



# **U-3ARC WEBINAR 33**


## **ENERGY EFFICIENCY IN AIR CONDITIONING**

**TRAINER:**

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 Definition of energy efficiency.

 The Seasonal Energy Efficiency Ratio (SEER), COP, EER.

 Importance of Energy Efficiency.

 Understanding AC System Energy Efficiency.

 Key Strategies to Optimize Energy Efficiency.

 Energy-Saving Practices for AC System Operation.

 Advanced Technologies for Energy Efficiency.

 The Role of Building Occupants in Energy Efficiency.

 Consequences of Inefficient Air Conditioning Systems on Energy Consumption and Costs.

 Common Mistakes Affecting Air Conditioner Efficiency.



# INTRODUCTION



**The  
Economist**

**INTELLIGENCE  
UNIT**

The Cooling Imperative,  
2019

**Cooling alone  
accounts for 10%  
of global electricity  
consumption**

**If inefficient systems are not replaced,  
demand is expected to triple in the  
next 30 years**

# INTRODUCTION Cont.



Air conditioning systems are crucial for maintaining indoor comfort, particularly in hot and humid weather.



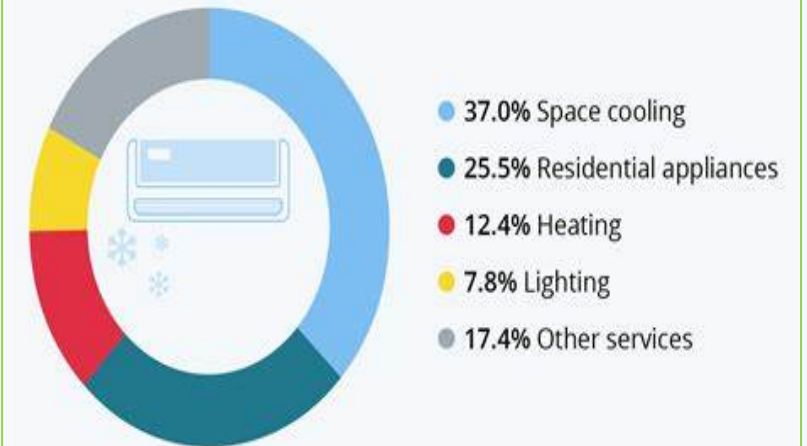
Air Conditioning is the biggest factor in growing electricity demand.



The global cooling consumption of the residential sector is expected to increase up to 34% in 2050 and 61% in 2100. (**Santamouris,2016**)

## Air Conditioning Biggest Factor in Growing Electricity Demand

Global electricity demand growth from 2018 to 2050, by energy use category



Source: International Energy Agency



statista



# WHAT IS ENERGY EFFICIENCY?



**Definition:** Energy efficiency refers to the ability of a system or device to achieve its desired output (such as cooling in the case of air conditioners) while minimizing energy consumption.



In simpler terms, an energy-efficient air conditioning system provides effective cooling without wasting excess power.

# COP, EER, & SEER



COP is a comprehensive metric for overall system performance. Mathematical expression

$$\text{COP} = \frac{\text{Cooling Capacity (Q)}}{\text{Electrical Power Input (W)}}$$



EER is a snapshot of efficiency at specific conditions. Mathematical expression.

$$\text{EER rating} = \frac{\text{Capacity (in BTU)}}{\text{Power (in W)}}$$



SEER captures practical efficiency over a season. Mathematical expression.

$$\text{SEER} = \frac{\text{Weighted Average of EERs}}{\text{Seasonal Energy Consumption}}$$





# Example Calculation:



Let's say your AC system has the following specifications:

**Cooling Output (Q):(12,000 BTU/hr)**

**Electrical Power Input (W):(1,200 W)**

**EER=12,000 BTU/hr/1,200 W=10 (approximately)**



**Typical EER ranges:**



**Window Air Conditioners: EER values may range from 8 to 12.**



**Central Air Conditioners: Modern systems can have EER ratings between 10 and 26.**

# Importance of Energy Efficiency:



## Cost Savings

Energy-efficient ACs consume less electricity, resulting in lower utility bills for homeowners and businesses.

## Env. Impact

By using energy-efficient models, we reduce our carbon footprint and help combat climate change.

## Comfort and Productivity

Efficient AC systems maintain consistent indoor temperatures, ensuring comfort for occupants.


## Long-Term Sustainability


As energy resources become scarcer, promoting energy efficiency becomes crucial.

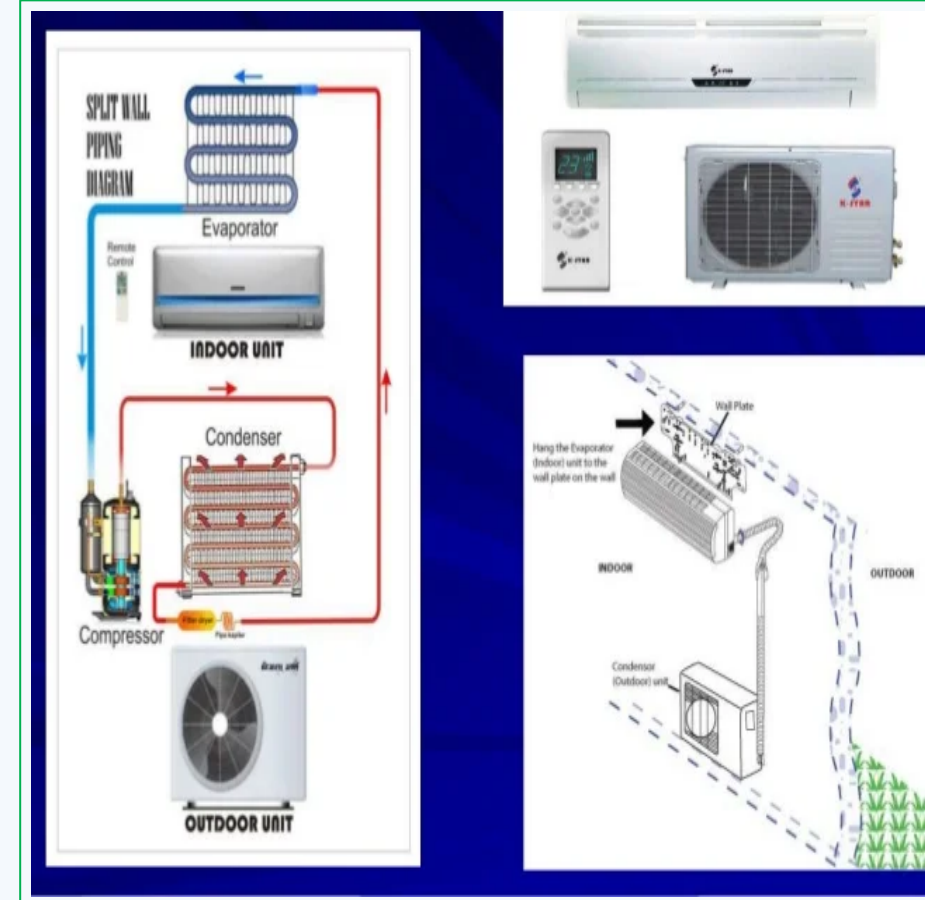


# Understanding AC System Energy Efficiency:



 Understanding AC systems' energy consumption and ratings is crucial for optimizing efficiency.

 Improving these systems can lead to significant energy savings and contribute to a greener future.



# Key Strategies to Optimize Energy Efficiency:





1. Proper Air Conditioning Sizing and Load Calculation.
2. Regular Maintenance and Cleaning.
3. Upgrading to Energy-Efficient Equipment.
4. Implementing Smart Thermostat Controls.
5. Optimizing Air Distribution and Ventilation.



# 1. PROPER AC SIZING AND LOAD CALCULATION



 Sizing Air Conditioning systems based on building needs avoids energy waste and efficiency issues.

 An oversized system wastes energy, while an undersized system struggles to cool effectively.

## • AC Sizing



## 2. REGULAR MAINTENANCE AND CLEANING



Regular maintenance of HVAC systems ensures optimal performance and energy efficiency.

• cleaning or replacing air filters.

• inspecting and cleaning coils.

• checking refrigerant levels.

• calibrating thermostats.

• Etc.

### • AC Maintenance





# 3. UPGRADING TO ENERGY-EFFICIENT EQUIPMENT



 Consider upgrading older, inefficient ACs with newer, energy-efficient models.

 Energy-efficient AC systems often have advanced features such as;

 variable speed compressor.

 intelligent controls.

 improved insulation.

- A shift from less energy-efficient to energy-efficient AC





# 4. IMPLEMENTING SMART THERMOSTAT CONTROLS



Energy saving

Smart thermostats allow for precise temperature control, scheduling, and remote management.



Energy saving

Smart thermostats help;



Energy saving

reduce unnecessary energy consumption.



Energy saving

improve comfort levels by optimizing temperature settings based on occupancy and activity patterns.



# 5. OPTIMIZING AIR DISTRIBUTION AND VENTILATION



Energy saving

Proper air distribution and ventilation play a crucial role in AC system efficiency.



Energy saving

Ensuring balanced airflows, sealing ductwork to prevent leaks.



Energy saving

Utilizing demand-based ventilation systems can help optimize energy usage and indoor air quality.

# Energy-Saving Practices for AC System Operation:



These include;

1. Temperature and Setback Optimization.
2. Utilizing Natural Ventilation and Daylighting.
3. Managing Humidity Levels Effectively.
4. Ensuring Proper Insulation and Sealing.
5. Monitoring and Adjusting Air Filters.
6. Use of natural refrigerant.




# 1. TEMPERATURE AND SETBACK OPTIMIZATION

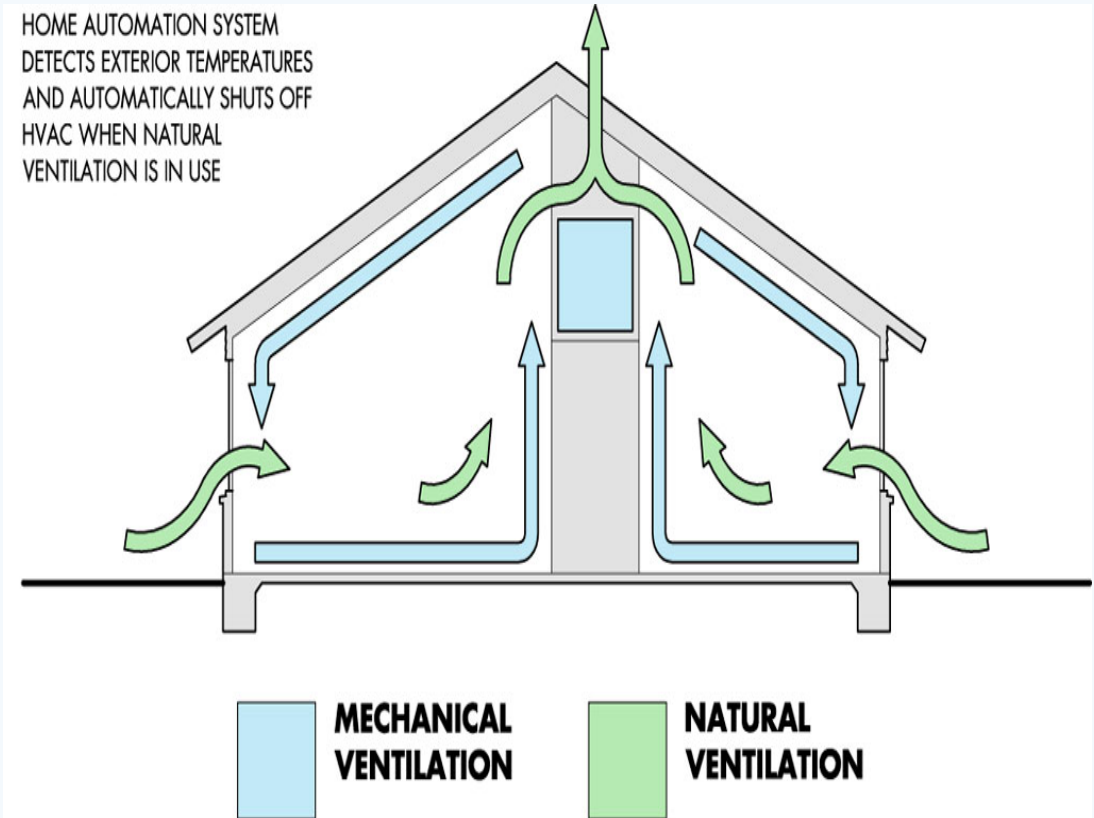


Adjusting temperature settings based on occupancy and implementing setback strategies during unoccupied hours can lead to significant energy savings.

## 2. UTILIZING NATURAL VENTILATION AND DAYLIGHTING



 Leveraging natural ventilation and utilizing daylighting techniques can reduce the need for mechanical cooling and lighting, thereby saving energy.



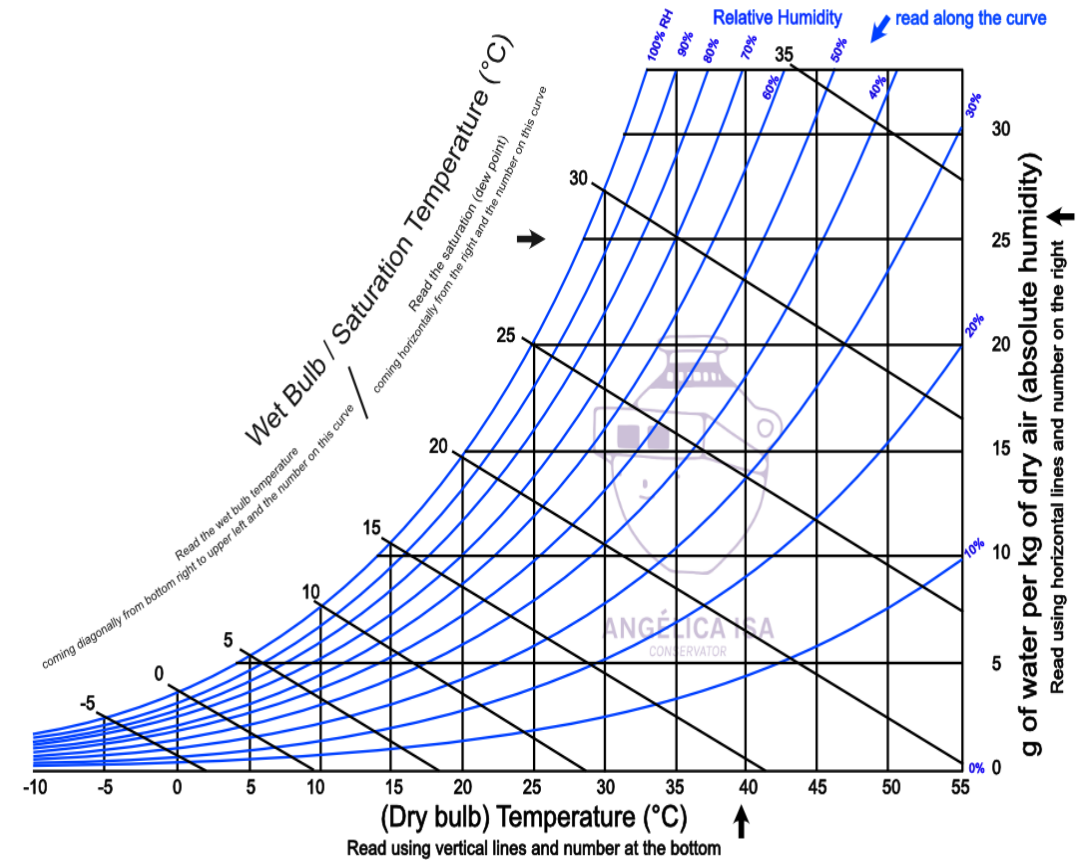
# 3. MANAGING HUMIDITY LEVEL EFFECTIVELY



While air conditioning systems primarily focus on cooling, they also dehumidify the air.



Higher humidity level makes the air feels warmer, increasing the workload on the AC system while lower humidity levels ease the workload.





# 4. ENSURING PROPER INSULATION AND SEALING



Well-insulated buildings with proper sealing minimize heat transfer, reduce energy loss, and improve AC system efficiency.

- **Duct Insulation**



# 5. MONITORING AND ADJUSTING AIR FILTERS



Energy saving

Regularly monitoring and cleaning or replacing air filters can improve



Energy saving

airflow,



Energy saving

reduce strain on the system.



Energy saving

enhance energy efficiency.





# 5. USE OF NATURAL REFRIGERANT



Natural refrigerants, such as ammonia, carbon dioxide, and hydrocarbons, have properties that make them more energy-efficient than synthetic refrigerants.



They typically have higher thermodynamic efficiency, meaning they can transfer heat more effectively, reducing the workload on the compressor.



Additionally, they have lower global warming potential (GWP) and ozone depletion potential (ODP), leading to less environmental impact.



This combination of factors results in air conditioners using natural refrigerants being more energy efficient overall.





# Advanced Technologies for Energy Efficiency:



Energy saving

Advancements in technology have introduced various solutions that can further optimize energy efficiency in AC systems. Among others are;



Energy saving

**Variable Speed Drives and Modulating Controls.**



Energy saving

**Heat Recovery and Energy Recycling Systems.**



Energy saving

**Building Automation and Energy Management Systems.**



Energy saving

**Demand-Based Ventilation and Occupancy Sensors.**

# 1. VARIABLE SPEED DRIVES AND MODULATING CONTROLS



Variable speed drives adjust the speed of AC system components based on demand, allowing for precise control and improved energy efficiency.





Modulating controls provides gradual adjustments, ensuring optimal performance.

# Variable Speed Compressors: A Quantum Leap in Energy Efficiency.



## What Are Variable Speed Compressors and Pump?

 Variable speed compressors, also known as inverter compressors or inverter-driven compressors, are a type of compressor used in air conditioners and heat pumps.

 Unlike traditional fixed-speed compressors that operate at a constant speed, variable speed compressors can adjust their speed dynamically based on cooling or heating requirements.





Energy  
saving

# How Do Variable Speed Compressor Work?



Energy  
saving

Variable speed compressors use frequency modulation guided by a Variable Frequency Drive (VFD).



Energy  
saving

The compressor can modulate its output up or down to match the cooling or heating needs of the building.

# Benefits of Variable Speed Compressors:



**Energy Savings:** Variable speed technology allows the unit to run at virtually any speed between 30% and 100%. This adaptability ensures that the compressor operates at the optimal speed for the current load, resulting in significant energy savings.



**Accurate Temperature Control:** The compressor matches power input with cooling capacity, maintaining stable temperature control.



**Reduced Energy Consumption:** Compared to fixed-speed or mechanically modulated compressors, variable-speed compressors can represent over a 30% reduction in annual energy bills.



**Improved Power Factor:** Variable speed technology improves power factor, leading to better power supply quality.

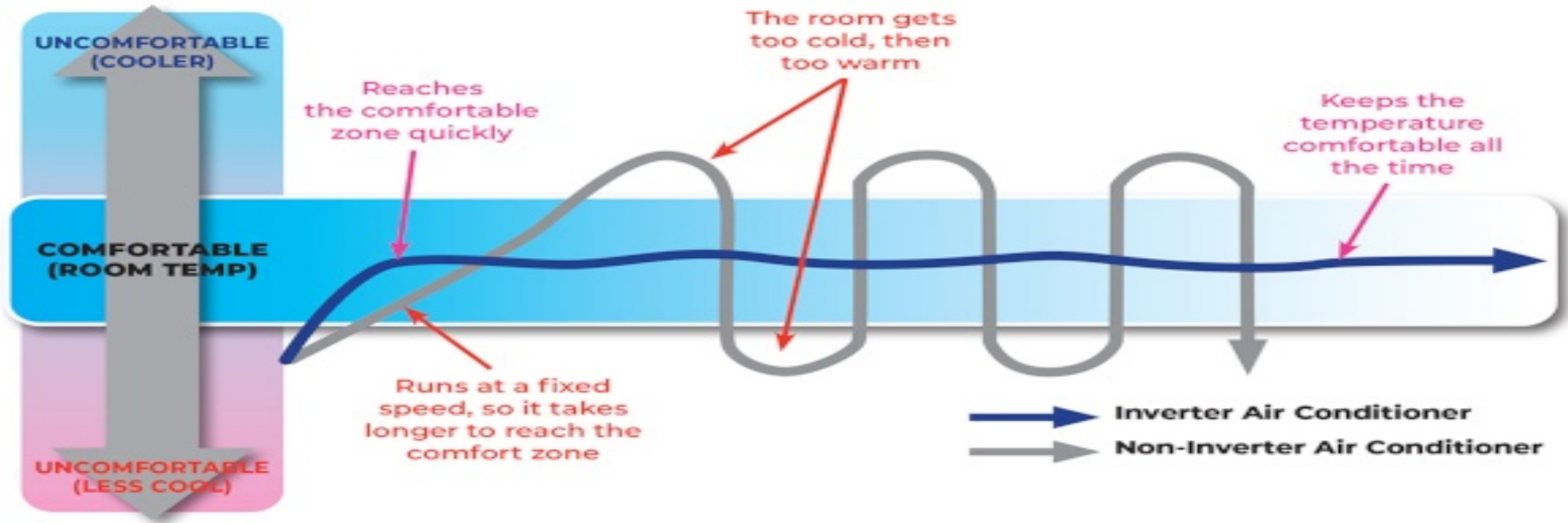


**Less Noise:** The gradual modulation reduces abrupt starts and stops, resulting in quieter operation.

# How Inverter Compressor Works




## How Inverter Technology Works

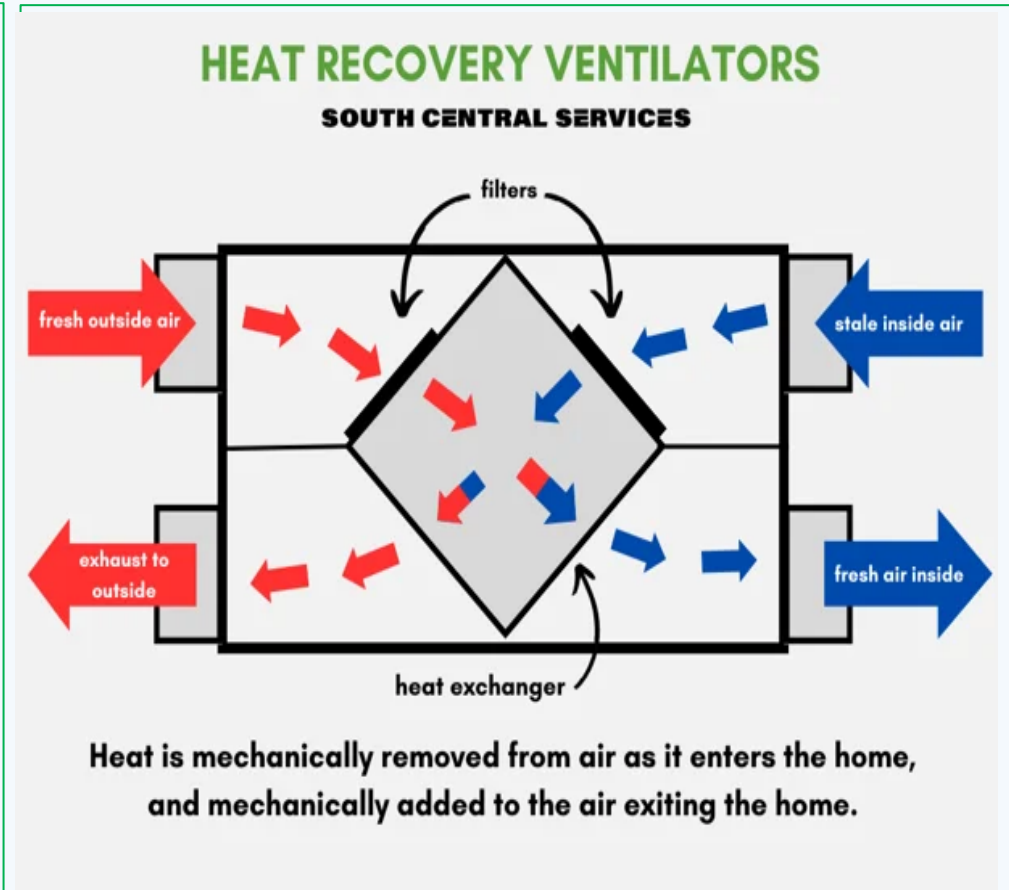




## 2. HEAT RECOVERY AND ENERGY RECYCLING SYSTEM



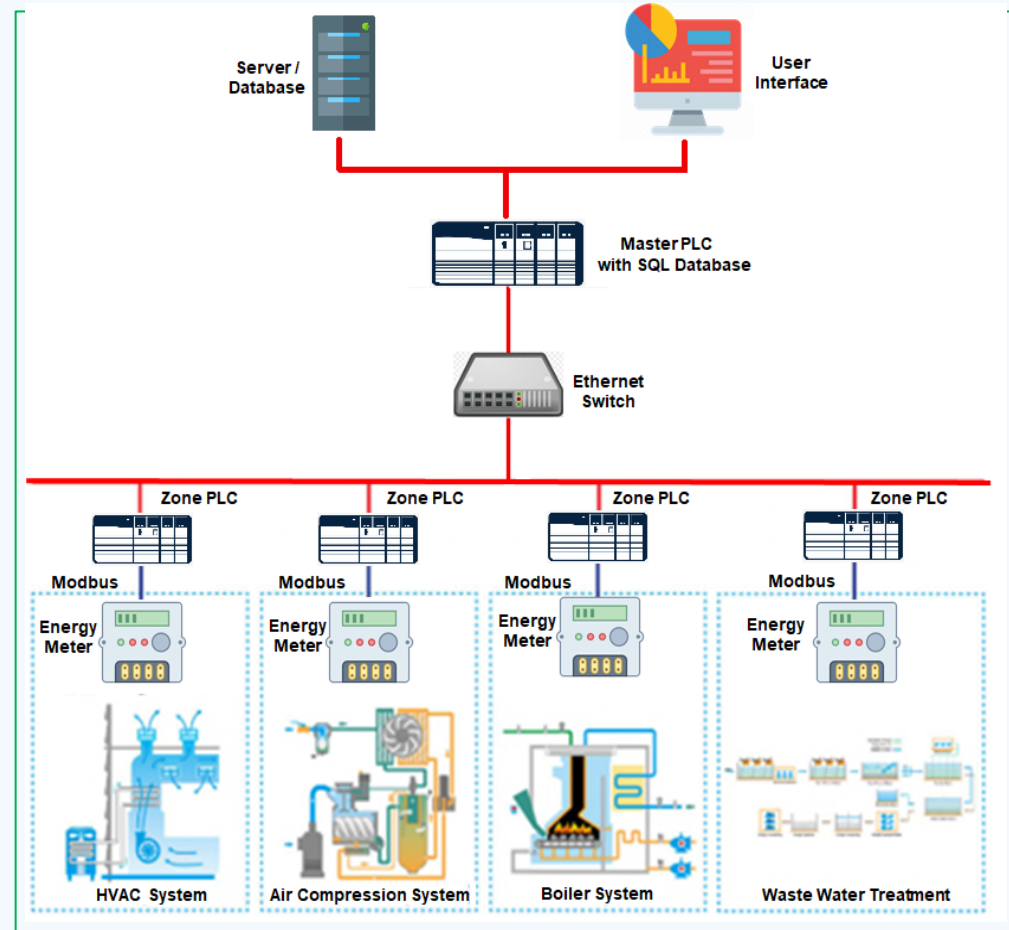
 Implementing heat recovery and energy recycling systems allows the capture and utilization of waste heat, resulting in energy savings and improved system efficiency.



# 3. BUILDING AUTOMATION AND ENERGY MANAGEMENT SYSTEM





Building automation systems integrate various AC components, lighting, and other systems, optimizing energy consumption based on real-time data and pre-defined settings.



# 4. DEMAND-BASED VENTILATION AND OCCUPANCY SENSORS



 Demand-based ventilation systems adjust airflow based on occupancy levels, improving energy efficiency.






 Occupancy sensors help optimize energy usage by activating or deactivating AC systems in response to occupancy changes.





# The Role of Building Occupants in Energy Efficiency:



-  Building occupants play a crucial role in achieving energy efficiency.
-  Educating occupants about energy-saving practices;
-  encouraging responsible usage of AC systems.
-  promoting energy awareness
-  contribute to overall energy efficiency goals.

# Consequences of Inefficient Air Conditioning (AC) Systems on Energy Consumption and Costs:



01

## Increased Energy Consumption:

Constant Operation: Inefficient ACs often run continuously to maintain the desired temperature. They struggle to cool the space efficiently, leading to prolonged operation.

02

## Higher Utility Bills:

Inefficient ACs result in significantly higher electricity bills. Homeowners and businesses pay more for cooling.

03

## Wasted Energy:

Heat Leakage: Inefficient systems allow heat to infiltrate indoor spaces. This forces the AC to work harder to maintain the set temperature.

04

## Shortened Lifespan:

Strain on Components: Inefficient ACs operate under stress, causing wear and tear on components like compressors and fans.

# What are some common mistakes that affect an air conditioner's efficiency?



**Low SEER Rating:** Mistake: Choosing an AC system with a low SEER rating.



**Improper Installation:** Mistake: Faulty installation, improper sizing, or incorrect placement of components.



**Lack of Maintenance:** Mistake: Neglecting maintenance tasks like cleaning filters, checking refrigerant levels, and inspecting coils.



**Air Leaks and Poor Insulation:** Mistake: Ignoring gaps, cracks, or poorly sealed ducts.



**Inefficient Thermostat Settings:** Mistake: Setting the thermostat too low or maintaining a significant temperature difference between indoors and outdoors.



# CONCLUSION



In conclusion, understanding and optimizing energy efficiency in air conditioning systems are crucial for both cost savings and environmental impact.



Capacity building of technicians is a crucial element in improving the energy efficiency of equipment today and in the future.



By choosing high SEER-rated models, maintaining regular maintenance, and avoiding common mistakes, we can enhance efficiency while staying comfortable.



Remember that informed decisions benefit both our wallets and the planet. Stay cool and energy-efficient! 😊🌿





***THANK YOU***

