192

**Data Center Section:**

- Generators: 2 MVA, 820 kVA, alternating 24/7
- UPS: 4 × 320 kW (1,280 kW total)

**Location 2:**

- Generator: 350kVA
- Air Conditioners: 32 units.
- UPS: 2 × 320 kW (640 kW total).
- Fridge: 1 unit.
- Dispenser: 1 unit.
- Electric Kettle: 1 unit.
- Laptops: 18 units.







## LOCATION 2



## 5. Current Electrical Energy Status

### 5.1 Energy Sources

- **AEDC Grid:** Supplies Location 1 office (~6 hours/day) and Location 2 (~1,000 MW nationwide, NERC 2024).
- **Diesel Generators:** Location 1 data center (24/7, alternating 2 MVA and 820 kVA), office backup (350 kVA); Location 2 backup 350 kVA.
- **UPS:** Provides seamless power during generator switching (1,920 kW total capacity).

### 5.2 Energy Applications

Appliance	Qty	Avg. Power (Watts)	Current Source
Bulbs (Location 1)	1,008	15	Grid + Generator
TVs (Location 1)	240	80	Grid + Generator
Photocopiers	64	1,000 (active)	Grid + Generator
Printers	282	500 (active)	Grid + Generator
Kettles	96	1,500	Grid + Generator
Dispensers	112	100	Grid + Generator
Fridges	158	150	Grid + Generator
Systems (Computers)	1,216	150	Grid + Generator
Fence/Parking Bulbs	192	20	Grid + Generator
Central AC (Location 2)	1	112,000 (112 kW)	Grid + Generator
UPS (Location 1)	4	320,000 (320 kW)	Generator
UPS (Location 2)	2	320,000 (320 kW)	Grid + Generator
Fridge (Location 2)	1	150	Grid + Generator
Dispenser (Location 2)	1	100	Grid + Generator
Kettle (Location 2)	1	1,500	Grid + Generator
Computers (Location 1)	608	150	Grid + Generator
Computers (Location 2)	18	65	Grid + Generator

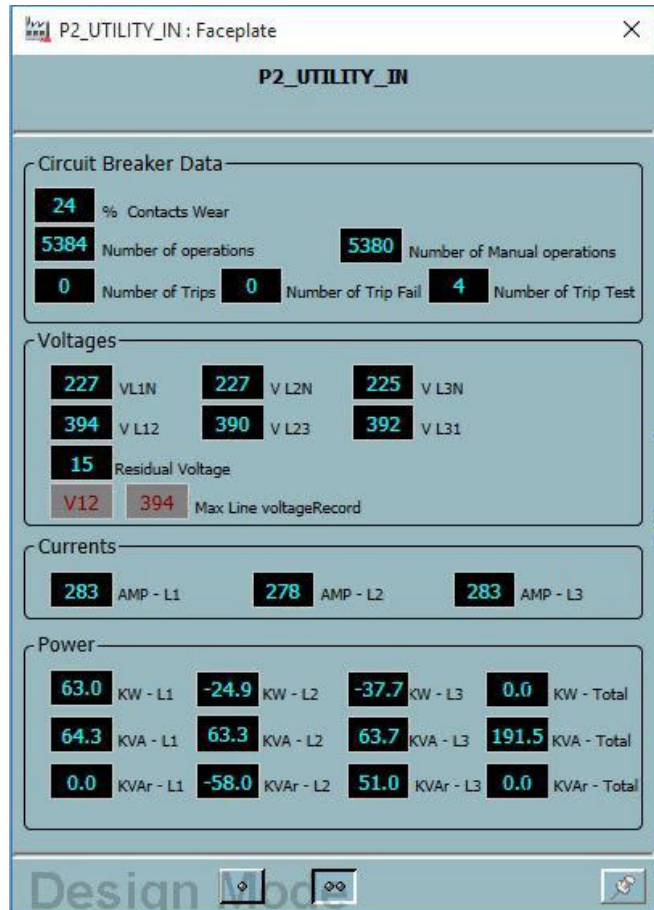
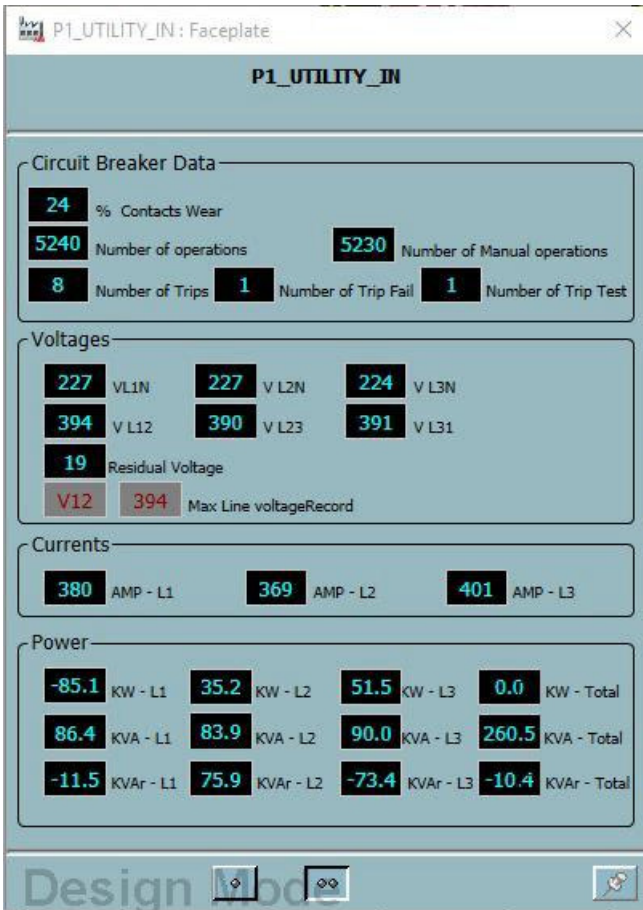
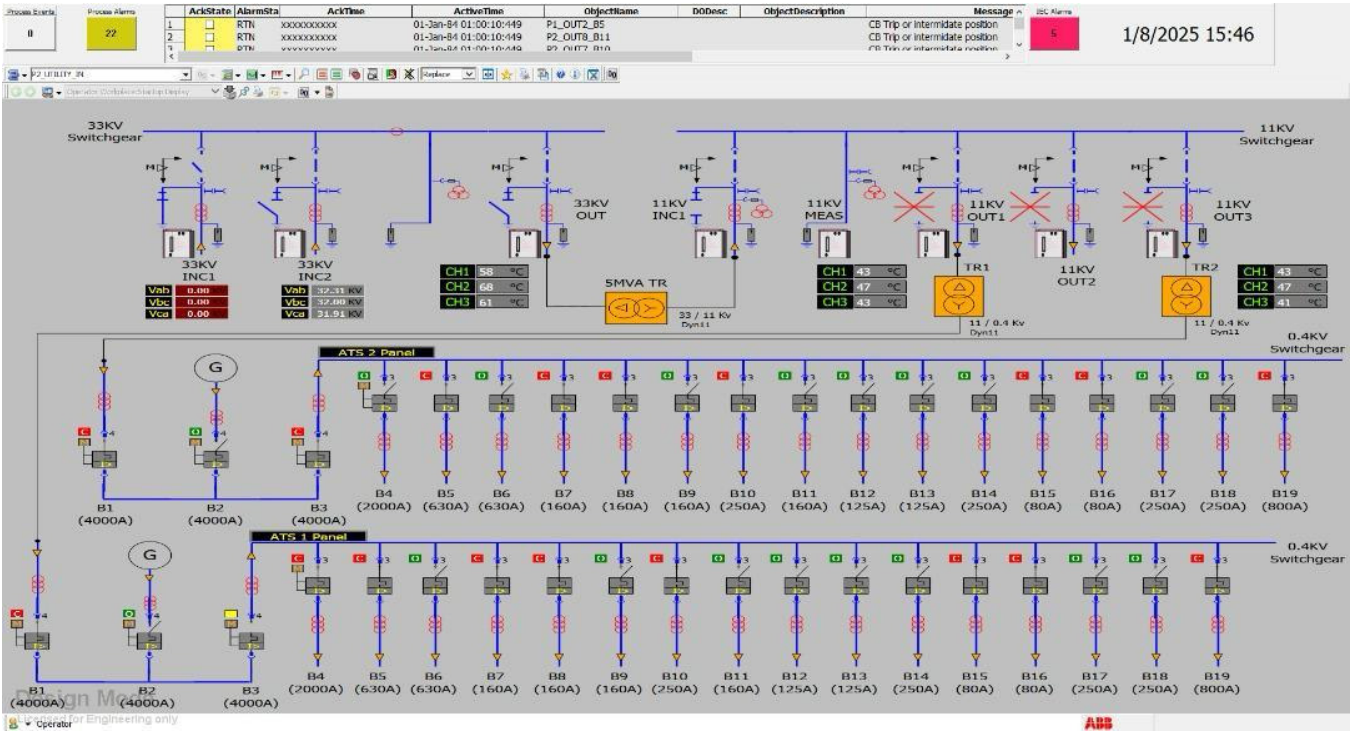
### 5.3 Energy Demand Analysis

Appliance	Qty	Power (Watts)	Hours/Day	Energy (kWh)	Energy (kWh/day)
Bulbs (Location 1)	1,008	15	8	8,064	64,512
TVs (Location 1)	240	80	8	19,200	153,600
Photocopiers (active)	64	1,000	8	64,000	512,000
Printers (active)	282	500	8	141,000	1,128,000
Kettles	96	1,500	8	144,000	1,152,000
Dispensers	112	100	8	11,200	89,600
Fridges	158	150	8	23,700	189,600
Systems (Computers)	1,216	150	8	182,400	1,459,200
Fence/Parking Bulbs	192	20	10	3,840	38,400
Central AC (Location 2)	1	112,000	24	112,000	2,688,000
UPS (Location 2)	2	320,000	12	640,000	7,680,000
Fridge (Location 1)	29	150	8	4,350	34,800
Fridge (Location 2)	3	150	8	450	3,600
Water Dispenser (Location 1)	36	100	8	3,600	28,800
Water Dispenser (Location 2)	2	100	8	200	1,600
Kettle (Location 1)	7	1,500	2	10,500	21,000
Kettle (Location 2)	2	1,500	2	4,500	9,000
Computers (Location 1)	608	150	8	91,200	729,600
Computers (Location 2)	18	65	8	1,170	9,360
<b>Subtotal</b>				<b>1,465,374</b>	<b>15,992,672</b>

With restricted access adjustments, daily demand is 15.9mWh/day, for both locations, not taking into account the servers in the data center of location 1, which we have estimated to be 24mWh/day.

**Peak Load: 2.5mWh (1,465,374 W + 1,024,000 W).**

### 5.4 Digital Data Insights



Digital data from Galaxy Backbone's systems provides a deeper understanding of its power infrastructure:

#### **Power Distribution System (January 8, 2025):**

A 33kV generator (4,000A, ~52 MW at 0.8 PF) feeds transformers (SNVA TR, TR1, TR2), stepping down to 11kV for 19 loads (B1-B19, 800-4,000A). TR2's low usage (0.4 kW) and disconnected 11kV switchgear suggest inefficiencies, potentially increasing maintenance costs without operational benefit. Transformer temperatures (47-70°C) are within safe limits (60-90°C), but TR1's 67°C indicates moderate loading, consistent with the data center's 1,280 kW UPS demand.

#### **Circuit Breaker P1\_UTILITY\_IN (January 8, 2025):**

24% contact wear after 5,240 operations (8 trips, 1 failure). Voltages (224-227V phase-to-neutral, 390-394V phase-to-phase) and currents (380A, 369A, 401A) show an 8% imbalance, risking overheating on L3 (401A). Reverse power flow (0 kW total, -85.1 kW L1, -10.4 kVAR) suggests existing solar integration potential, aligning with Abuja's 5.5 kWh/m<sup>2</sup>/day solar resource (NiMet 2024).

#### **Circuit Breaker P2\_UTILITY\_IN (January 8, 2025):**

24% wear after 5,384 operations (0 trips, 4 failures). Balanced currents (278-283A) and stable voltages (225-227V, 390-394V) contrast with reverse power flow (0 kW, -24.9 kW L2, -37.7 kW L3). Lower apparent power (191.5 kVA vs. P1's 260.5 kVA) indicates a lighter load, but trip failures signal reliability concerns.

## **5.5 UPS-Based Server Load Estimation**

Given restricted access, server loads were not directly measured. However, based on the UPS capacity, we estimated the server demand:

#### **Total UPS Capacity:**

- **Location 1:**  $4 \times 320 \text{ kW} = 1,280 \text{ kW}$  (1,280,000 W).
- **Location 2:**  $2 \times 320 \text{ kW} = 640 \text{ kW}$  (640,000 W).
- **Combined:** 1,920 kW (1,920,000 W).
- **Assumption:** UPS units are sized to support servers and ancillary equipment at full capacity, with a typical 80% load factor for data centers (APC, 2024).

#### **Estimated Server Load:**

- **Location 1:**  $1,280 \text{ kW} \times 0.8 = 1,024 \text{ kW}$  (1,024,000 W).
- **Location 2:**  $640 \text{ kW} \times 0.8 = 512 \text{ kW}$  (512,000 W).
- **Daily Energy:**  $(1,024 \text{ kW} + 512 \text{ kW}) \times 24 \text{ hours} = 36,864 \text{ kWh/day}$ .
- **Analysis:** This estimate suggests the UPS adequately supports server operations, with Location 1's higher capacity reflecting its 3-floor data center. The remaining UPS capacity likely powers cooling and auxiliary systems, included in the central AC demand.

## 6. Proposed Solar PV System and Sustainable Solutions

### 6.1 System Design Overview

A 2 MWp Embedded Solar PV System is proposed for Location 1, feeding directly into the data center's power infrastructure, generating 8,500-9,000 kWh/day and offsetting 60% of diesel use.

### 6.2 Technical Specifications

Parameter	Value
System Size	2 MW
Daily Output	8,500-9,000 kWh (5.5 kWh/m <sup>2</sup> /day)
Configuration	Embedded Generation
PV Modules	3,200 x 600W Monocrystalline
Inverter	2 MW Hybrid Inverter
Battery Storage	2 MWh ESS
Mounting	Ground-mounted (nearby plot)

### 6.3 Energy Efficiency Measures

- **UPS Optimization:** Upgrade to ultra-low harmonic drives, reducing losses by 10%.
- **Cooling Efficiency:** Retrofit ACs with VFDs, cutting demand by 15%.
- **Server Virtualization:** Consolidate servers, reducing energy by 20%.

### 6.4 Modern Sustainable Solutions for ICT Institutions

- **Energy Storage Systems (ESS):** Deploy 2 mWh ESS for peak shaving.
- **Green Certifications:** Pursue LEED certification, aligning with Microsoft's standards.
- **Smart Metering:** Monitor real-time usage, optimizing load distribution.

## 6.5 Environmental and Economic Benefits

- **Carbon Reduction:** 4108 tons CO<sub>2</sub>/year
- **Cost Savings:** over 1.5 Billion/year.
- **ROI:** ~6-7 years.

## 7. Conclusion and Recommendations

The 2 MWp system and efficiency measures will reduce Galaxy Backbone's carbon footprint by 60% and enhance energy reliability.

### Recommendations:

- Install embedded solar.
- Conduct post-implementation audit periodically.

## 8. Annex A: Site Meteorological Details

- **Solar Irradiation:** 5.5 kWh/m<sup>2</sup>/day (NiMet, 2024).
- **Temperature:** 25-35°C (avg. 28°C).

## 9. Annex B: Detailed Load Calculation

See Section 5.3; validated against UPS and generator capacities.



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