| ****Sl. No.**** | ****Equipment**** | ****Specifications**** | ****Application/Use Case**** |
| --- | --- | --- | --- |
| 1 | **Solar Photovoltaic (PV) Research Unit** | - 10 kW monocrystalline PV array (efficiency >20%)- Grid-tied inverters with MPPT- Class AAA solar simulator for indoor testing | Experimental analysis of solar cell efficiency, performance degradation, and integration in hybrid PV systems |
| 2 | **Wind Energy Experimental Platform** | - 5 kW variable-speed wind turbine- Blade pitch control- Laboratory-scale wind tunnel | Studies on wind energy potential, blade optimization, and site-specific aerodynamic analysis |
| 3 | **Bioenergy Conversion System** | - Lab-scale biomass gasifier and anaerobic digester- Real-time biogas monitoring- Feedstock preparation unit | Energy generation research from organic waste, including agricultural residues and municipal solid waste |
| 4 | **Battery Research and Testing Station** | - Lithium-ion and redox flow battery modules (up to 50 kWh total)- Battery Management System (BMS)- Integrated safety and control | R&D on battery performance, charge-discharge profiles, health monitoring, and energy storage integration |
| 5 | **Power Quality Analysis Unit** | - Advanced 3-phase power analyzers (e.g., Fluke 435 II equivalent)- Harmonics, sags, swells, and transient event capture | Power system diagnostics, energy audit, and fault detection in renewable systems |
| 6 | **Thermal Imaging and Heat Flux Monitoring Kit** | - Infrared cameras (with thermal sensitivity <0.05°C)- Heat flux sensors and surface temperature probes | Assessment of heat losses in buildings and systems for improving thermal efficiency |
| 7 | **High-Performance Computing (HPC) Cluster** | - 4 compute nodes with 32-core CPUs, 128 GB RAM, and NVIDIA GPUs per node- Shared storage and networking | Simulations in fluid dynamics, power systems, AI-based forecasting, and optimization algorithms |
| 8 | **Real-Time Data Acquisition (DAQ) System** | - NI DAQ units with modular I/O- Sensor interfaces for voltage, temperature, pressure, and current | Monitoring and control of experimental setups in renewable energy studies |
| 9 | **Scientific Workstations** | - 3 units with Intel i9 CPUs, 64 GB RAM, 1 TB SSD, and GPU support with 24 in high pitch and high quality monitor,3 piece GPU support laptop with i5 CPU,16 GB RAM 512 GB SSD with GPU support | Data processing, energy modeling, simulation, and software development |

| ****Sl. No.**** | ****Software Tool**** | ****Capabilities**** | ****Research/Analysis Purpose**** |
| --- | --- | --- | --- |
| 1 | **PV\*SOL Premium** | 3D modeling, yield forecasting, shading analysis, economic viability | Optimization of solar PV systems under different site and weather conditions |
| 2 | **BioWin** | Process modeling for anaerobic digestion, biogas yield simulation | Simulation of waste-to-energy systems; design of bioenergy solutions |
| 3 | **MATLAB & Simulink (Lifetime License)** | Toolboxes for power systems, control systems, machine learning | Development and simulation of energy storage, smart grid, and renewable control systems |
| 4 | **HOMER Pro** | Hybrid system design, techno-economic optimization | Planning of off-grid microgrids and hybrid energy networks for rural electrification |
| 5 | **Python & R with ML Libraries** | NumPy, Pandas, Scikit-learn, TensorFlow, etc. | Energy demand prediction, load profiling, predictive maintenance, fault classification |
| 6 | **ANSYS Fluent** | CFD for heat and mass transfer in energy systems | Simulation of airflow, turbine dynamics, and thermal performance of renewable systems |
| 7 | **COMSOL Multiphysics** | Coupled physics simulations: thermal, mechanical, electrical | Design and analysis of complex energy conversion and storage devices |
| 8 | **LEAP (Long-range Energy Alternatives Planning System)** | Policy scenario modeling, emission forecasting | Strategic energy planning and policy evaluation aligned with Bangladesh’s climate goals |
| 9 | **LabVIEW** | Real-time control and monitoring of experiments via DAQ integration | Experiment automation, lab equipment interfacing, and process control |
| 10 | **RETScreen Expert** | Feasibility analysis, financial modeling, GHG impact | Evaluation and planning of pilot projects and renewable installations |

| ****Sl. No.**** | ****Equipment**** | ****Key Features**** | ****Applications**** |
| --- | --- | --- | --- |
| 1 | **Transformer Diagnostic Analyzer** | - Winding resistance, turns ratio, OLTC tests, magnetic balance- Short-circuit and CT/VT testing | Transformer performance analysis and preventive maintenance |
| 2 | **Ultrasonic Leak & Discharge Detector** | - PRPD mapping, acoustic imaging, leak quantification | Partial discharge localization and leakage detection in pressurized systems and substations |
| 3 | **Battery Impedance Tester** | - Compatible with Li-ion, NiCD, VRLA batteries- Measures voltage, impedance, ripple | Battery health analysis, especially in backup and renewable energy systems |
| 4 | **Battery Cycling and Endurance Test System** | - Multi-channel charge/discharge, cycle life simulation, real-time data logging | Lifecycle testing of energy storage systems for EVs and solar applications |
| 5 | **Rotating Machinery Insulation Tester** | - Insulation diagnostics (PF, tan delta), capacitance, loss analysis | Predictive maintenance and fault detection in motors and generators |
| 6 | **Comprehensive Power Quality Analyzer** | - Voltage/current on all phases- Harmonics, transients, interruptions- USB data logging, portable design | Power quality assessment in grid and off-grid energy systems; preventive maintenance |