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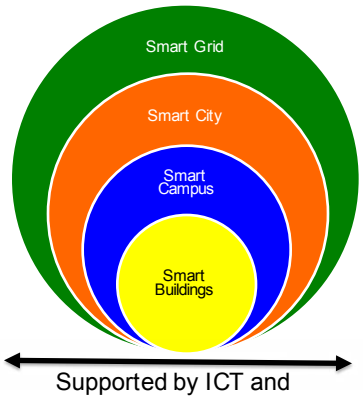
BUILDING ENERGY MANAGEMENT AND ENERGY CONSERVATION

Invited Lecture

Professor Saifur Rahman, PhD
Virginia Tech, USA

Jamia Milia Islamia, New Delhi, India, 09 March 2018

From Smart Buildings to Smart Grid



Smart grid: Bi-directional flows of energy, remote control/automation of power, integrated distributed energy…

Smart city: Complex system of interconnected infrastructures and services…

Smart Campus: A collection of buildings managed by the same facility manager…

Smart buildings: Intelligent building automation systems, smart devices, productive users, grid integration…

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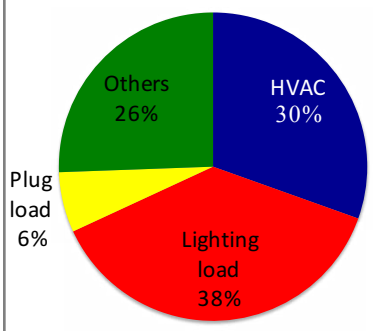
Virginia Tech Focus

Develop an open source, low cost, low power consumption platform that can monitor and control majority of loads in buildings to **improve energy efficiency** and **facilitate demand response** implementation.



Electricity Usage in Buildings

Three major loads in buildings:

- HVAC
- Lighting loads
- Plug loads

Source: EIA - Commercial Building Energy Consumption Survey (CBECS)
http://www.eia.gov/consumption/commercial/data/2003/index.cfm?view=consumption#e1a

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What makes a Building Smart

Source: Smart Building Market To Grow 30% by 2020, http://www.iotsolutionprovider.com/smart-building/smart-building-market-to-grow-30-by-2020, December 2015.

A single platform for monitoring and control of HVAC, lighting, water supply, sensor networks, security camera & fire emergency

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Smart Building Savings

- 40% of energy usage
- 30% of water usage
- 10% to 30% of building maintenance cost

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Energy Efficiency

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Energy Conservation

Occupancy Sensor for controlling lights

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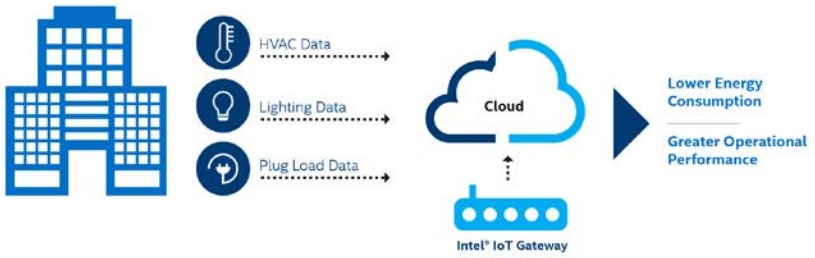
Affordable Energy Management



With Internet of Things (IoT) technology, stand-alone systems can be connected, resulting in clear insights that reduce energy consumption and improve building performance.

Picture from: https://www.intel.com/content/www/us/en/energy/solutions/smart-building-energy-management.html

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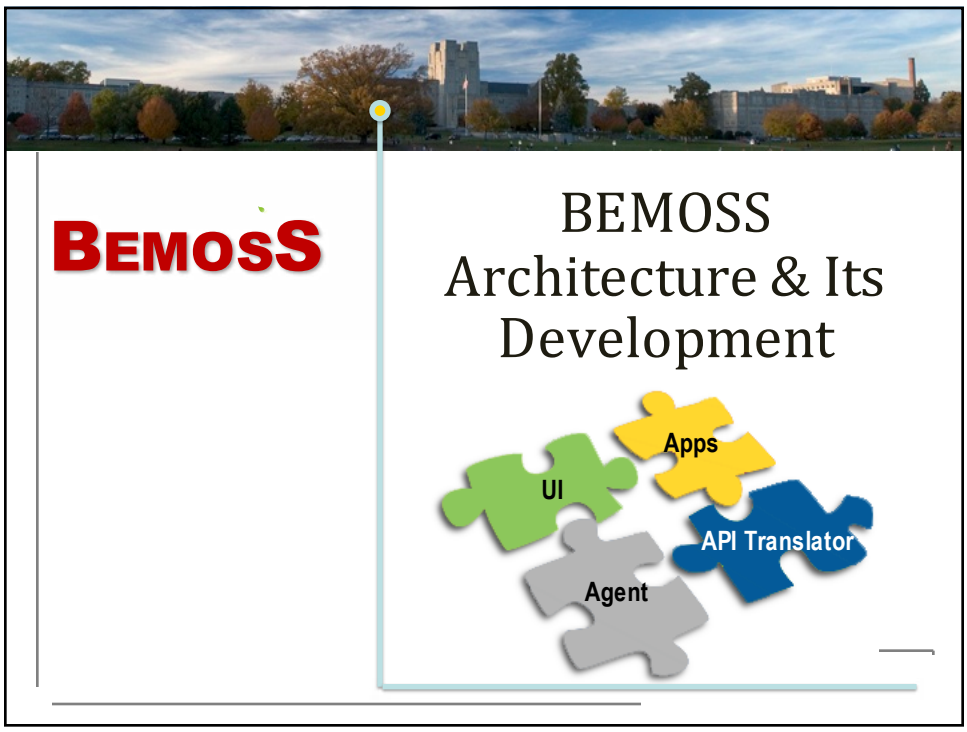
BEMOSS
BEMOSS Architecture & Its Development
Apps
UI
API Translator
Agent


BEMOSS can automatically discover and control
Sensors/ PowerMeters
Power meter (Modbus)
Power meter (BACnet/Modbus)
Light sensor (BACnet)
Occupancy sensor (BACnet)
Plug load controller (BACnet)
Smart plug (ZigBee)
Smart plug (WiFi)
Plug Load Controllers
CT30 (WiFi)
CT50 (WiFi)
CT80 (ZigBee SE)
EXL-01610 (BACnet)
Nest (WiFi)
HVAC Load Controllers
VAV controller (Modbus)
RTU (Modbus)
Philips Hue (WiFi)
Light switch (WiFi)
Lighting load controller (BACnet)
Step-dimmed ballast (ZigBee)
Lighting Load Controllers
BEMOSS
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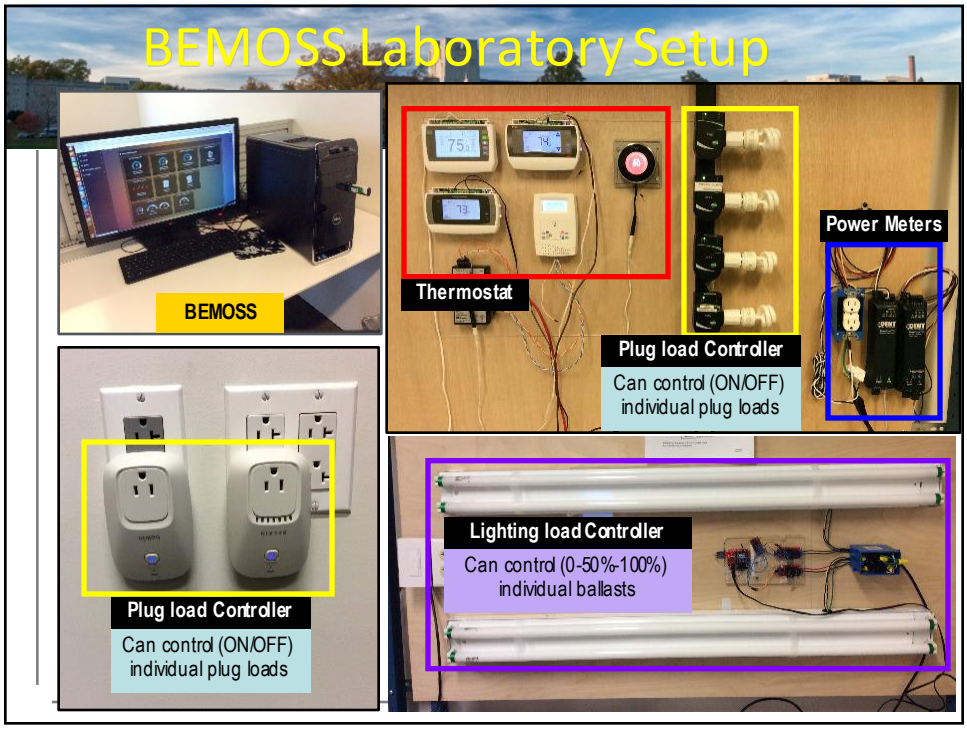
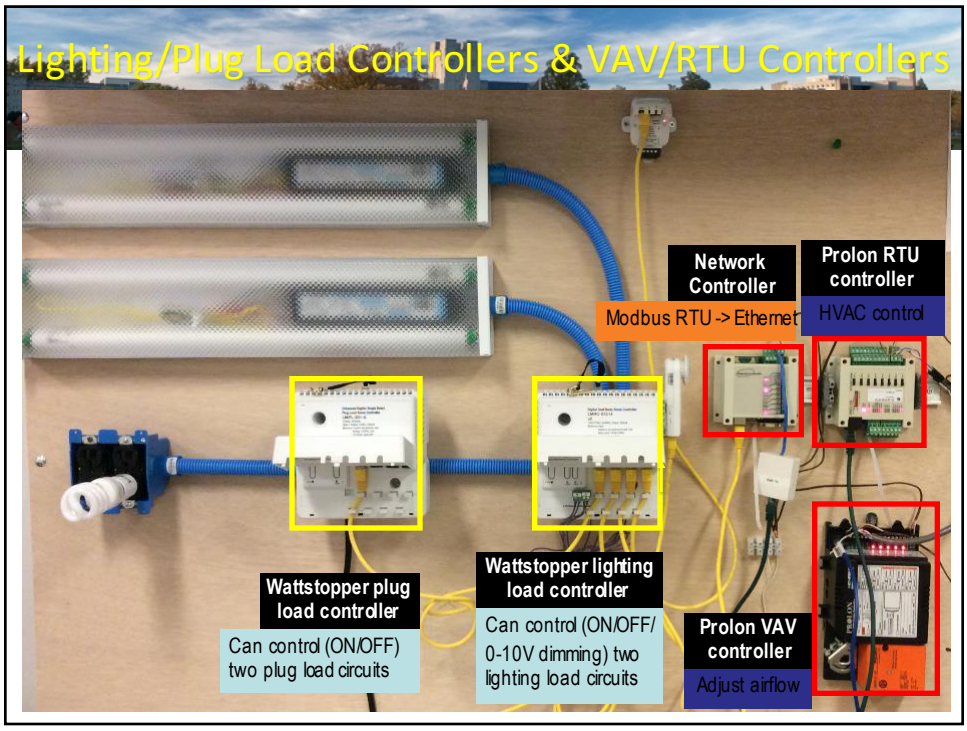

BEMOSS Laboratory Setup
BEMOSS
Thermostat
Power Meters
Plug load Controller
Can control (ON/OFF) individual plug loads
Plug load Controller
Can control (ON/OFF) individual plug loads
Lighting load Controller
Can control (0-50%-100%) individual ballasts


Lighting/Plug Load Controllers & VAV/RTU Controllers
Network Controller
Modbus RTU -> Ethernet
Prolon RTU controller
HVAC control
Wattstopper plug load controller
Can control (ON/OFF) two plug load circuits
Wattstopper lighting load controller
Can control (ON/OFF/ 0-10V dimming) two lighting load circuits
Prolon VAV controller
Adjust airflow

BEMOSS Deployment in Four Buildings

Building 1 – Virginia Tech Architecture Building
- **Location: Alexandria, VA**
- **Demonstration: HVAC, plug load control**

Building 2 – Equipment Bureau
- **Location: Arlington, VA**
- **Demonstration: Lighting control**

Building 3 – Virginia Tech buildin
- **Location: Blacksburg, VA**
- **Demonstration: HVAC control**

Building 4 – PG County building
- Location: Camp Springs, MD
- Demonstration: HVAC control

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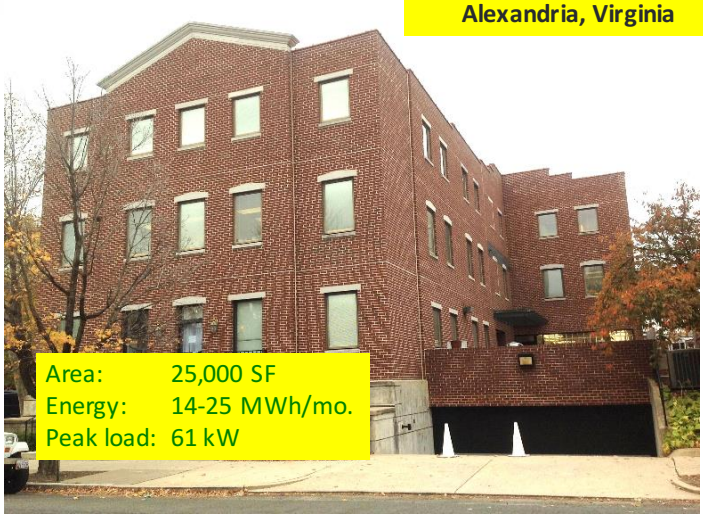
Building 1 – VT Building in Alexandria, VA

Alexandria, Virginia



Area: 25,000 SF
Energy: 14-25 MWh/mo.
Peak load: 61 kW

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A June 2016 – high temperature33◦ C

June1, 2016 vs. June22, 2016

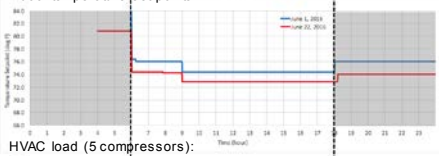
B 25,000 sqft building (Alexandria, VA)

C Raising set point 1.6◦ F saves 17% in HVAC load

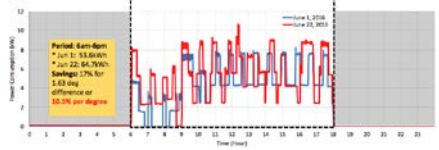
Raising the set point by 1◦C from 6am-6pm demonstrates 17% energy savings in HVAC load.

Outdoor temperature profiles:

Indoor temperature set-points:



HVAC load (5 compressors):



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Building 2 – Office Building, Arlington, VA

Arlington, Virginia

Office building size: 5,000 sqft

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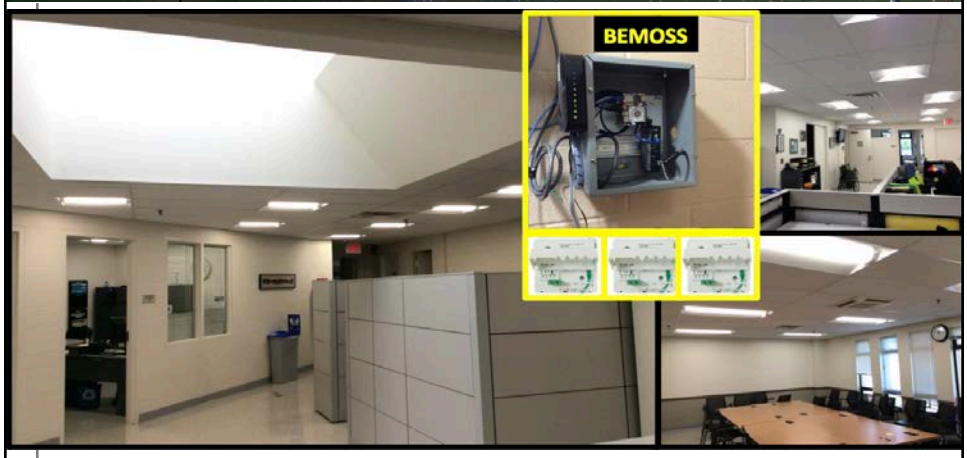
BEMOSS for Lighting Control



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Energy Savings by controlling light intensity

Month	Total Measured Energy Consumption (kWh)	Total Calculated Energy Consumption without Dimming (kWh)	Energy Savings by Dimming (%)
October 2016	264.37	399.90	33.89%
November 2016	278.13	423.78	34.37%
December 2016	280.76	426.40	34.16%
Total (October-December)	823.26	1250.08	34.14%

Note: Scheduled dimming level from 6:30am to 9:00pm. Open office area A: 50%; Open office area B: 45%; Chief office's desk area: 60%; Chief office's meeting area: 50%; Conference room A: 50%; Conference room B: 45%. Lights are off after 9:00pm.

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Bldg 3 – Office Building in Blacksburg, VA

Retailed building: ~50,000 sqft
Peak demand: ~160kW
Electricity consumption: 46-65MWh/month

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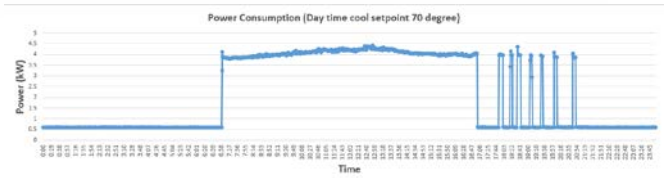
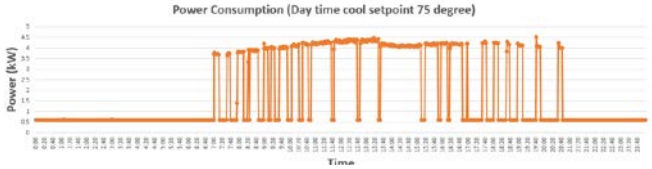
Building 3: Energy Savings

June 6, 2016:
day-time cool set point 21 deg C.

May 27, 2016:
day-time cool set point 24 deg C.





Dates	Cool set-point	Total daily energy usage	Energy saving
June 6, 2016	21	52.1 kWh	7.4 kWh (14.2%)
May 27, 2016	24	44.7 kWh	

Solar PV System on BEMOSS Platform

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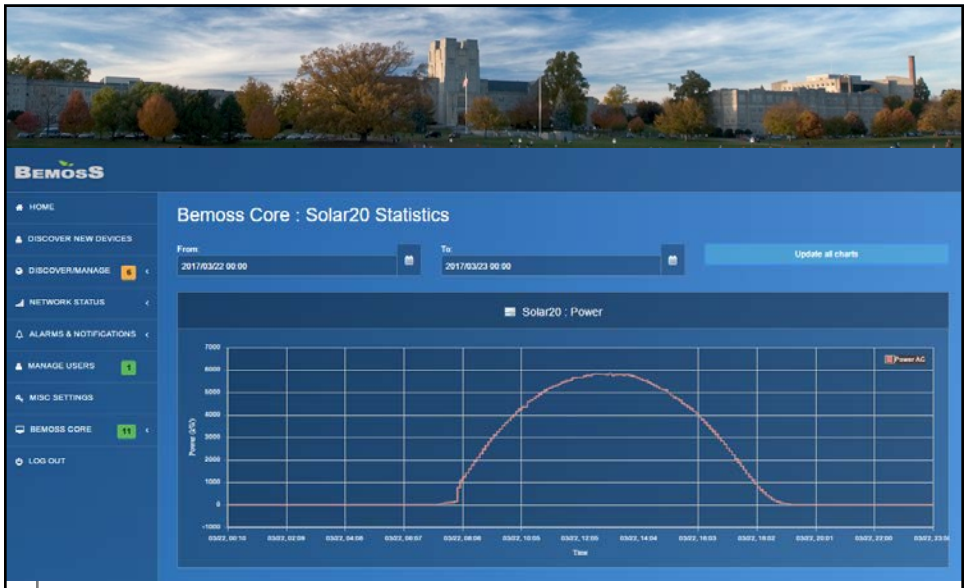

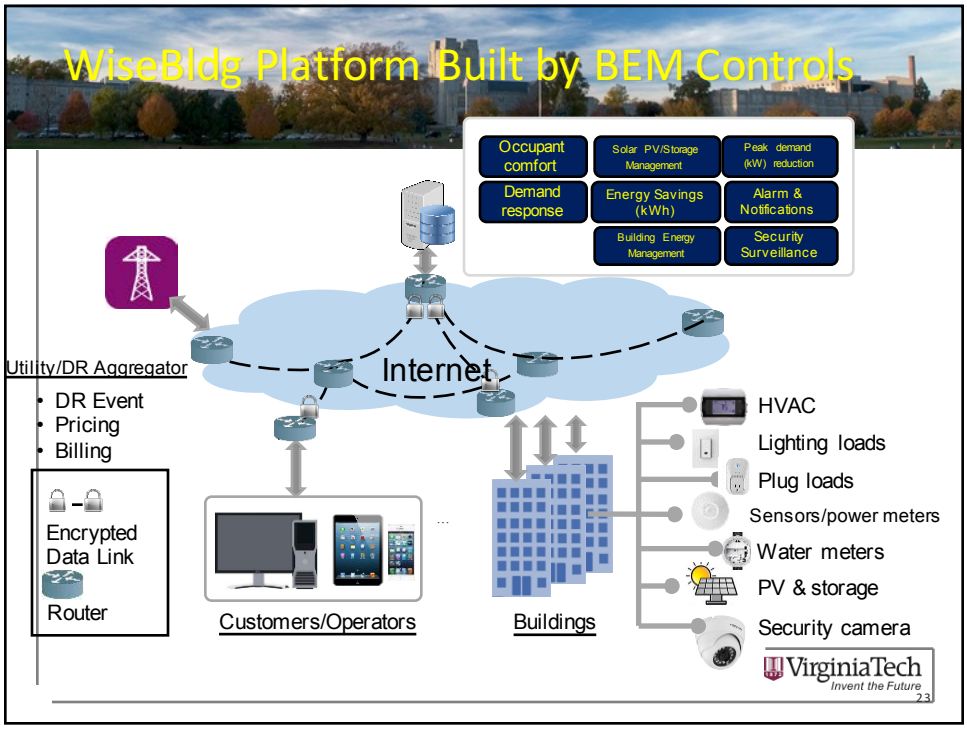
WiseBldg Platform Built by BEM Controls
Occupant comfort
Solar PV/Storage Management
Peak demand (kW) reduction
Demand response
Energy Savings (kWh)
Alarm & Notifications
Building Energy Management
Security Surveillance
Internet
Utility/DR Aggregator
• DR Event
• Pricing
• Billing
Encrypted Data Link
Router
Customers/Operators
Buildings
HVAC
Lighting loads
Plug loads
Sensors/power meters
Water meters
PV & storage
Security camera
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Transitioning from a Research Project to a Commercial Enterprise
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Commercial Business for Deployment

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SMALL BUSINESS TECHNOLOGY TRANSFER

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What can be done at Jamia

Identify buildings with highest electricity consumptions

Analyze the possible reasons

Identify conservation opportunities – plugging the leaks

Select a building for deploying efficient technologies

Monitor the performance

Plan for broader deployments

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Source: www.indiatoday.in

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Jamia Milia Islamia

You have a GREEN campus

Make it a SMART campus

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