

“Future of Airconditioning in Buildings”

Advances in AC System Efficiency

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Discussion Topics

1. A/C Equipment Efficiency Ratings
2. Need of High Efficiency A/C Systems
3. Ways to Improve A/C Systems Efficiency
4. Government Regulations and Incentives Program
5. Conclusions
6. References

1. A/C Equipment Efficiency

- SEER (Seasonal Energy Efficiency Ratio)
- EER (Energy Efficiency Ratio)
- ENERGY STAR® Certification
- COP (Coefficient of Performance)
- APF (Annual Performance Factor)
- IPLV (Integrated Part Load Value)



$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

1A. SEER and EER

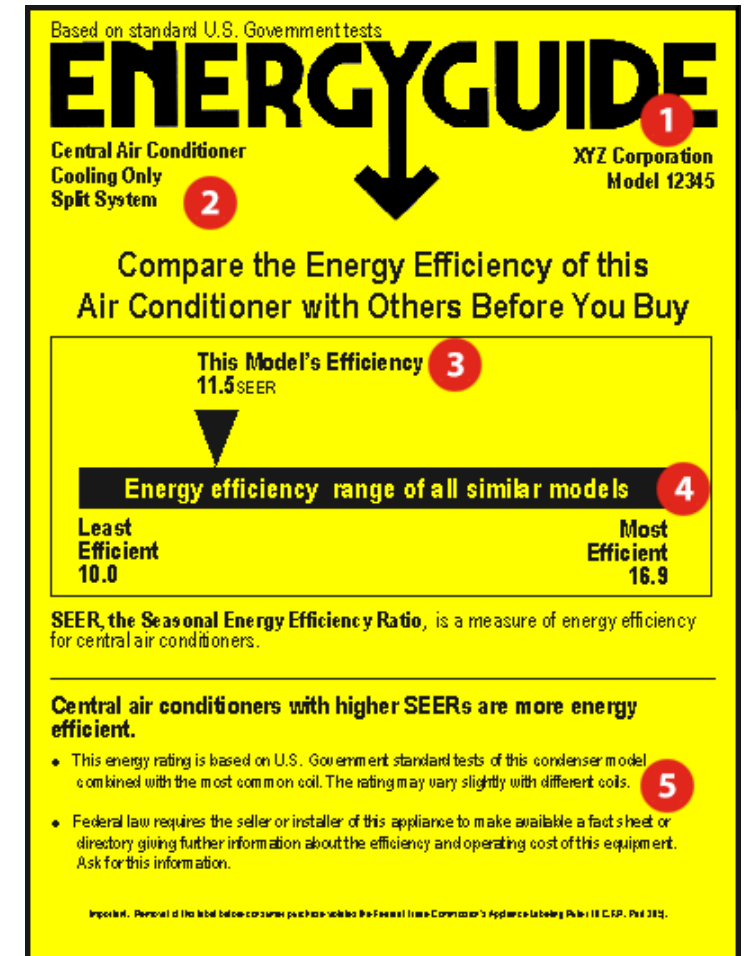
SEER & EER = Cooling Output (BTU)/Electricity Usage in (KW-Hr)

SEER Rating are Based on a Seasonal Average

EER is Calculated Under Specific Test Conditions

Higher SEER/EER Means Unit is More Energy Efficient

Most Efficient System Have SEER Ratings Between 20 and 28



2A. Need of High Efficiency A/C Systems

- Environmental Benefits
Low Carbon Emissions

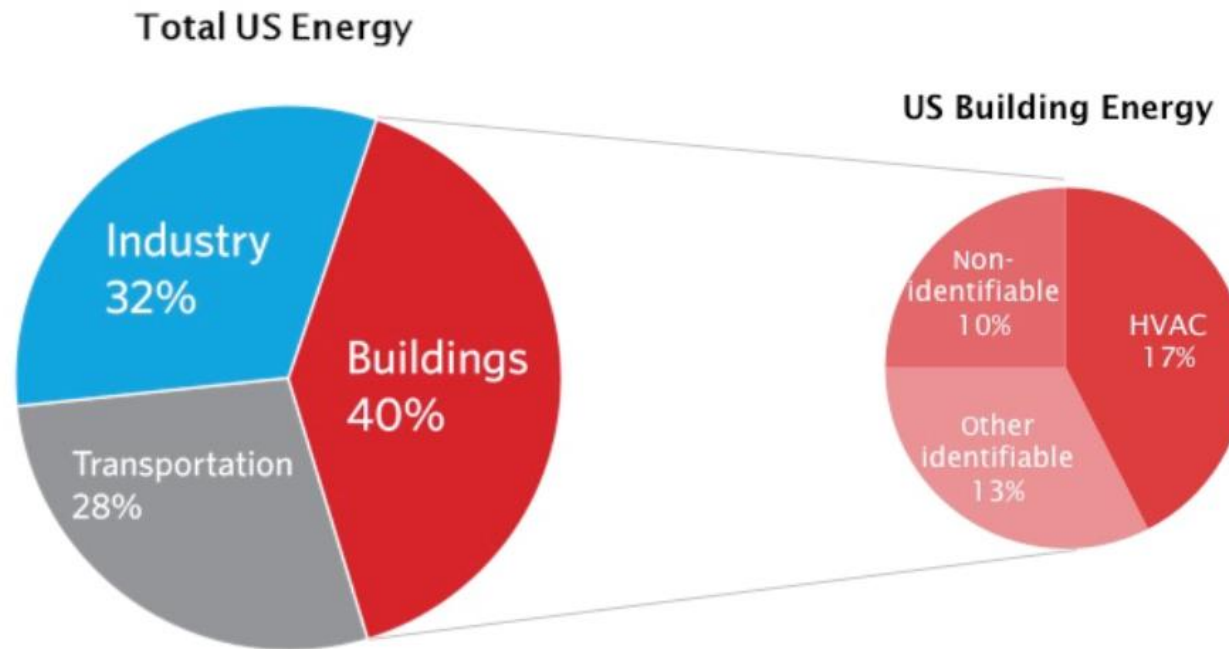


- Financial Benefits
Low Electricity Cost



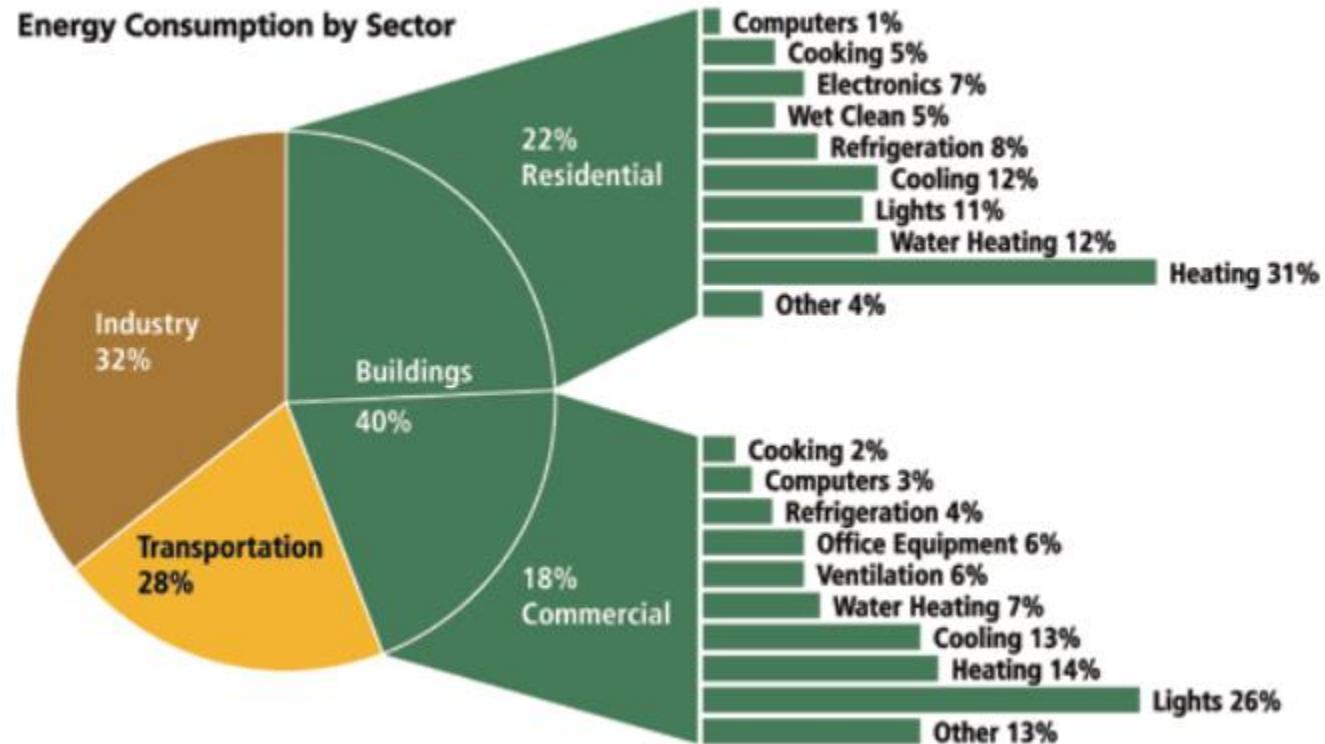
2B. Need of High Efficiency A/C System

US energy consumption 2010

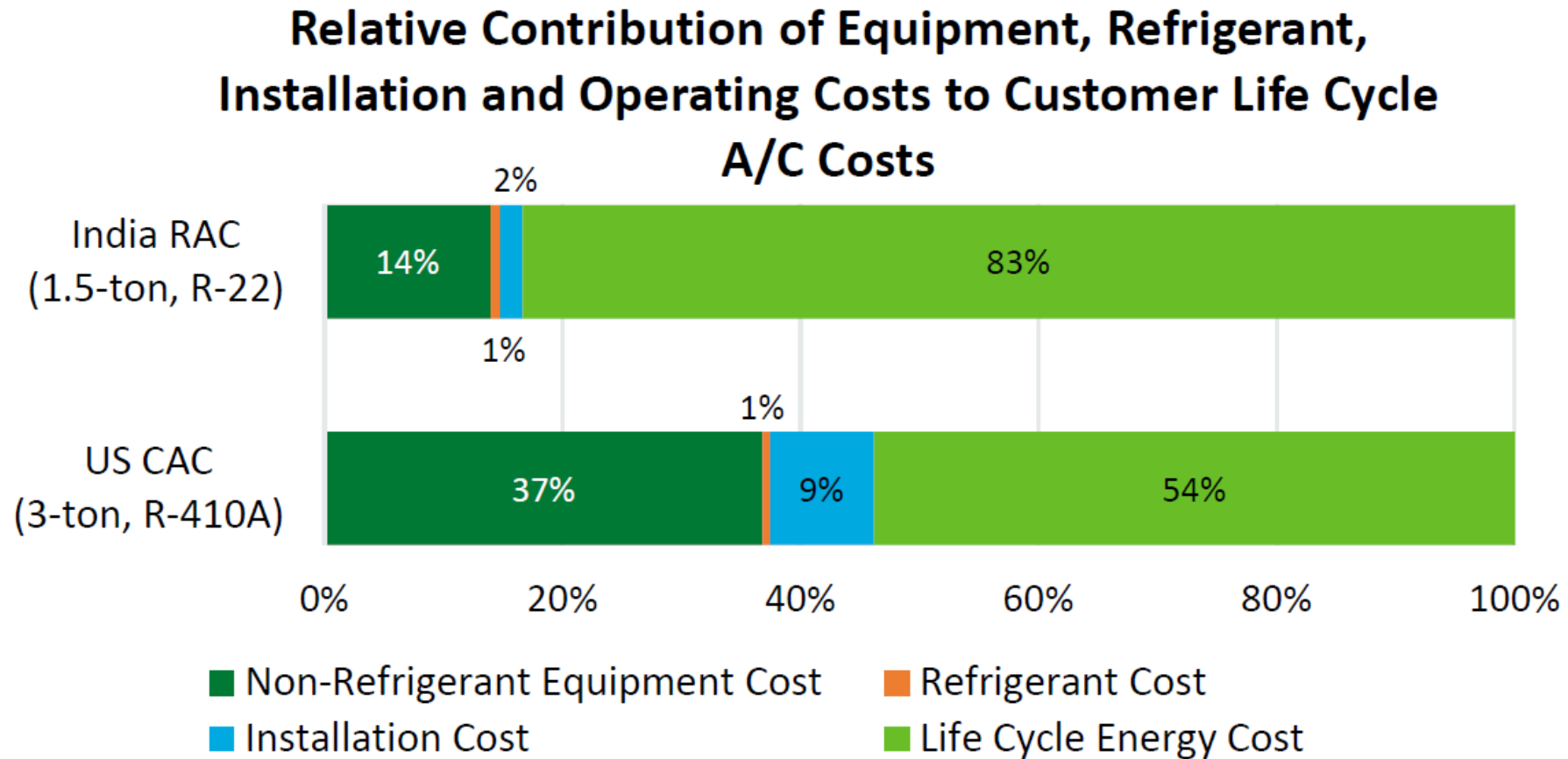


Source: US Department of Energy – Buildings Data Energy Handbook

2C. Need of High Efficiency A/C System



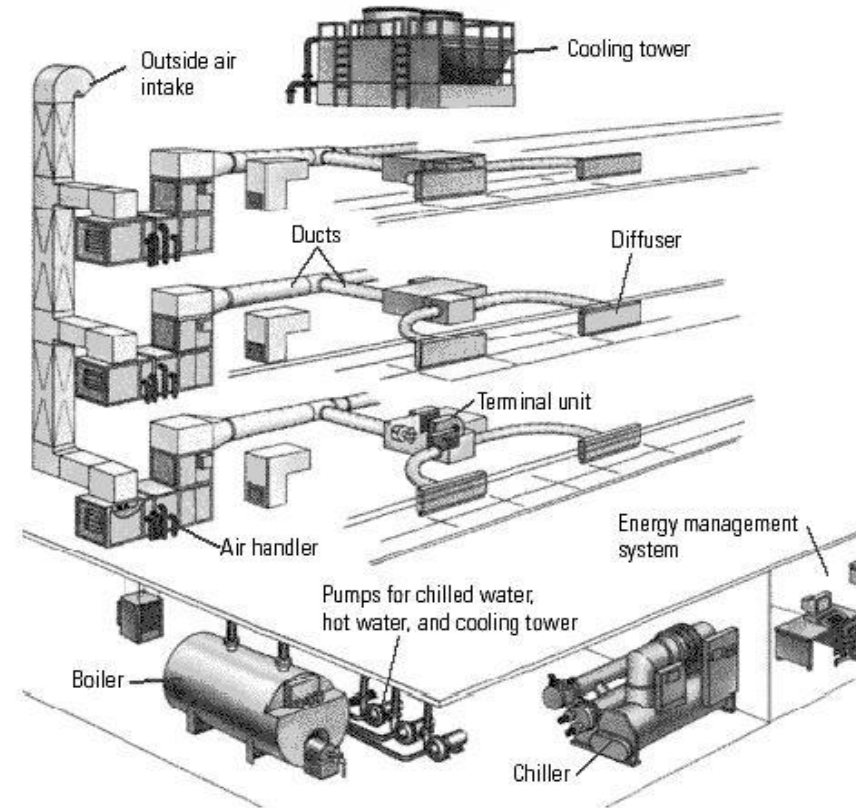
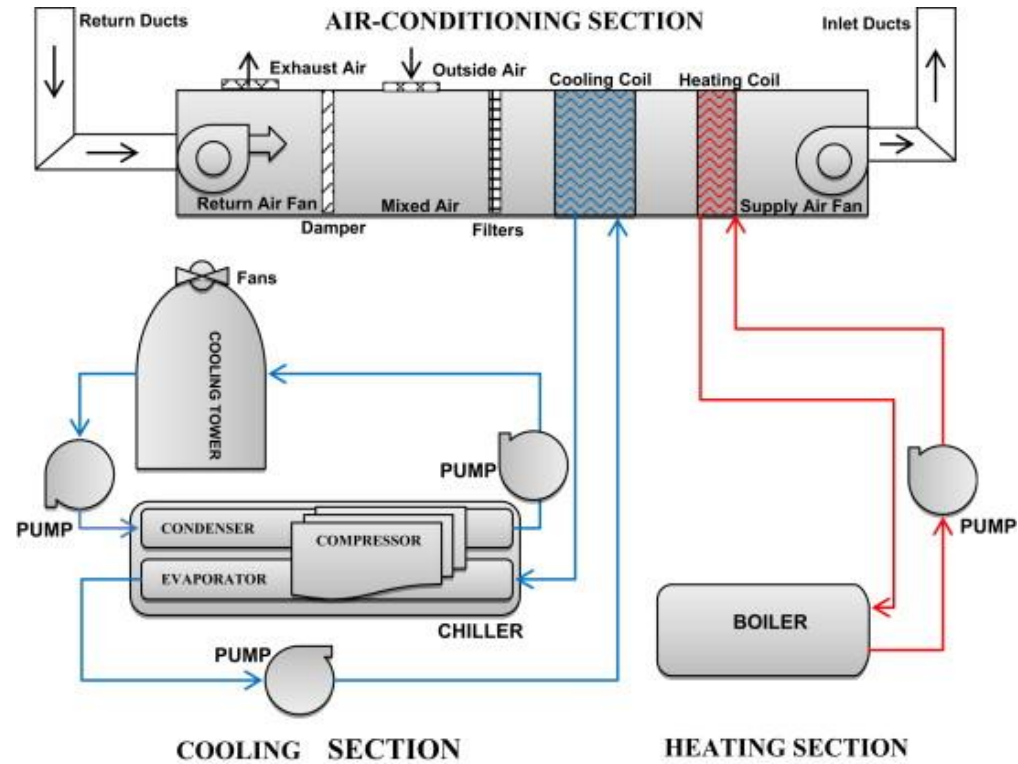
2D. Need of High Efficiency A/C Systems



3. Ways to improve AC System Efficiency

- A. Improvement in AC Equipment Designs
- B. Improvement in Building Designs
- C. Proper Selection of HVAC System
- D. Adoption of Building Automation Control
- E. Proper Training and Operation of HVAC System
- F. Preventative Maintenance of HVAC System

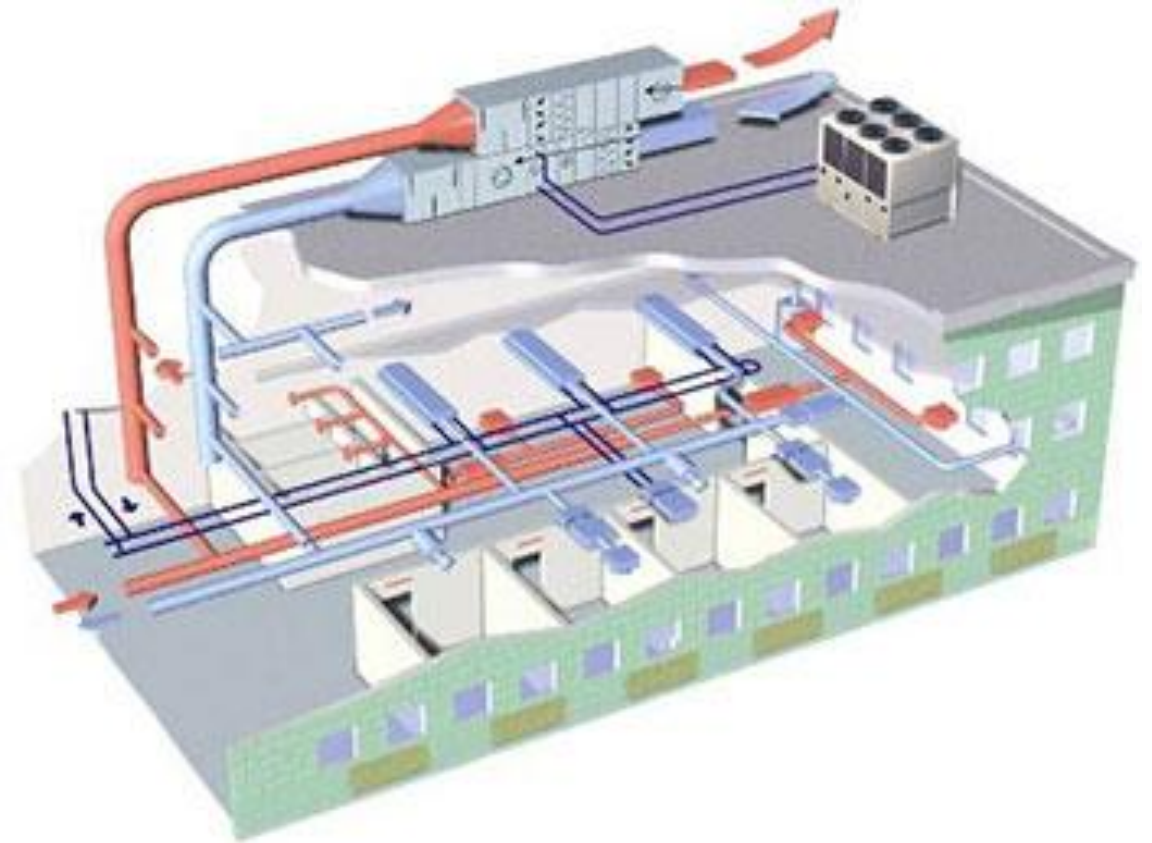
3A. Improvement in AC Equipment Design



Commercial Building – Centralized Ducted AC System

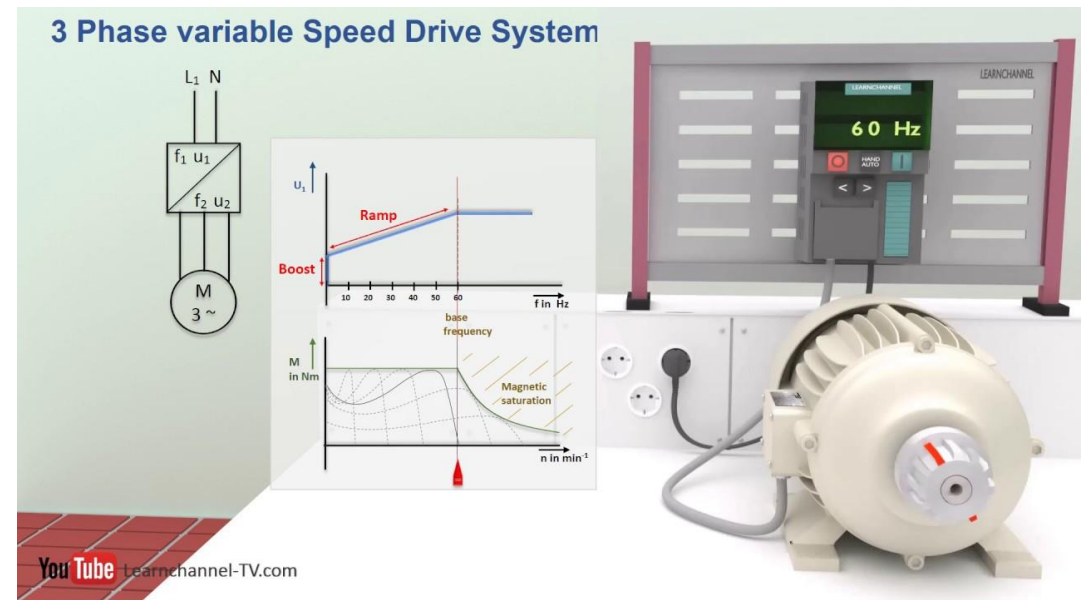
3A. Improvement in AC Equipment Design

1. Variable Speed Drive
2. Advanced Compressors
3. Improved Heat Exchangers
4. Electronic Expansion Valves
5. High Efficiency Fans
6. High Efficiency Motors
7. Advanced Controls
8. Electronic Actuators
9. High Efficiency Filters
10. Low Resistant Ducts, Pipes and their Fittings
11. Well Designed Diffusers and Grilles



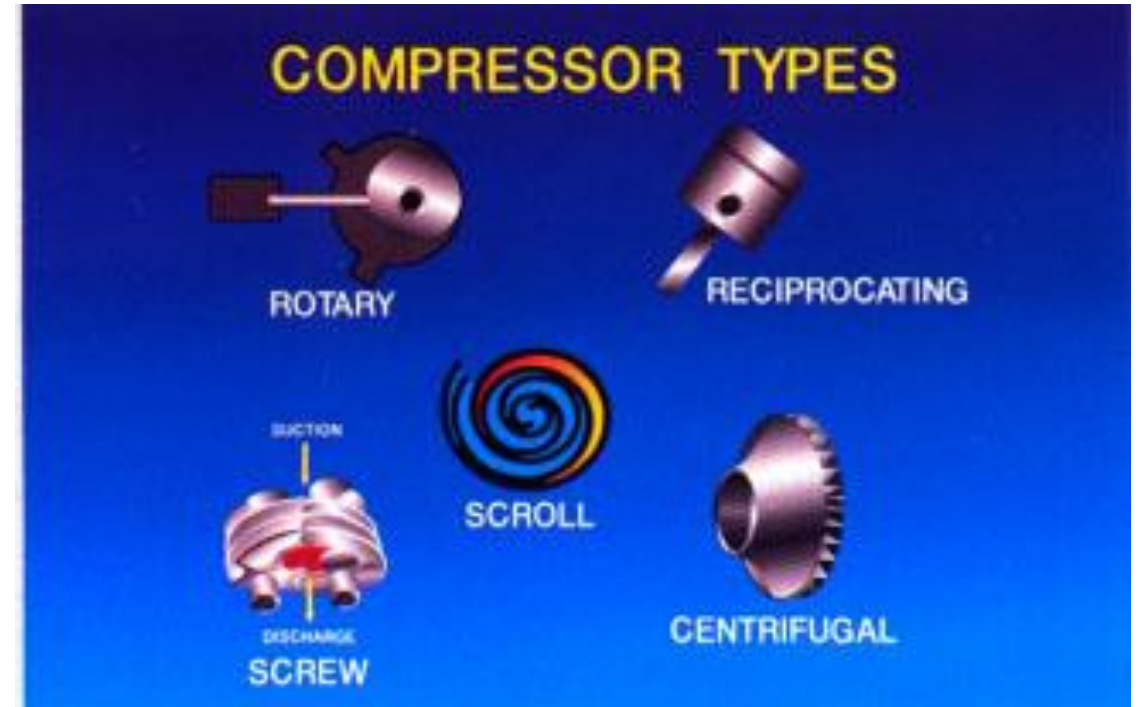
3A1. Variable Speed Drives

- Efficiency Improvement on Compressors and Fan Motors
- AC System Match Part-Load Cooling Demands
- Improve Seasonal Efficiency
- Reduce Cycling Losses
- Help to Meet the airflow requirements



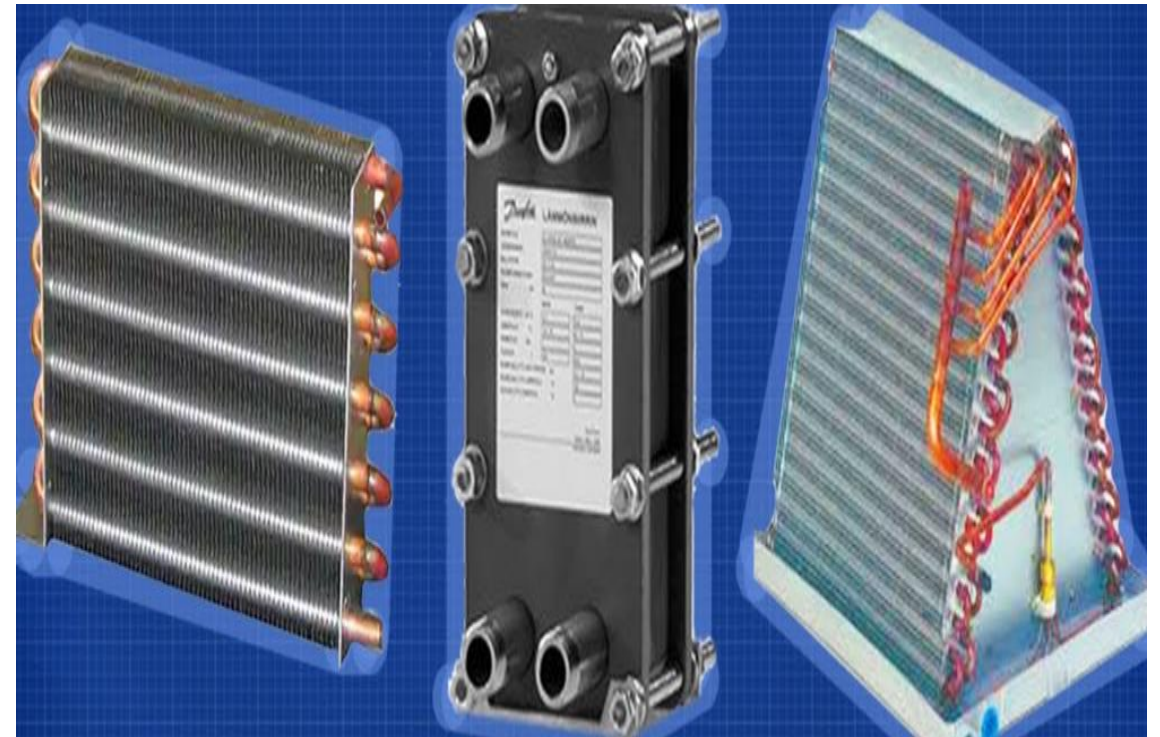
3A2. Advanced Compressors

- Reciprocating Compressors
- Scroll Compressors
- Rotary Compressors
- Multiple Compressors in Series to Improve Part-Load Performance



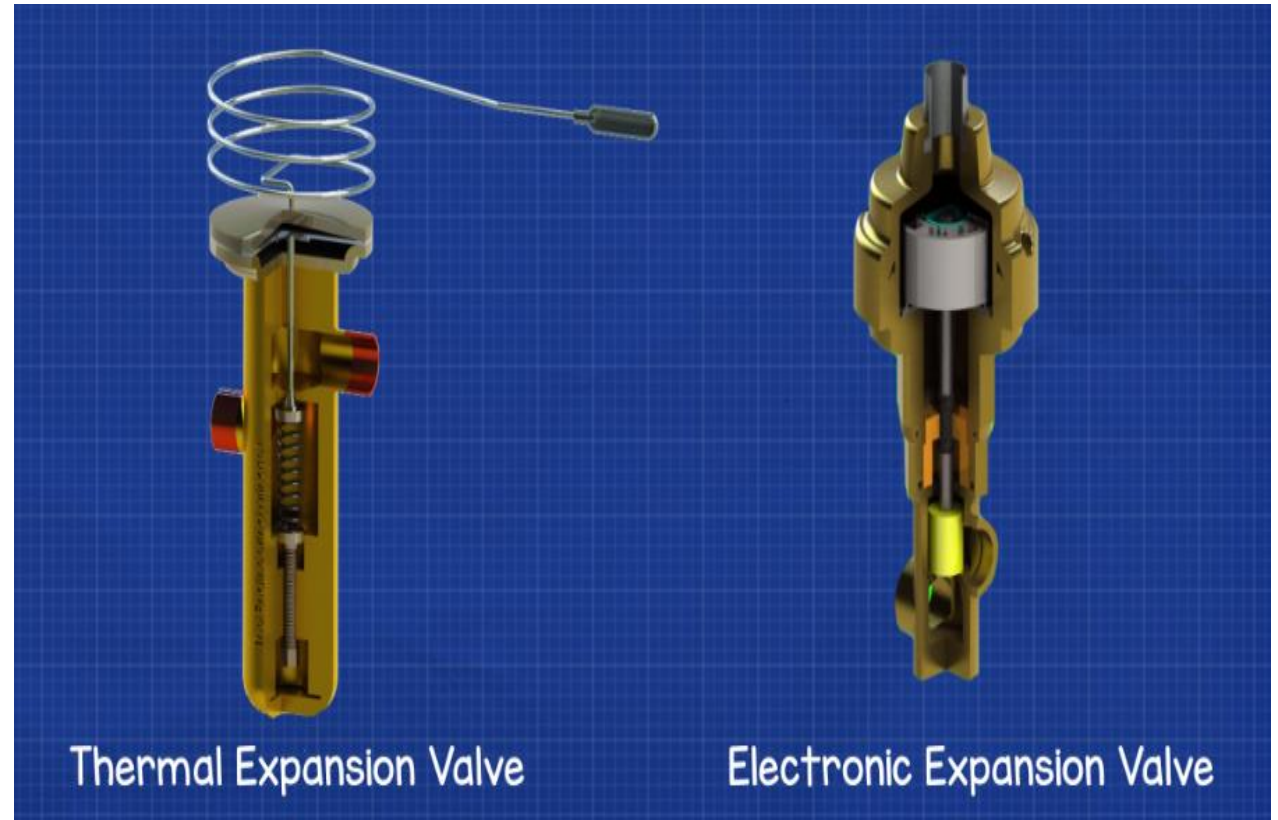
3A3. Improved Heat Exchangers

- Microchannel Heat Exchangers
- Reduce Refrigerant Charge
- Reduce Fan Energy Consumption
- Smaller in Size



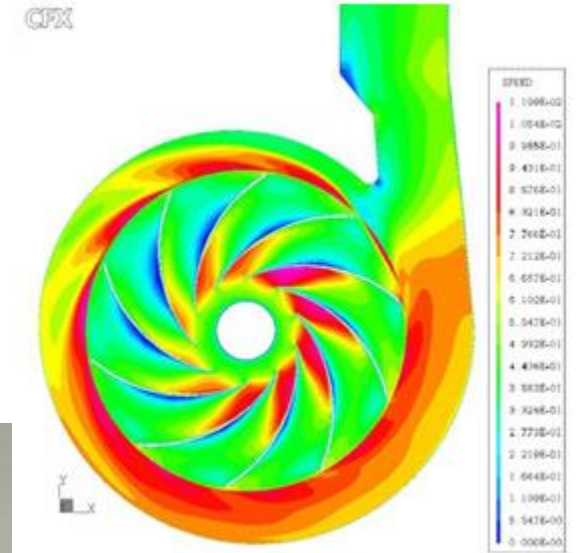
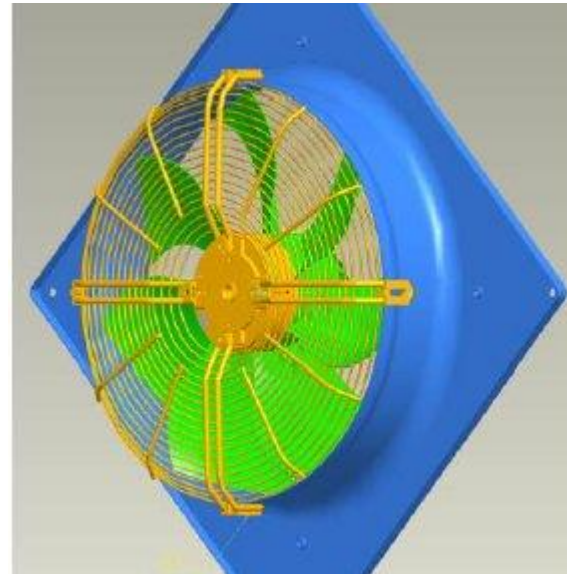
3A4. Electronic Expansion Valves Towers

- Control Refrigerant Flow Through Evaporation Coil
- Provide Increased Modulation Capabilities
- Match Variable Capacity AC System more closely



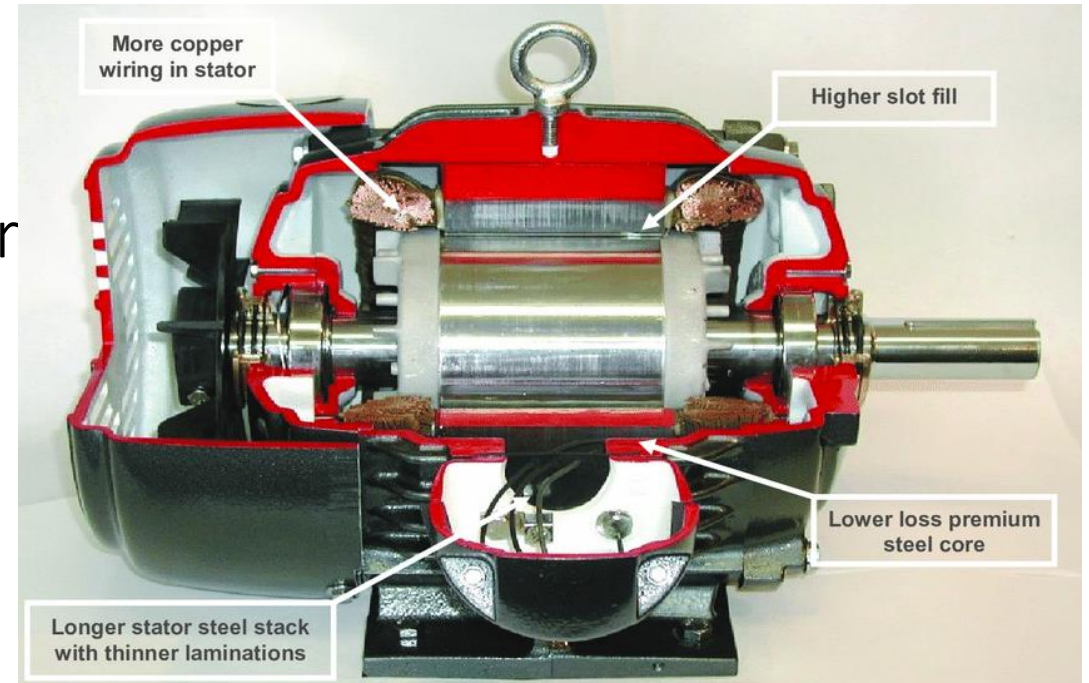
3A5. High Efficiency Fans

- More Aerodynamic Axial and Centrifugal Fans
- High Efficiency Motors
- VSD Controls



3A6. High Efficiency Motors

- Core components for compressors and fans
- New Electrically commutated motor (ECM)
- Operate at a Wider Range of Conditions



3A7. Advanced Sensors

- Occupancy Sensors
- Temperature Sensors
- Humidity Sensors
- Pressure Sensors



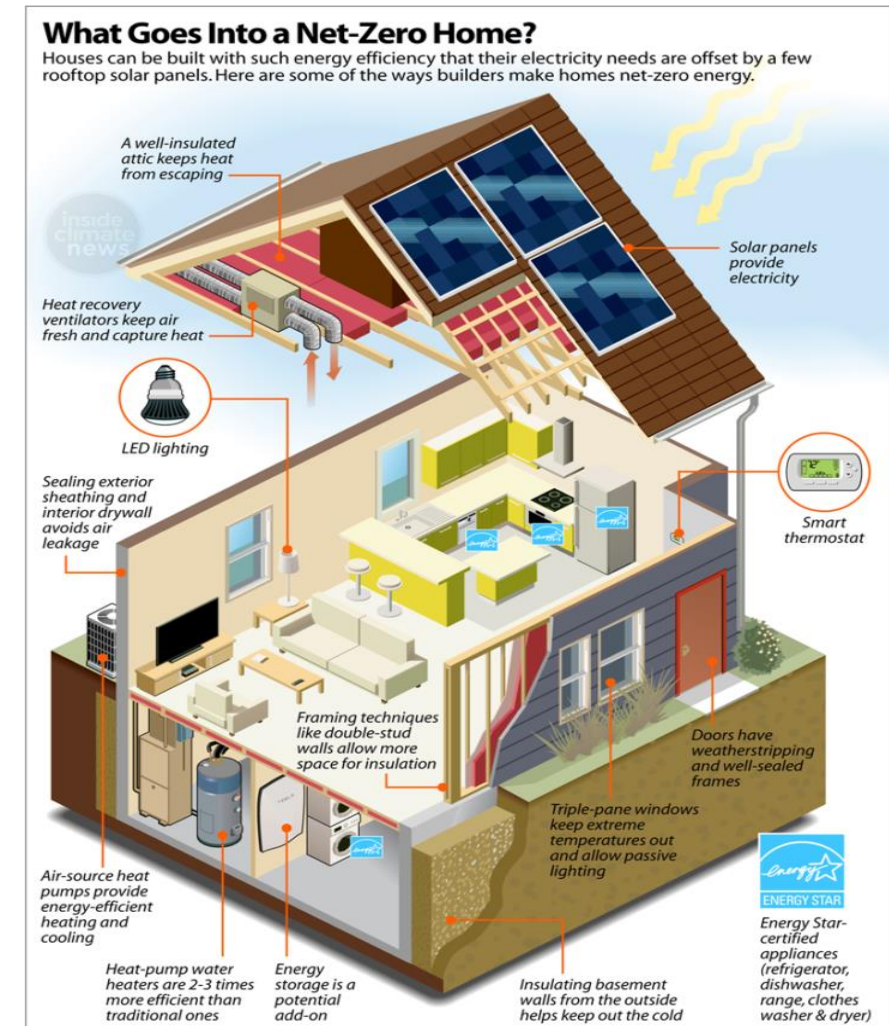
3A8-11. Actuators, Filters, Ducts and Diffusers

- Electronic Actuators
- High Efficiency Filters
- Low Resistant Ducts
- High Quality Diffusers



3B. High Performance Building Design

- Reduce Cooling Load
- Building Codes
- Energy Codes
- ASHRAE Performance Standard 90.1
- International Energy Conservation Code IECC113



SOURCE: InsideClimate News research

PAUL HORN / InsideClimate News

3B. High Performance Building Design

- **Building Envelope (External)**
 - Insulation
 - Windows
 - Doors
 - Thermal Bridges
 - Roofing
 - Surface Orientation
 - Infiltration/ Exfiltration
- **Waste Heat Reduction (Internal)**
 - Lighting
 - Appliances



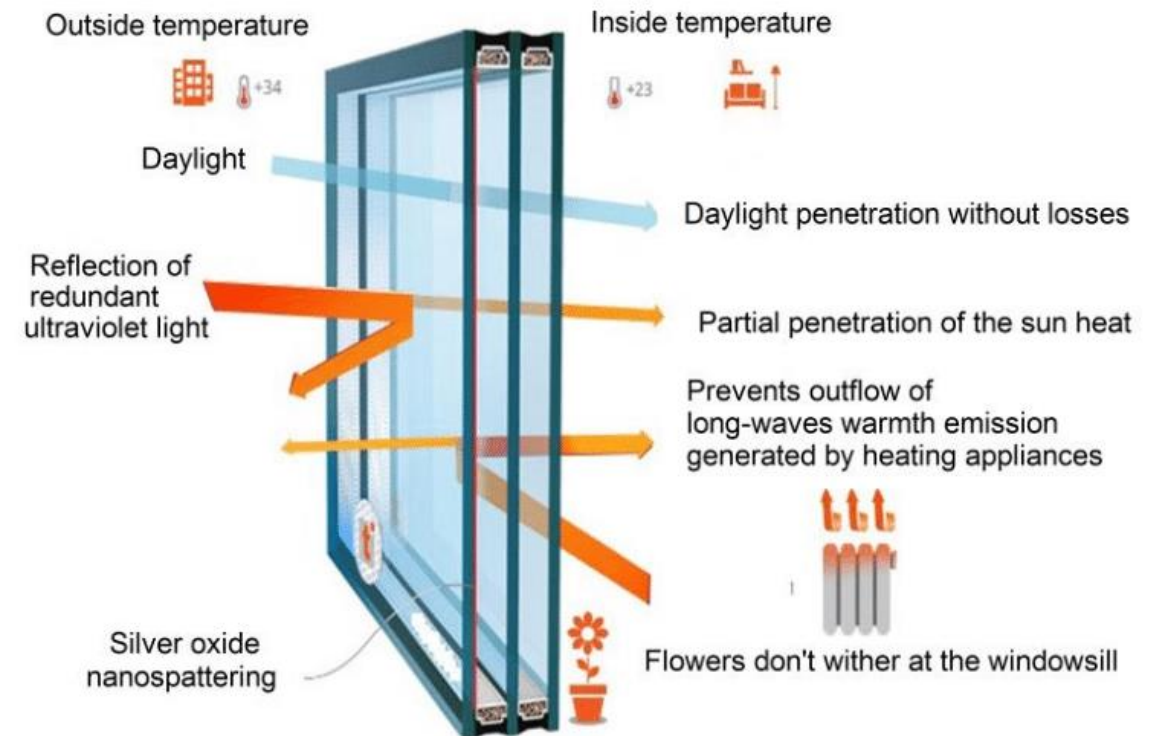
3B1. Insulation

- Increase Wall Thickness
- Increase R-value for Insulation,
- Insulated attics, Walls and Floors
- Reduce conduction heat gains
- Cooling Load Reductions up to 38%



3B2. Windows

- Multi-pane Glass Window
 - Inert Gas Fill b/w Panes
 - Low-E Coating Window
 - Reduced U-factor
- Dynamic Glazing Technology
 - Reduce Solar Heat Gains
 - Filtering Out Infrared Radiation
 - Provide Natural Lighting
- Reduce Cooling Loads up to 20%



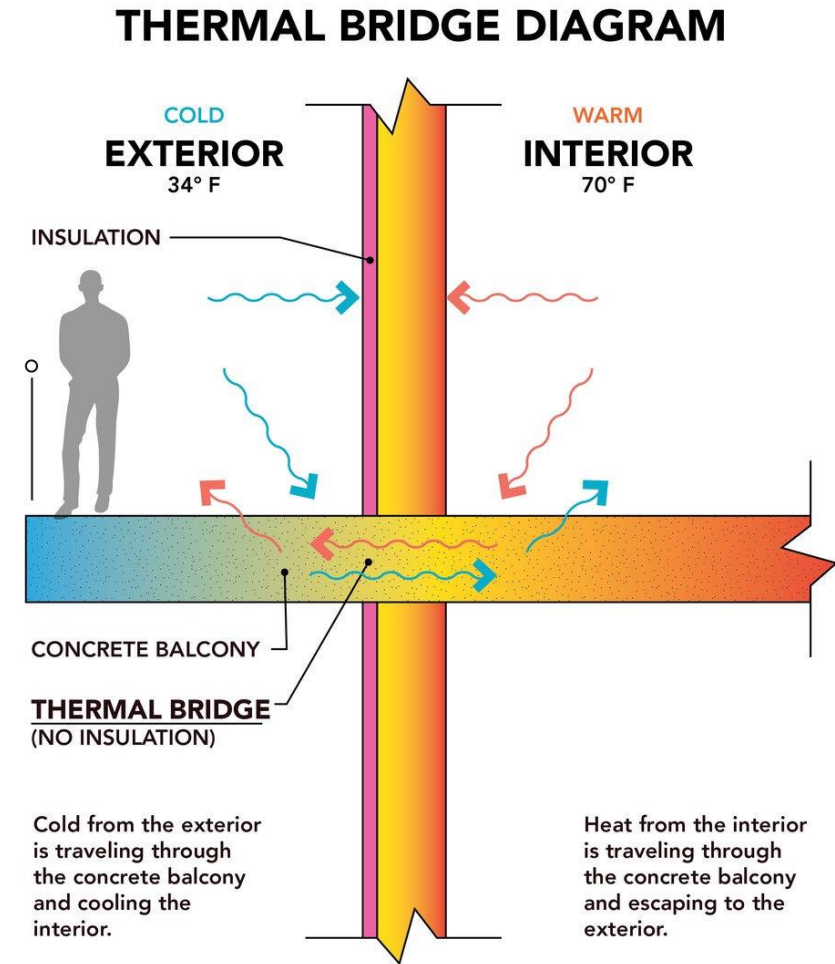
3B3. Doors

- Vestibules
- Revolving doors
- Door closers
- Doors Seals



3B4. Thermal Bridges

- Eliminate Gaps in Building Insulation
- Allow Increased Conduction



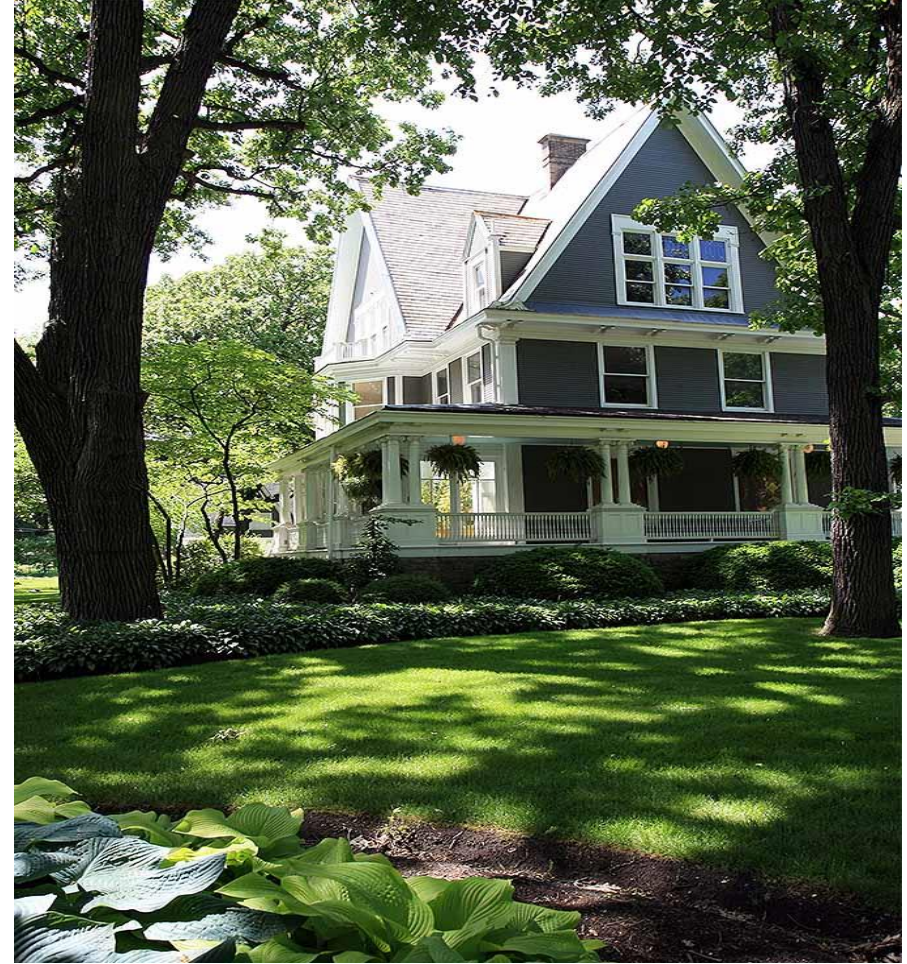
3B5. Roofing

- Install Light Colored Roofing
 - To Increase Albedo and Reduce Solar Heat Gain
- Vegetative Roofs
 - Reduce Roof Temperatures Through Process Called Evapotranspiration



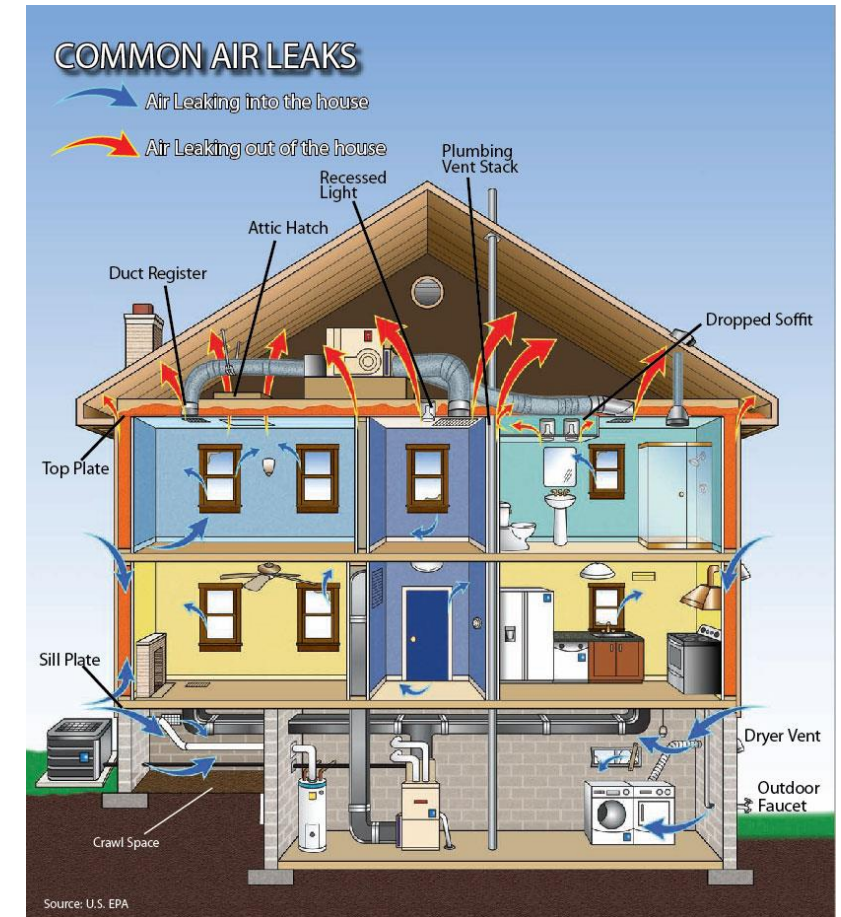
3B6. Surface Orientation

- Avoid Large Sunlit Exposures
- Shaded By Vegetation
- Building Outcroppings



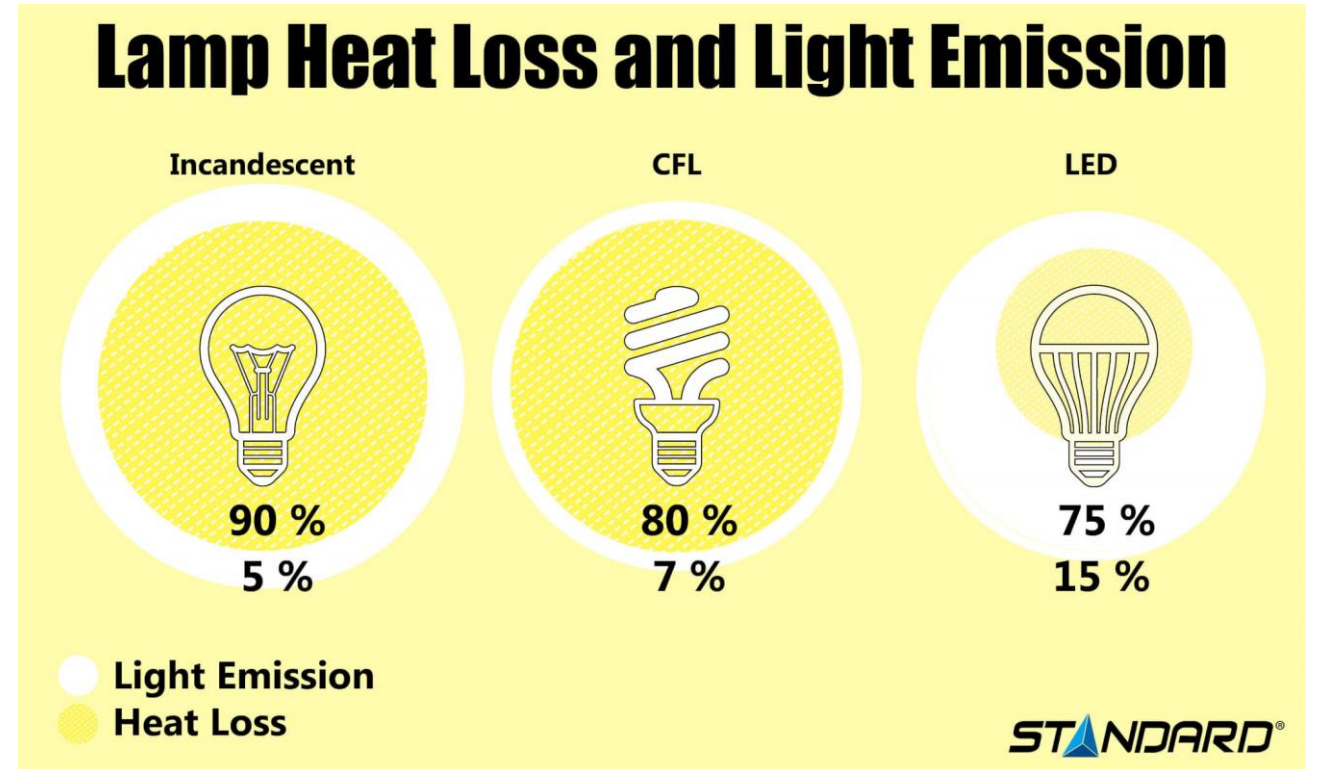
3B7. Infiltration/ Exfiltration

- Minimize Air Exchange b/w conditioned Space
- HPB- Tight Building Envelopes



3B8. Lighting

- Install LED Lighting
- Occupancy Sensors
- Reduce Waste Heat



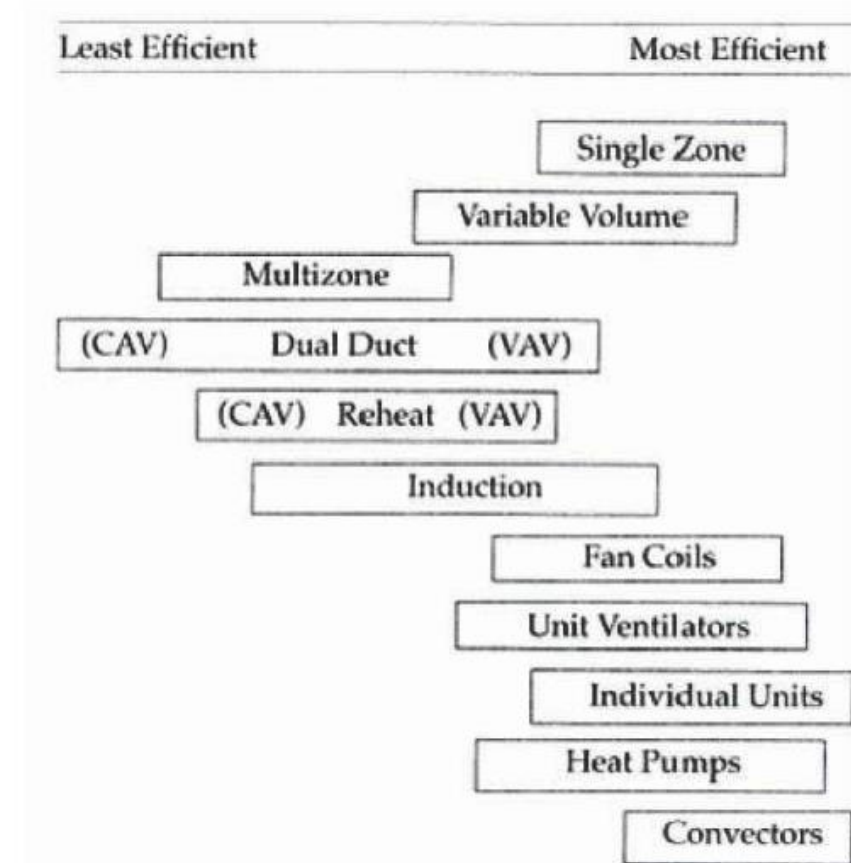
3B9. Appliances

- Install Energy Efficient Appliances,
- Appliances Dispel Heat



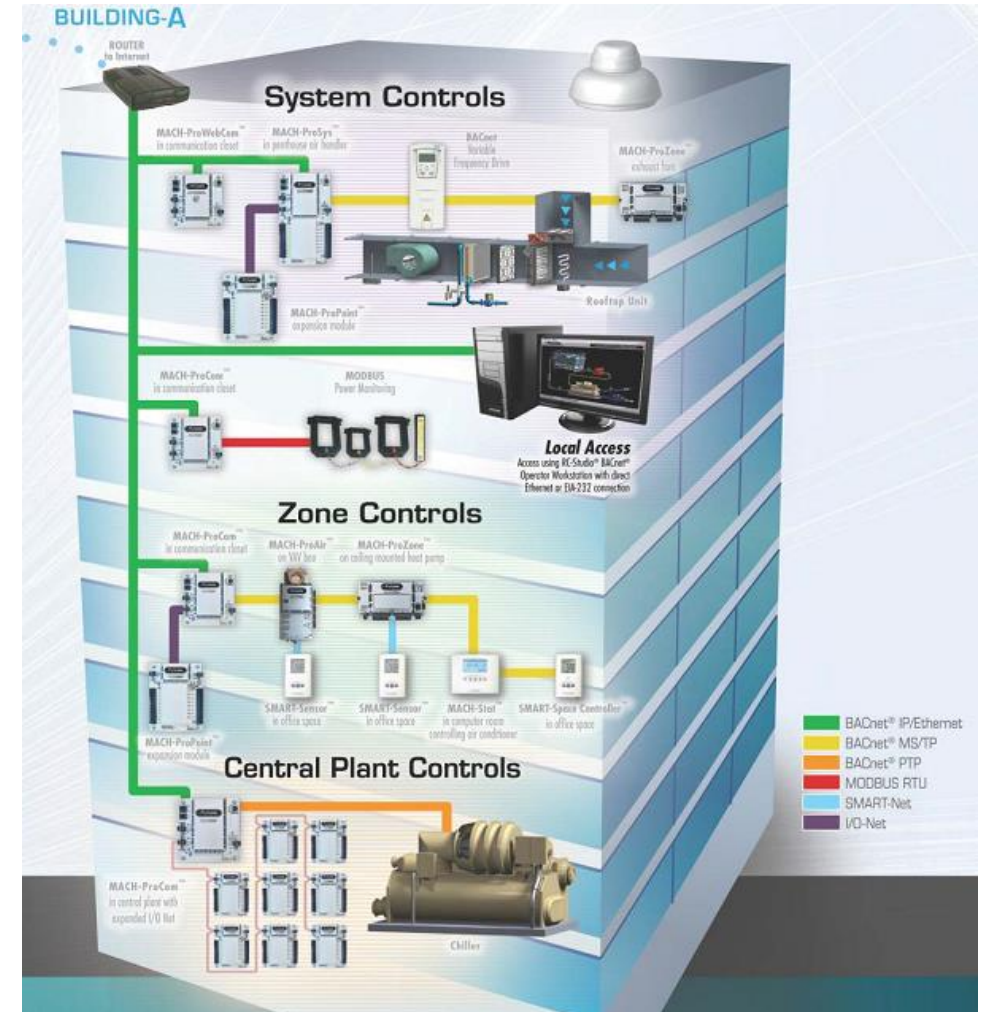
3C. HVAC System Selection

- System Selection Based on Needs and Locations
- Centralized and Decentralized Systems
- Different HVAC Distribution System



3D. Building Automation Controls

- HVAC Equipment Automation
- Smart Thermostats
- Better Control and Energy Efficiency
- Better Understand Your Facility's Energy Consumption
- Remote Access to HVAC Equipment
- Easy Troubleshooting as Trends Data Available
- Limits the Manpower Required



3E. Proper Training and Operation of HVAC System

Proper Training

- Where was training on HVAC systems completed?
- How long was the training?
- Was HVAC experience learned just from others?



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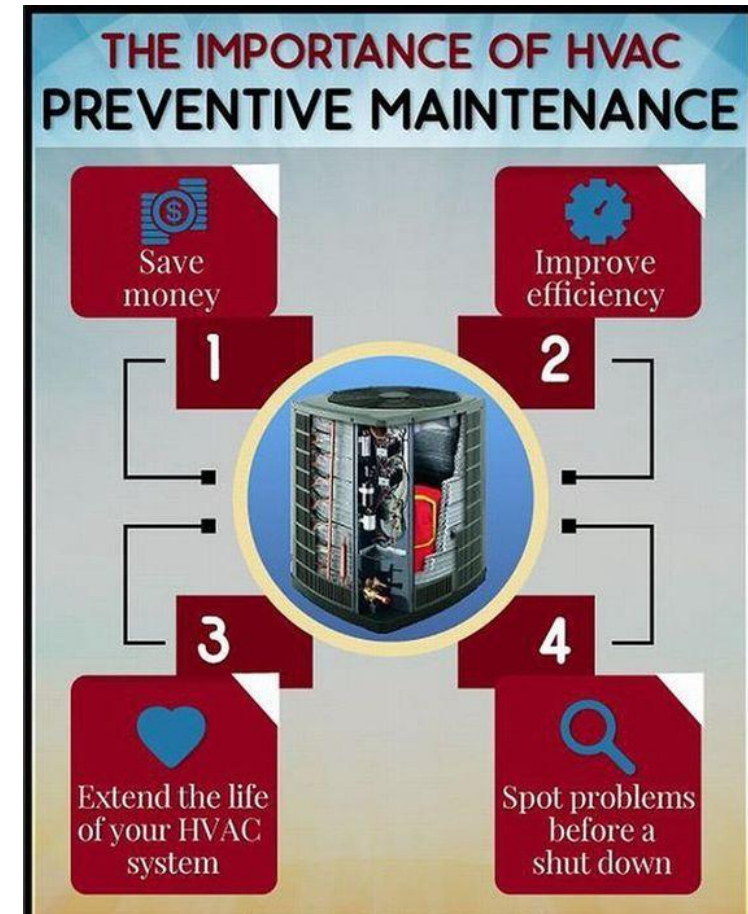
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3F. Preventive Maintenance of HVAC System

- Replacement of Air Filters
- Clean Heat Transfer Coils Including Condensers and Evaporators
- Inspect Ducts and Piping to Avoid Leakage and Damages.
- Inspect and Repair Air Ducts and Fan Motors.
- Inspect Dampers



4. Government Efforts

- Building and Energy Code Developments
- Minimum Efficiency Standards
- Comparative & Endorsement Labels
- Public Challenges and Awards
- Incentive Programs



5. Conclusions

- There are several systems to represent AC efficiency. Seasonal Energy Efficiency Ratio (SEER) is a more reliable rating system.
- AC system is one of the major cause of GHG emissions. AC Systems emit GHG gases directly in terms of refrigerant leaks and indirectly in terms of electricity consumption which is mostly generated by Coal Fired Power Plants
- To improve AC System efficiency we not only have to get the most efficient air conditioner available, but we also have to increase our building performance, implement Building Automation System or Smart Home System and we have to learn about the A/C System and we have to keep our AC System well maintained throughout the life cycle.
- Governments must have to do their part to minimize the GHG emissions by making policies and motivating people to develop and use high efficient AC System.

6. References

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THANKS !

Any Questions?

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