

Energy Conservation in Educational Institutes

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What is Energy Conservation?

Energy conservation means :

“saving or conserving energy by using less amount of energy for carrying out a given job, activity or service”

Energy in Focus

Energy mainly used in three forms:

➤ **Electrical Energy**

- **Most versatile and most widely used form of energy**
- Used for lighting, ventilation, cooling, heating, mechanical work, and so on

➤ **Thermal Energy**

- Used for building and industrial heating
- Used in motor vehicles by converting thermal to mechanical energy

➤ **Chemical Energy**

- Used for energy storage and chemical processing

- Focus here will be on Conservation of Electrical Energy -

Part 1

Why to Conserve
Energy?

Why to Conserve Energy?

A phrase often used in the present context:

1 unit of energy saved = 1 unit of energy generated

Is that right?

No.

It is wrong.

Why to Conserve Energy?

Let me give you my own equation:

1 unit of energy consumed
= 1.25 units of energy generated
+ 1 kg of greenhouse gases emitted into environment
+ Rs. 4 to 8 spent by the consumer

Is that right? Yes.

Then the corrected phrase would be:

1 unit of energy saved
= 1.25 units of energy generated
+ 1 kg of greenhouse gas emissions avoided
+ Rs. 4 to 8 saved by the consumer

Is that right? Yes.

Why to Conserve Energy?

Four good reasons:

1. To reduce requirement of energy generation
2. To protect environment
3. To reduce electricity bill of the consumer
4. To minimize health hazards arising out of excessive use of energy

Reason #1 : Reduction in Energy Generation Requirement

Reduction in energy generation would lead to:

- a) Reduction of capital investment on energy generation, transmission and distribution infrastructure.
- b) Conservation of non-renewable resources of energy (fossil fuels) for higher-priority use.

Reason #2 : Protection of Environment

Protection of environment would mean:

(a) Reduction in atmospheric pollution:

- Air pollution
- Water pollution

(b) Reduction in environmental hazards, such as

- Deforestation for dam construction
- Flooding from breach in a large dam
- Radioactive emissions from a nuclear power plant

Reason #3 : Reduction in Electricity Bill

Reduction in electricity bill would mean:

- (a) Avoiding wastage of money
- (b) Improving quality of life by spending money on useful things

Reason #4 : Minimization of Health Hazards

Minimization of health hazards arising out of :

- (a) Excessive use of air conditioners
- (b) Excessive lighting in working area
- (c) Excessive use of energy in any form has some adverse effects on the health of the user

Effects of Excessive Air-Conditioning on Health

- *Prolonged exposure to temp. below 23°C can:*
 - *Trigger respiratory illness*
 - *Cause chest infection or bronchitis*
 - *Cause cold, flu, sinus, bloody nose, body aches, sore joints, arthritis*
 - *Lead to dry skin and itching*
 - *Lead to dry and lusterless hair*
 - *Lead to dry eyes*
- *Switching suddenly from a hot and humid outdoor to an extremely cold and dry room, or vice a versa, can cause serious health problems.*
- *It is suspected that air conditioning plays a major role even in the soaring **obesity** rates in the modern society.*

Effects of Excessive Lighting on Health

Excessive lighting in working area can cause:

- Stress
- Headache
- High blood pressure
- Fatigue

Part 2

How to Conserve Energy?

How to Conserve Energy?

Five measures to conserve electrical energy:

1. Spread awareness about necessity and benefits of energy conservation
2. Avoid wastage of energy
3. Improve energy efficiency
4. Use automatic energy and demand management
(Upgrade PDS to Smart Micro-grid)
5. Produce renewable energy

To assess potentials of
Energy Conservation and Renewable Energy Generation
begin with Energy Audit

Measure #1 : Spread Awareness

- Special talks and lectures
- Events : Workshops, Road shows
- National Energy Conservation Day
- Posters and banners
- Student projects
- Demonstration projects
- Set up an “Energy Conservation Committee” at Institute level
- Take up “Energy Conservation” as a “Mission of the Institute”.

Examples of Poster & Banner

ENERGY CONSERVATION MISSION-2017*
*The Light and Exhaust Fan of this Wash-Room
are
AUTOMATICALLY SWITCHED ON & OFF*

Benefits

1. *Huge energy saving of 70 - 80%*
2. *GHG emissions into environment reduced by 70 - 80%*
3. *Convenience of users: No manual switching required*



*An Initiative of:
Energy Conservation Committee of Sharda University
For Technical details, contact Prof. H.K. Verma : Extension 2550



Measure #2 : Avoid Wastage of Energy

- a) Avoid over-use of lights, fans, air conditioners etc.
- b) Switch off lights, fans, ACs etc. when not in use
- c) Use natural light
- d) Use natural ventilation
- e) **Automatic control of lights, fans, AC etc.**

Automatic Control of Lights, Fans and ACs

- Device-level automation
 - Motion-based automatic control
 - Motion-cum-light based automatic control
 - Day-light based automatic control
 - Occupancy-based automatic control
 - Time-based automatic control
 - Prediction-based automatic control
 - Remote control
- Network-enabled automation
 - Building automation using sensor and actuator network

Measure #3 : Improve Energy Efficiency




Energy Efficiency means:

“Percentage of the total energy input to a machine or equipment or service that is consumed in useful work or in converting to useful output”,
“and not wasted as useless heat etc.”

How to Improve Energy Efficiency?

- a) Use energy-efficient lights
- b) Use energy-efficient air conditioners
- c) Use energy-efficient refrigerators
- d) Use energy-efficient water geysers
- e) Use energy-efficient TV, motors, pumps and all other equipment/ appliances
- f) Prevent air leakage through building envelope

Energy Efficiency of Various Lamps

Characteristic	 Incandescent Light Bulb	 Compact Fluorescent Lamp (CFL)	 Light Emitting Diode Lamp (LED)
Life Span (average)	1,200 hours	5,000 hours	20,000 hours
Power (Wattage) (for 800 lumens)	60 watts	13-15 watts	8-10 watts
Energy efficiency (lumens/watt)	12-15	50-60	80-100
Energy saving	0%	70-80%	85-90%
Contains toxic mercury?	No	Yes	No
Turns on instantly?	Yes	No (takes time to warm up)	Yes

Energy Efficiency of Various Tube Lights

Characteristic	T-12 Tube (1.5 inch dia)	T-8 Tube (1 inch dia)	T-5 Tube (5/8 inch dia)	T-LED (1 inch dia)
Life Span (average)	5,000 hours	5,000 hours	5,000 hours	20,000 hours
Power consumption of tube only	40 watts	36 watts	28 watts	18 watts
Power cons. with choke/driver (typical)	45 watts	40 watts	30 watts	20 watts
Energy efficiency (typical) (lumens/watt)	35	40	50	80
Energy saving	0%	10-12%	30-35%	50-60%
Contains toxic mercury?	Yes	Yes	Yes	No
Turns on instantly?	No	No	No	Yes

Energy Saving with Air Conditioner

*Being the largest energy consumption appliances,
ACs need maximum attention !*

- a) Set temperature of your room AC between 24°C to 27°C
- b) Use microprocessor-based AC energy saver device
- c) Use occupancy-based AC energy saver device
- d) Use room AC with high-star rating
- e) Use Inverter AC
- f) Use VRV / VRF AC

What is Best Temp. Setting of Room AC?

- The best temperature setting of your Room A.C. is
24⁰C to 27⁰C
- Why?
- Four Reasons:
 - I. Your money
 - II. Your health
 - III. Your comfort
 - IV. Your environment

You Can Avoid Huge Money Wastage

<i>Temperature Setting</i>	<i>Your Monthly Bill</i>	<i>Your Monthly Wastage</i>
18 ⁰ C	Rs. 3000	200%
20 ⁰ C	Rs. 2550	155%
22 ⁰ C	Rs. 2100	110%
24 ⁰ C	Rs. 1660	66%
25 ⁰ C	Rs. 1440	44%
26 ⁰ C	Rs. 1220	22%
27 ⁰ C	Rs. 1000	0%

Assumptions: Star Rating = **, Capacity = 2 tons, Tariff = Rs. 6.50 per unit
Usage = 8 hours a day and 30 days in a month
Efficiency fall = 5% per degree below 27⁰C

You Can Protect Your Health !

- *Prolonged exposure to temp. below 23°C can:*
 - *Trigger respiratory illness*
 - *Cause chest infection or bronchitis*
 - *Cause cold, flu, sinus, bloody nose, body aches, sore joints, arthritis*
 - *Lead to dry skin and itching*
 - *Lead to dry and lusterless hair*
 - *Lead to dry eyes*
- *Switching suddenly from a hot and humid outdoor to an extremely cold and dry room, or vice a versa, can cause serious health problems.*
- *It is suspected that air conditioning plays a major role even in the soaring **obesity** rates in the modern society.*

You will be More Comfortable !

Studies have revealed the following:

- *97% of users are comfortable at 25⁰C*
- *85% of users are comfortable between 24⁰C and 27⁰C*
- *More than half the users are uncomfortable below 23⁰C or above 28⁰C.*

You will Protect Your Environment too !

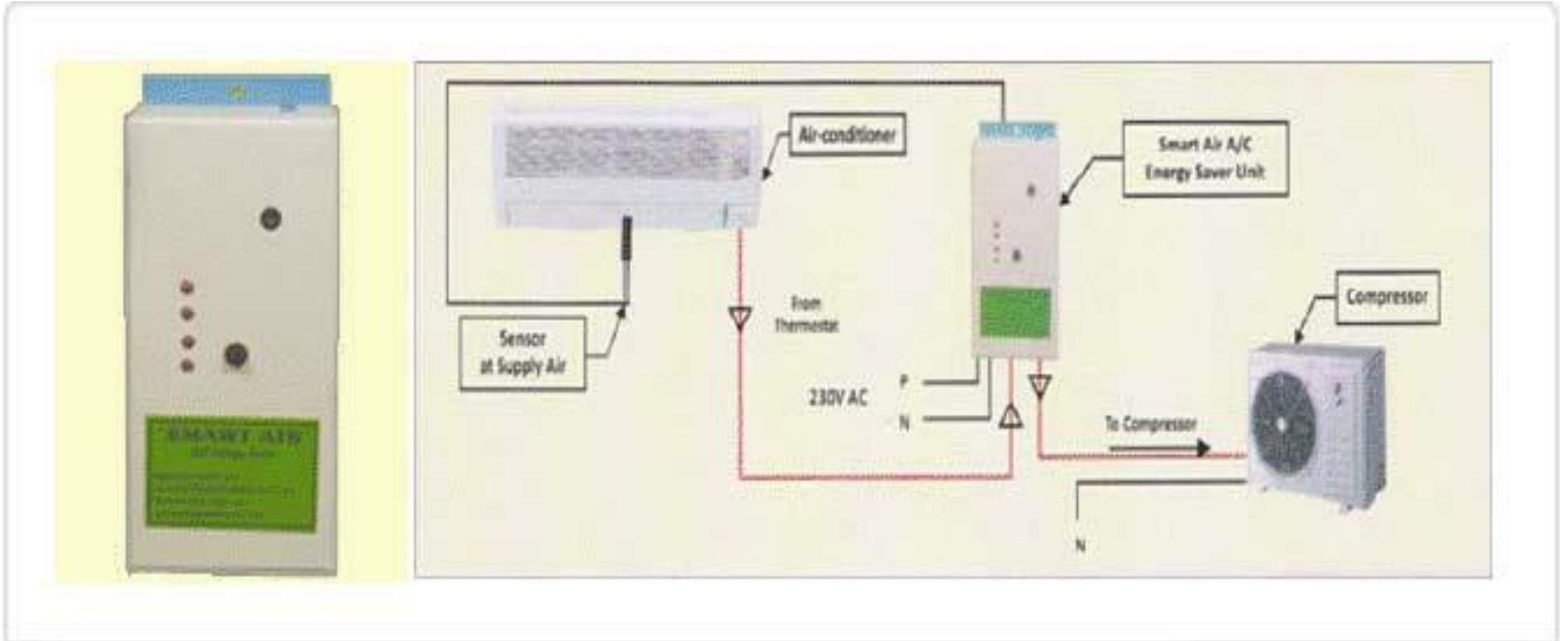
- Reduction in CO₂ emissions from power plants:

Unnecessary use of air conditioners means extra load and extra energy generation, which in turn means avoidable extra CO₂ emissions from power plants (For India: 1 kg per kWh consumed)

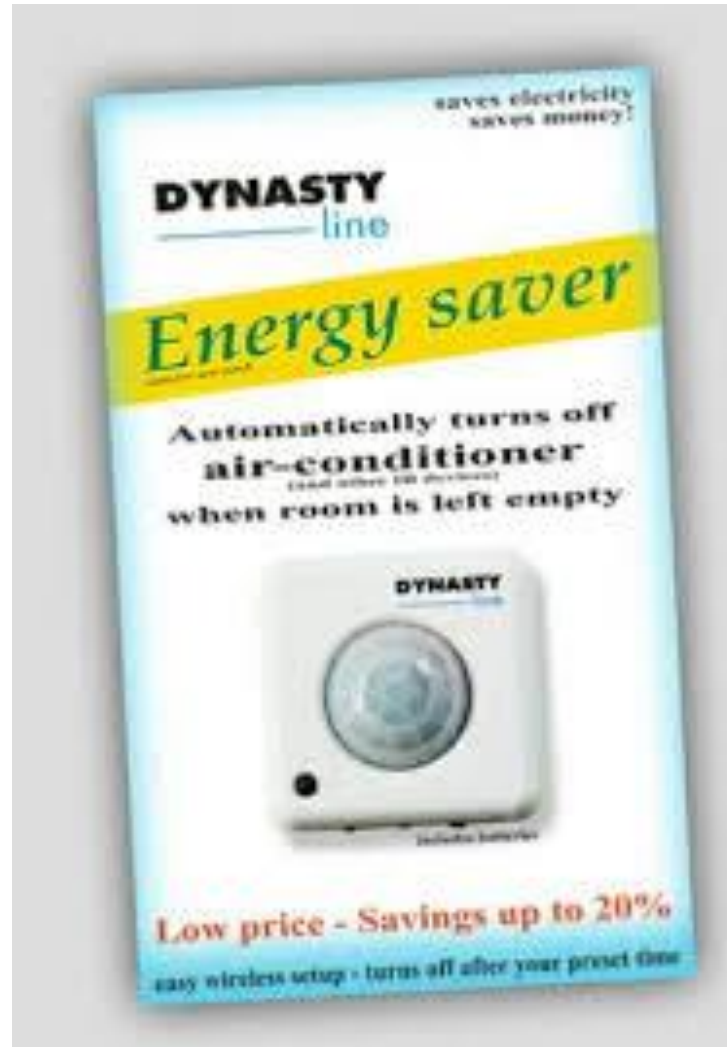
- Faster recovery of ozone layer:

Although ozone-depleting chloro-fluoro-carbons (CFCs), used formerly as cooling agents, have been replaced by hydro-chloro-fluoro-carbons (HCFCs), which deplete 95 percent less ozone, but their excessive use will push back the recovery of ozone layer by several years.

Microprocessor-Based AC Energy Saver



Occupancy-Based AC Energy Saver



Energy Conservation in Educational Institutes

Star Rating versus Energy Efficiency of Room AC

New BEE Energy Efficiency Ratings (EER) for Room Air Conditioners

STAR RATING LEVELS - Jan 1, 2014 - Dec 31, 2015

EER (W/W)

WINDOW AC

SPLIT AC

Star Rating	Minimum	Maximum	Star Rating	Minimum	Maximum
1 Star ★	2.50	2.69	1 Star ★	2.70	2.89
2 Star ★★	2.70	2.89	2 Star ★★	2.90	3.09
3 Star ★★★	2.90	3.09	3 Star ★★★	3.10	3.29
4 Star ★★★★	3.10	3.29	4 Star ★★★★	3.30	3.49
5 Star ★★★★★	3.30	-	5 Star ★★★★★	3.50	-

Energy Efficiency Rating (EER)

Cooling Capacity (W)

= -----

Power Consumption (W)

Inverter Air Conditioner

- AC fitted with inverter compressor.
- Inverter compressor is a gas compressor driven by an inverter (VFD)
- VFD helps to control speed of the compressor motor to modulate cooling capacity of the AC.
- Technically, it uses PID control in place of ON-OFF control.
- Capacity modulation is to match cooling output to the cooling requirement.
- Modulation of cooling capacity : typically, 20% - 100% of full capacity.
- **Benefits of Inverter AC:**
 - Biggest benefit : Energy saving : 10% – 40% depending on cooling load
 - No frequent inrush currents, so no voltage dips in mains supply
 - Accurate temperature control, so more comfort to users
 - Less noise (no frequent on/off operations of compressor).

VRV / VRF Air Conditioner

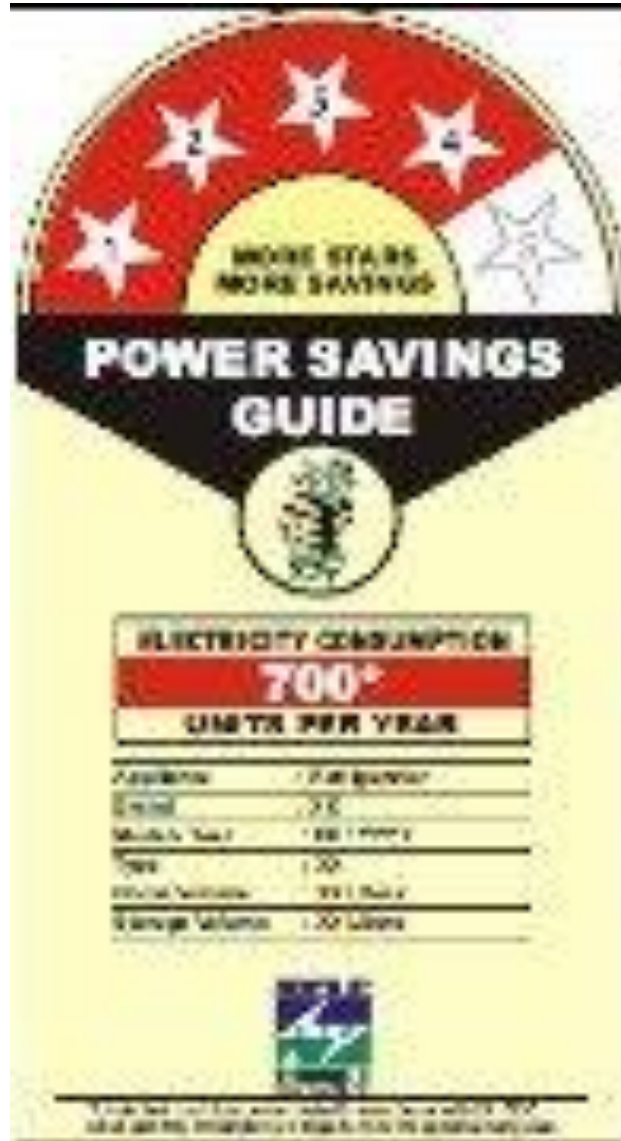
- **VRV** : Variable Refrigerant Volume : official trademark of Daikin
- **VRF** : Variable Refrigerant Flow : Term used by others for similar AC systems.
- VRF AC system is fully automatic.
- It regulates its power consumption based on the outside temperature and the demand from the indoor units by *varying the refrigerant flow in compressor*.
- Each user can select following parameters on his indoor unit:
 - Operation mode (on/off)
 - Operation state (Cool/Heat/Fan/Dry/Auto)
 - Set-point temperature (desired temperature inside)
 - Fan speed (high/medium/low/auto)
- Biggest benefit : Energy saving : 10% – 40% depending on nature of demand.

Energy Efficiency of Refrigerator

Being the second largest energy consumption gadget,
Refrigerator also needs special attention !

- a) Use refrigerator with high-star rating
- b) Use Inverter refrigerator

Star Ratings of Refrigerator



BEE Star Label – Big label

For refrigerators, air-conditioners, geysers and washing machine

This is a label for 4-star refrigerator. It consumes 700 kWh in a year. A 5 star refrigerator will consume lower units for same capacity and cooling

Inverter Refrigerator

- Refrigerator fitted with inverter compressor.
- Inverter compressor is a gas compressor driven by an inverter (VFD)
- VFD helps to control speed of the compressor motor to modulate cooling capacity of the refrigerator.
- Technically, it uses PID control in place of ON-OFF control.
- Capacity modulation is to match cooling output to the cooling requirement.
- Modulation of cooling capacity : typically, 20% - 100% of full capacity.
- **Benefits of Inverter Refrigerator :**
 - Biggest benefit : Energy saving : 10% – 40% depending on cooling load
 - In an ordinary refrigerator, chiller compartment freezing is very likely, but this does not happen in an inverter refrigerator.
 - No frequent inrush currents, so no voltage dips in mains supply
 - Less noise (no frequent on/off operations of compressor).

Measure # 4

Upgrade PDS to
Smart Micro-Grid

What is Micro-Grid?

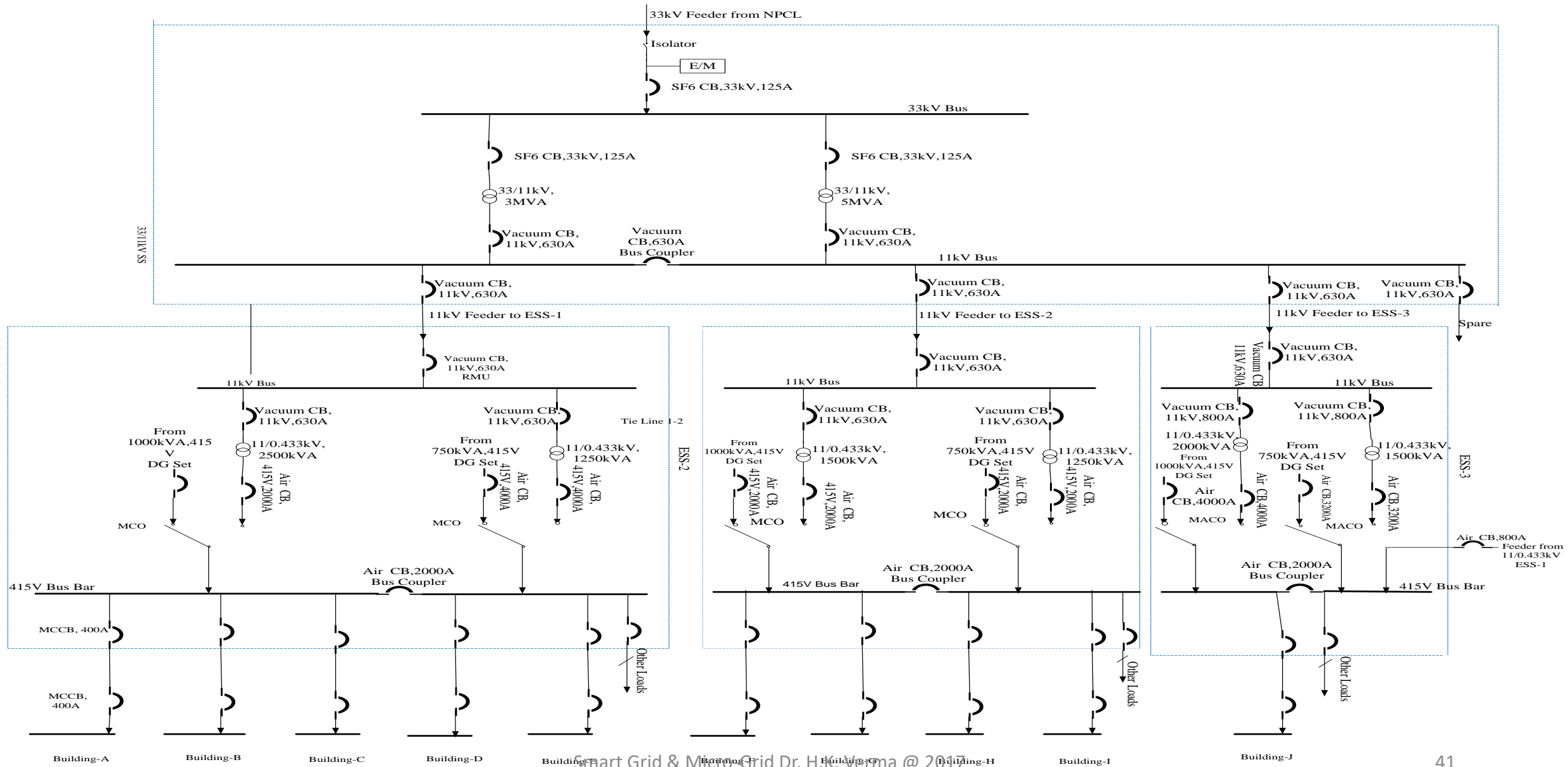
“Micro-Grid” is a power distribution system with its own renewable energy resources, generation and loads, with defined boundaries.

Types:	Operating Modes:
1. AC micro-grid	A - Grid connected mode
2. DC micro-grid	B - Islanded mode
3. Hybrid micro-grid	

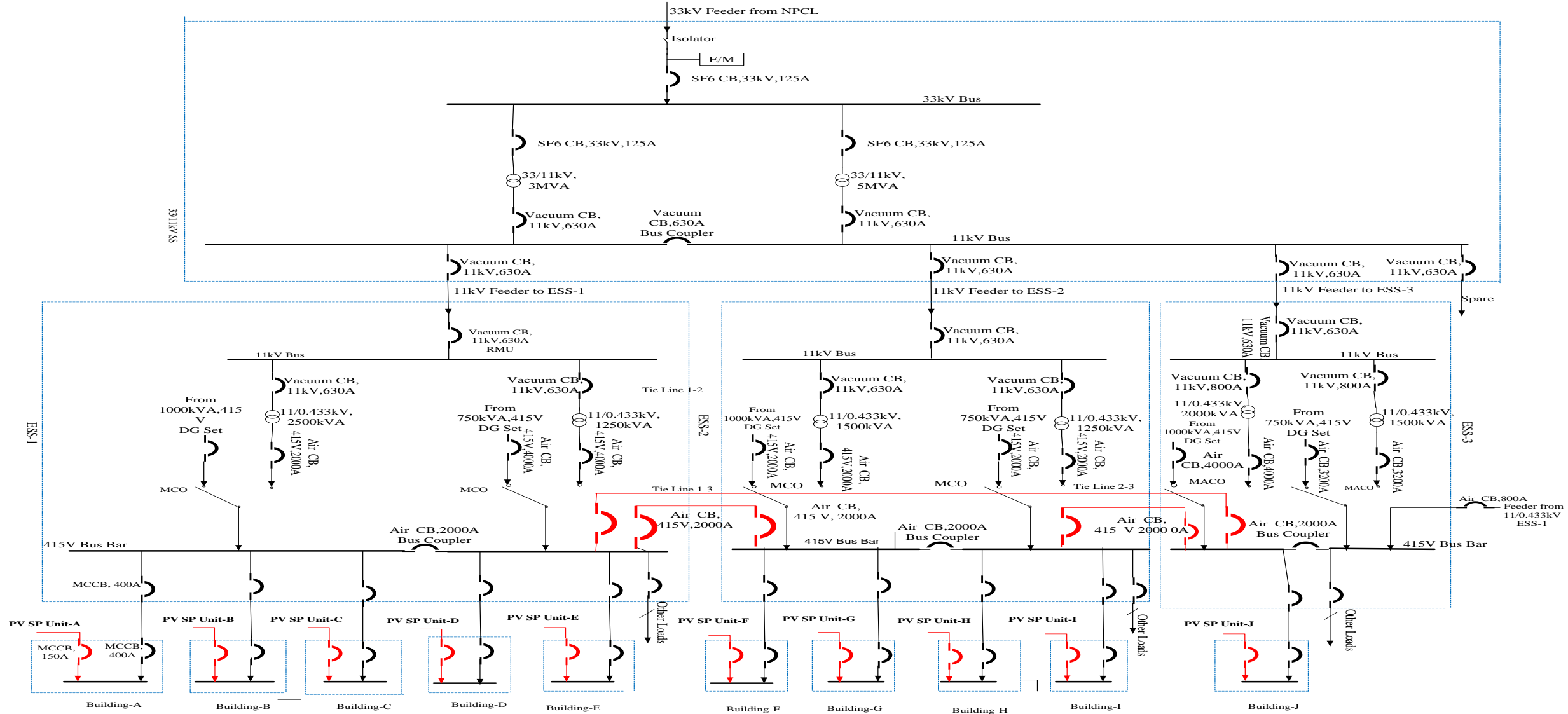
Upgradation of PDS to Micro-Grid

1. Add inter-substation links
2. Add renewable distributed generation (RDG):
Typically, a roof-top PV solar power plant
3. Integrate PV solar power plant with PDS at major load points

Typical Power Distribution System



Micro-Grid : PDS with Distributed Generation and Tie-Lines



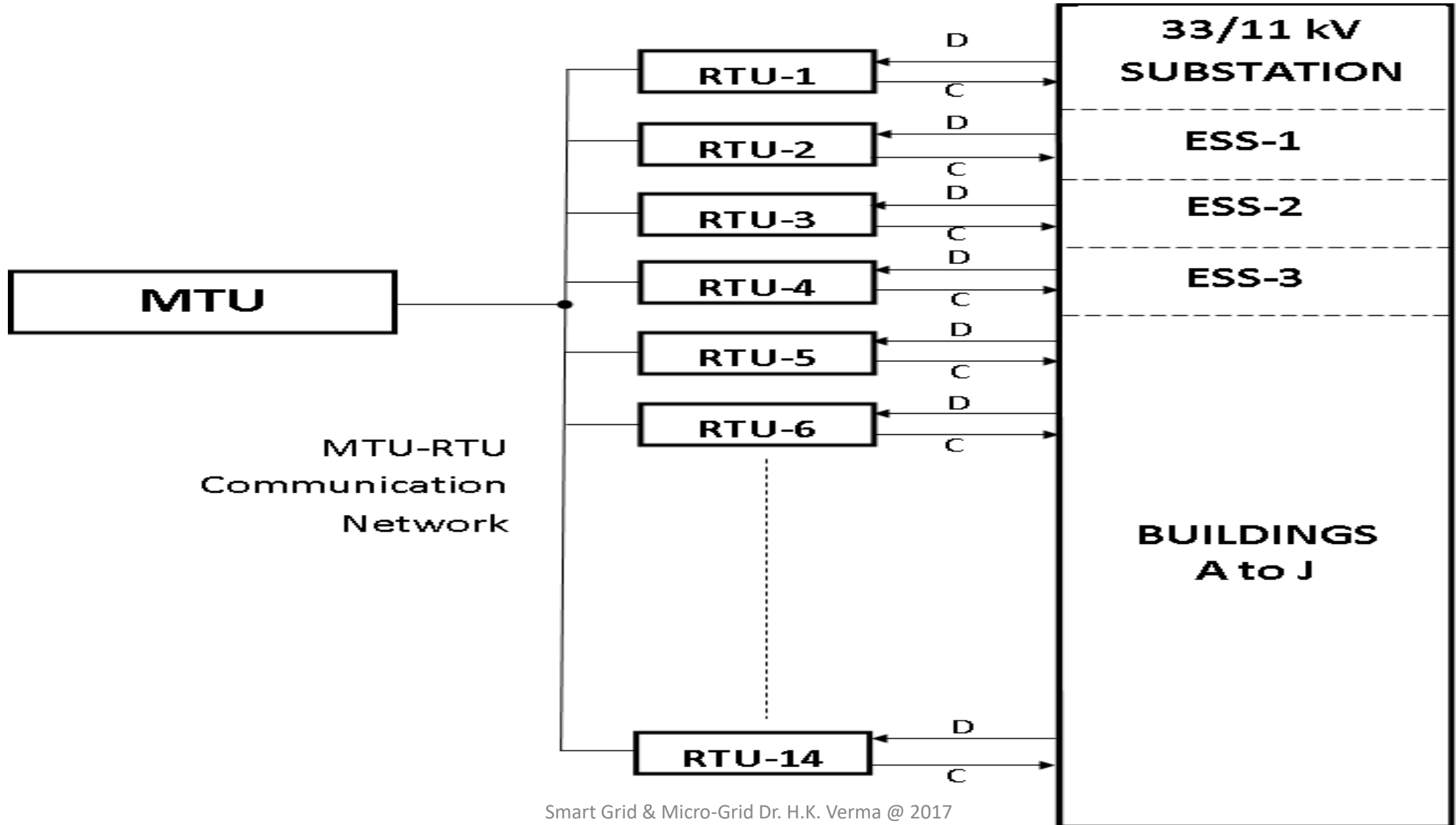
LEGEND:-
MCO: Manual Change Over Switch, 1000A
MACO: Both Manual & Auto Change Over Switch, 1000A

Smart Micro-Grid Objectives

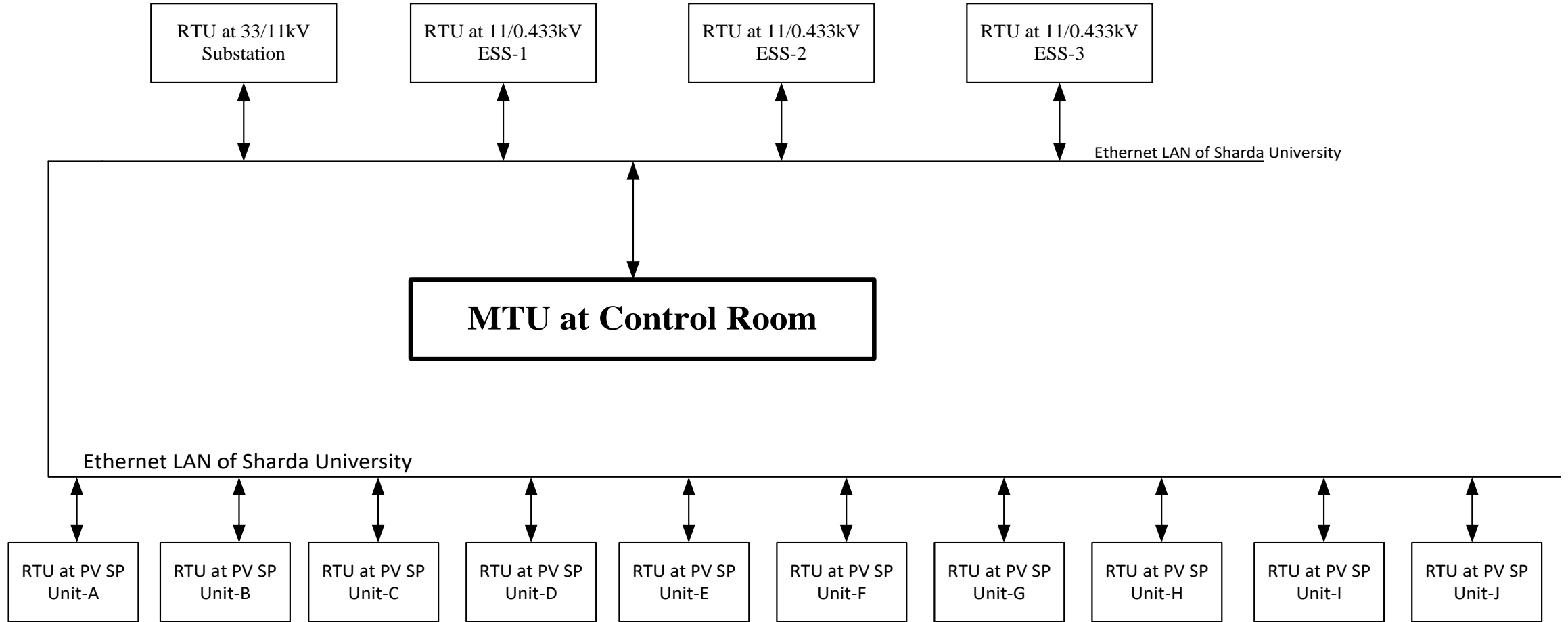
Major Objectives of Smart Micro-Grid are:

1. To improve efficiency of power distribution
2. To improve power quality
3. To maximize use of renewable energy resources
4. To minimize energy and demand costs
5. To gather operational data of micro-grid

Typical Layout of SCADA System for Smart Micro-Grid



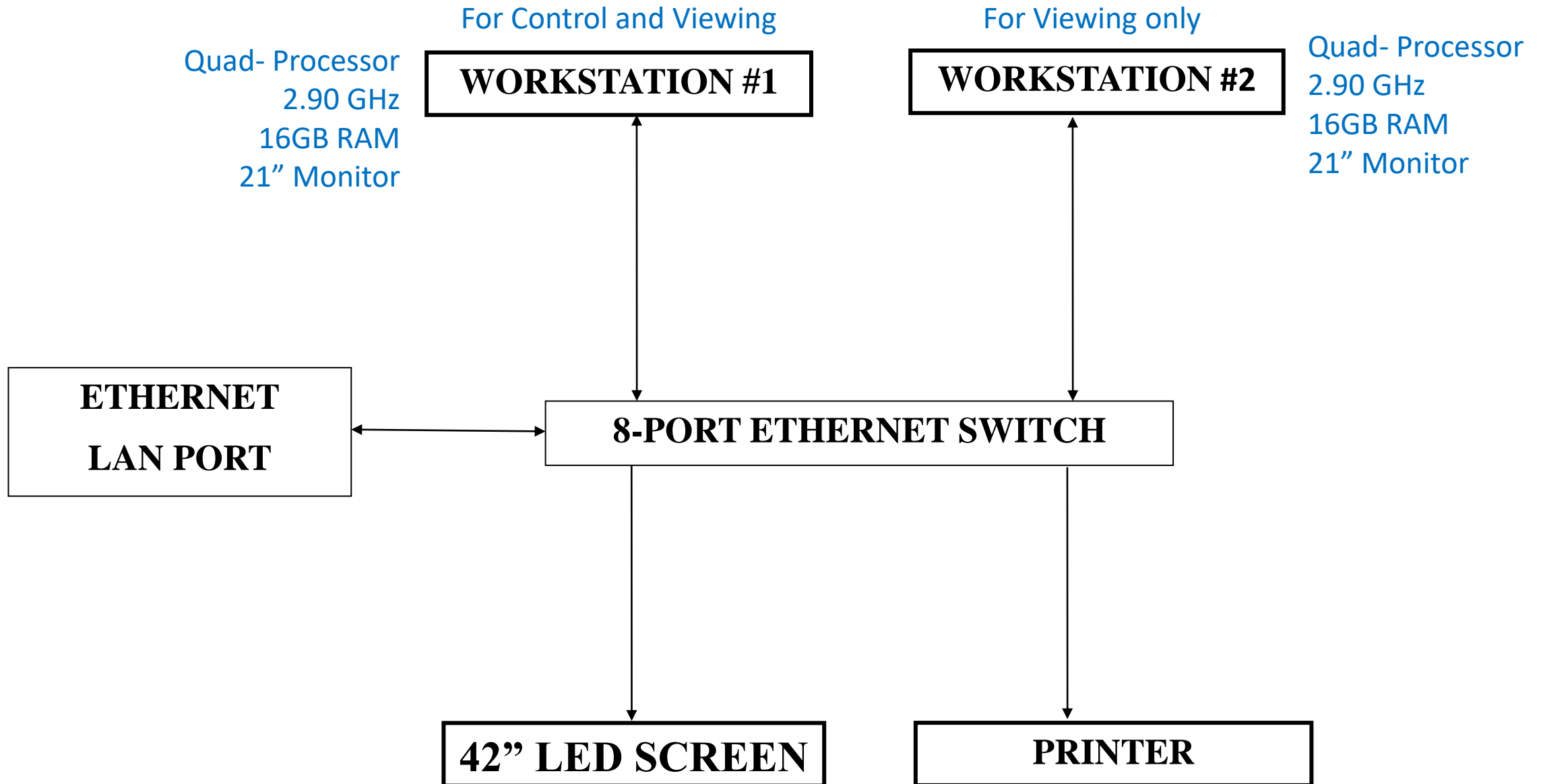
Data Network for MTU-RTU Communication



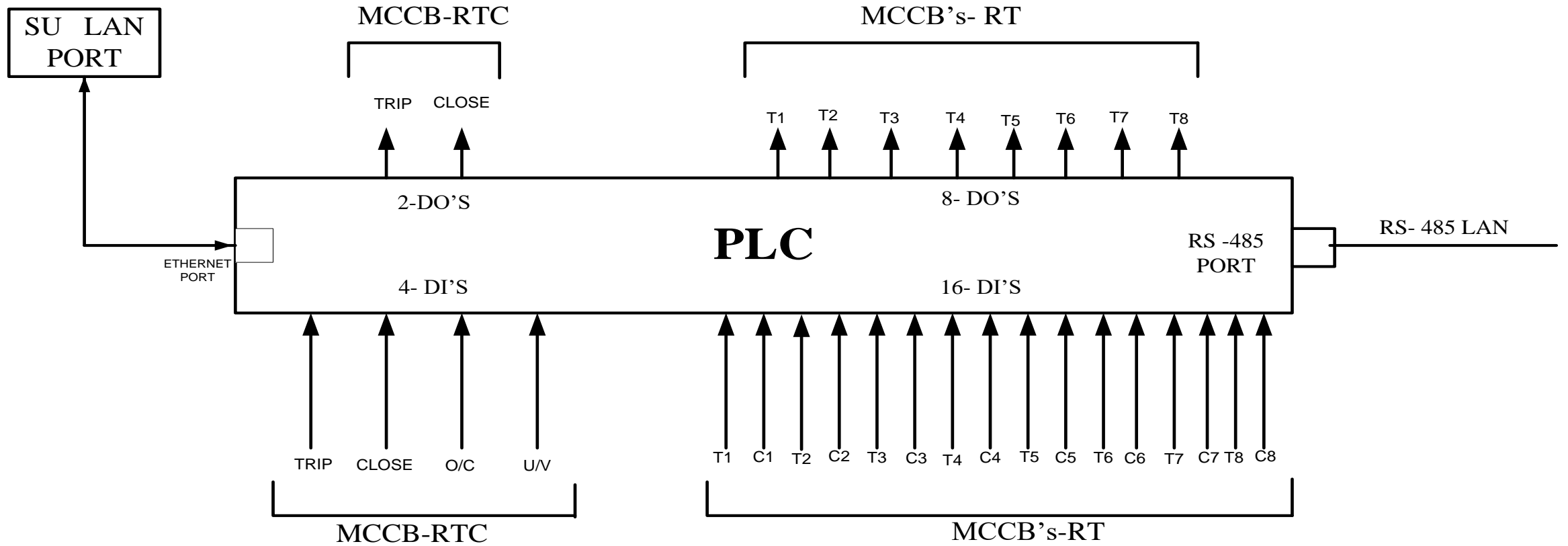
Legend

ESS: Electric Substation
 PV SP : Photo Voltaic Solar Power
 RTU: Remote Terminal Unit
 MTU: Master Terminal Unit

Master Terminal Unit (Control Room)



Remote Terminal Unit



Legend

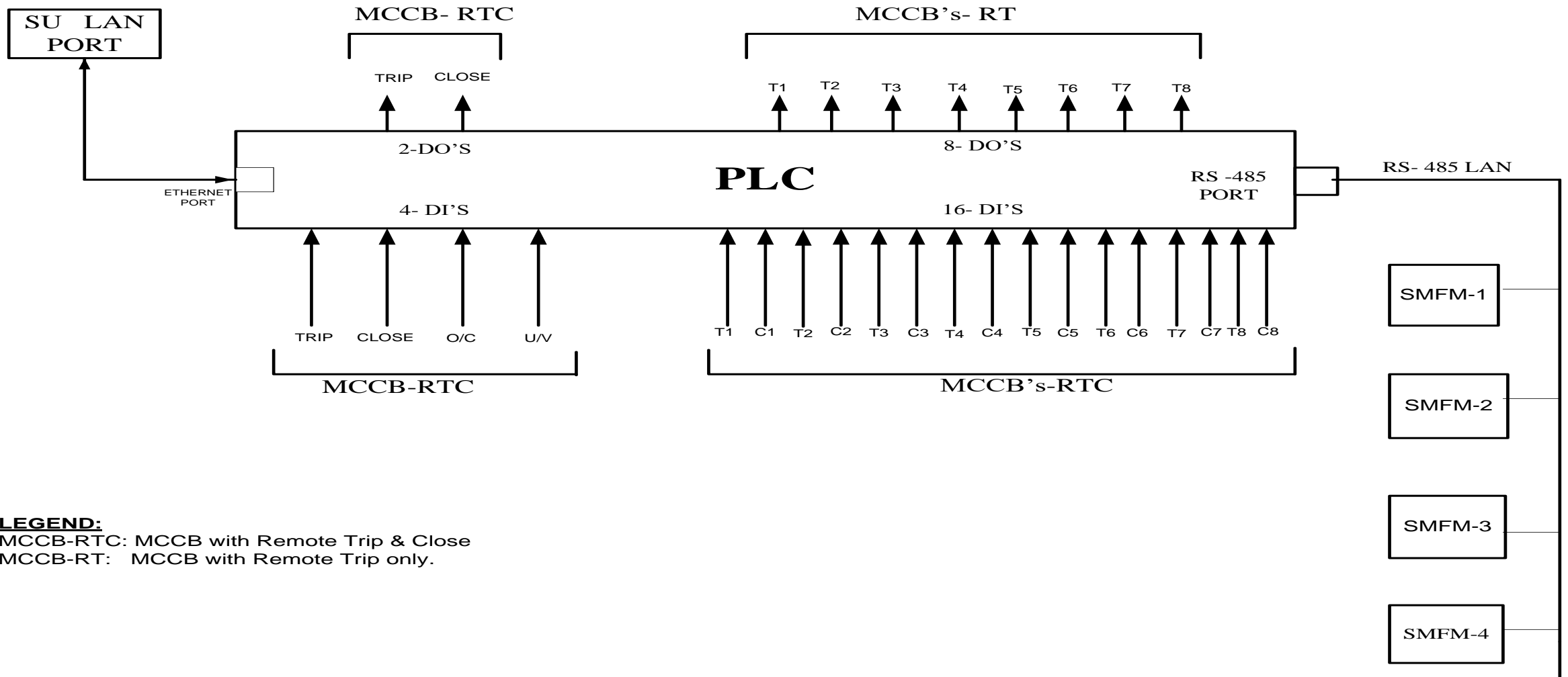
MCCB-RTC: MCCB with Remote Trip & Close.

MCCB-RT: MCCB with Remote Trip only.

Advanced Metering System (AMS)

- Smart multi-function digital meters on :
 - 33-kV feeder
 - 11-kV feeders
 - Inter SS tie lines
 - 415-V mains feeders
 - Load feeders
- RTU to read SMF meters on RS485-PAN
- CTs and cabling required for each SMF meter
- RTUs to transmit SMF meter readings to MTU on Ethernet-LAN

RS485 PAN for Advanced Metering



LEGEND:

MCCB-RTC: MCCB with Remote Trip & Close
 MCCB-RT: MCCB with Remote Trip only.

Software Modules for RTU

1. Remote control program
2. Data acquisition program
3. Remote meter selection and reading program
4. Data processing and storage program
5. RTU-SMFM communication program
6. RTU-MTU communication program

Software Modules for MTU

1. Human-Machine Interface (HMI) program
2. MTU-RTU communication program
3. Data storage, processing and retrieval program
4. Trends computation and display program
5. Alarms and alerts program
6. Sequence-of-events monitoring and recording program
7. Distribution Automation (DA) program
8. Energy Management (EM) program
9. Demand Management (DM) program
10. Report generation program

Measure # 5

Produce

Renewable Energy

Renewable Energy

Renewable Energy :

Energy resource is renewed or replenished automatically in the nature

Sustainable Energy :

Either energy resource is renewed or replenished automatically in the nature, or it is consumed so little that it would last tens of thousands of years or beyond.

**Nuclear energy is claimed as sustainable !
However, it cannot be claimed as renewable.**

Green Energy

Green Energy :

Its impact on environment should be negligible.

Carbon-Neutral Energy :

Carbon emissions over full life cycle of mining, manufacturing, operation and de-commissioning are around 10 g of CO₂eq. per kWh of generation.

**Environmentally hazardous nuclear energy is claimed as carbon-neutral !
However, it cannot be claimed as a green energy.**

Distributed Energy

Distributed Energy is the one that is

**“generated at or very near to
the primary point of consumption”**

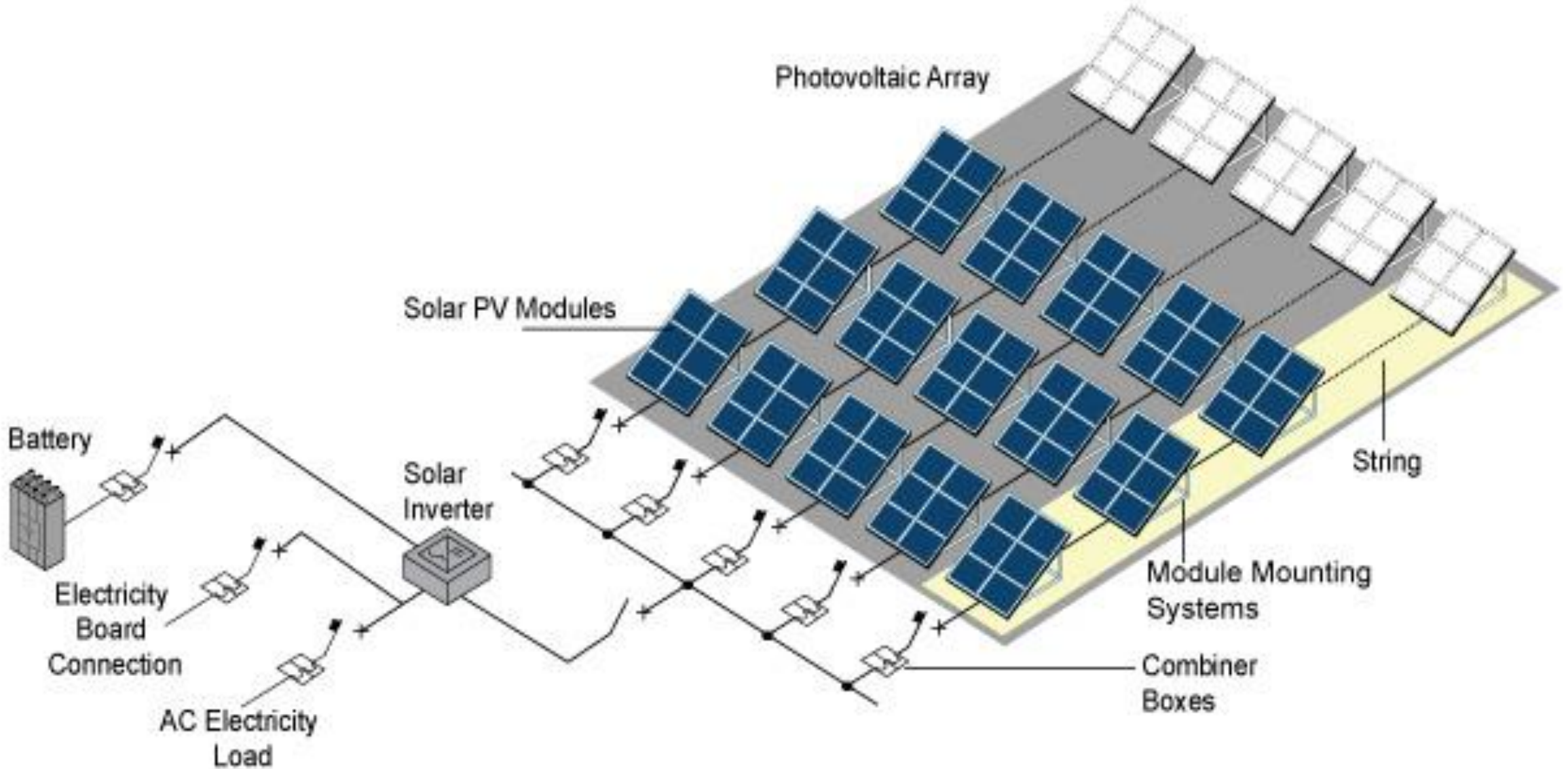
Distributed Energy

Roof-Top PV Solar Power Plant
and
Run-of-River Small Hydro Power Plant
are the only two cases of
“Renewable, Green and Distributed Energy”

Roof-Top PV Solar Power Plant

- **Roof-Top PV Solar Energy is:**
 - **Renewable energy,**
 - **Green energy,**
 - **Distributed energy**
- Power Plant to be distributed over roof-tops of several buildings
- PV Panels and Inverter Panel to be located on roof-tops of buildings
- AC Breaker-and-Metering Panel to be located next to Electrical Mains Panel in buildings
- Point-of-connection (POC) : 415-V bus in Electrical Mains Panel.

Roof-Top PV Solar Power Plant : Typical Layout



Part 3

Energy Audit

Energy Audit

To assess
Energy Conservation Potential
and
Renewable Energy Generation Potential,

begin with
Energy Audit of the Organization

What is Energy Audit?

An energy audit is a preliminary activity towards instituting energy conservation programs in an establishment.

It consists of activities that seek to identify conservation opportunities preliminary to the development of an energy savings program.

Preliminary Energy Audit

Detailed or Comprehensive Energy Audit

Preliminary Energy Audit

- Completed in a relatively short period of time
- Using readily available site information
- Using rules of thumb
- Based on walkthrough survey
- All figures (input data and results) are only indicative.

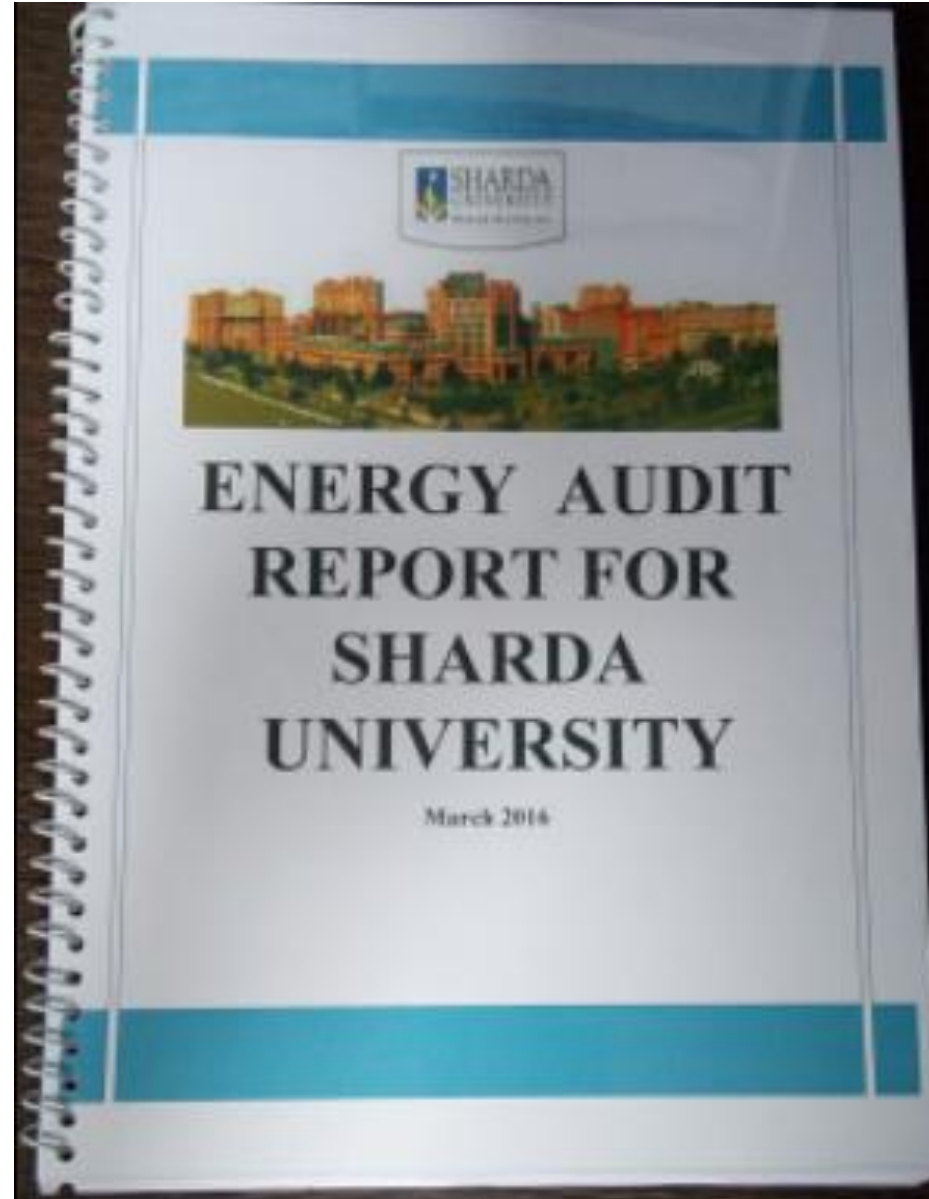
Detailed Energy Audit : Steps

1. Conduct a walk through survey
2. Establish the audit mandate (expectations) and scope
3. Conduct a detailed survey
4. Analyse energy consumption and costs
5. Compare energy performance
 - One period with another,
 - One facility with a similar one within institute
 - Externally with best practices available within academia
6. Profile energy use patterns
7. Prepare inventory of energy usage (loads)
8. Identify energy management opportunities
9. Assess the benefits: (assess the potential energy and cost savings, and spell out intangible benefits)
10. Prepare Audit Report

Energy Audit Report : Contents

1. Analysis of energy use
2. Identification of energy conservation projects
 - Opportunities for energy savings
 - Focus on major energy users and areas
 - Apply the 80/20 rule, focus on opportunities that provide 80% of the saving but require 20% input.
 - Spend more time on those which have shorter payback periods.
3. Cost benefit analysis
 - Calculate cost of project and the savings expected
4. Develop action plan
 - Major steps for implementing
 - People responsible
 - Plan for monitoring the results.

Energy Audit Report : Example



Thanks