# Energy Saving in Residential Buildings by Using Heat Load Calculations

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**ABSTRACT**

*When it comes to sizing air conditioning appliances, cooling load measurements are important. It is essential to have the accurate value of cooling loads and seasonal cooling requirements of houses when developing energy-efficiency and clean energy-sources cooling systems for buildings. Accurate methods for measuring heat loads are important for equipment collection, system configuration, and system construction. The energy sources architecture for buildings becomes more efficient with the aid of reliable data on heating loads and seasonal heating demands. The current study emphasizes the relationship between heating load values and building insulation thermal properties; as a result, a mathematically adjusted method of measuring heating load values and seasonal heating demands of residential buildings is established. The latest findings are linked to ASHRAE guidelines are ventilation system design, it accepts all the indoor air quality, minimizes the ventilation rates, and minimizes all the adverse health effects from most of the occupants.*

**Keyword:** *HVAC System, ASHRAE, Residential Building*

## Introduction

The energy-saving has the commercial and the residential buildings. It will vary between 30-70% (Chen, Yang, Lee, Chi, 2016). India plans to implement energy efficiency. The building sector has the measures in the early stages. The potential of improvements has the use of data requires building energy efficiency. The energy is based on the influences of direct measurement and is seldom available around the data. The measures of energy efficiency are more rigorous. Electrical applications have one factor contributing to the use of variety in energy buildings' growth in recent decades. Residential has the intensity of energy defined as the use per square foot of living space. The use of electricity can be delivered to the sites of fuels and losses incurred in generating and transmitting the electricity.

Geography shifts the population (EX: The northeastern and the midwestern regions of the United States have more temperature.) In latter regions, the energy intensity tends to be lower and has the delivered energy basis. The commercial energy intensity is measured in energy use per square root, and the floor area can be declined. Commercial buildings have the energy intensity of the declined spite is 45%. In the year 2020, The electricity utility-scale generation of the United States has shown that 60% of the electricity is generated from fossil fuels such as coal, natural gas, and petroleum. Almost 20%of electricity is generated from nuclear energy and another 20% from renewable energy sources. Improvements have energy efficiency as the critical factor with the intensity of the building. The new applications have the efficiency standards of state and federal (Chen 2016). The benefits of energy efficiency have investments in buildings. The reduction of the energy has space heating. The reduced electricity has the use of lighting and the domestic type applications. Energy conservation in the building requires the saving of the energy of the building materials.

The construction of a building has the design and the improved performance of enhancing the efficiency of heating (Kaur, Chana, 2015). The reduction of the energy has the consumption of energy conservation and the thermal energy phase storage. There are effective ways and helps the company to manage energy to keep the cost down. Sound energy has the efficiency of reducing waste, and that costs your company money. Energy has organizations' performances, and they belong to the industry that belongs to the same industry. The energy

efficiency includes the sound plant energy management has the technologies—the environment strategy of reductions in GHG and the air pollutants.

The guide of energy has the measures of energy efficiency and has the commercial. There is specific consumption of energy that may vary widely among different plants (Colinet, Colinet, Román, Román, 2016). The save of the energy has the cost, and they can be boosted with sustainability. The energy efficiency has the analytics that has the additional savings. The costs related to the saving are based on the study of the data from the real world. The monthly energy bills use the data in the past 12-24 months. The wide range has energy measures and cost-saving measures. There is a benefit in saving the cost of the energy with the initial training stays. The gross energy consumption is correlated to the energy savings.

## Thermal behavior

The thermal behavior has the position of the absorbing pane influences. The saving has the quantity that can be tinted with the pane faces of indoor in the heating and outdoor season in the season of cooling. It has the solar filtering of the fact that is required in the summer. The penetration has the solar radiation and the solar heat behavior gain in the outdoor environment. They minimize the consumption of heating in the winter and have the use solar energy. The energy savings can be controlled by overheating, and that depends on the used systems and strategies. The savings of the energy can be connected to the use of potential. The commercial building wastes 30% of its energy is 30%. The thermostat can be set in the evenings, and the buildings are not occupied. The thermostats can be adjusted in the changes of seasons. The heating and the peak cooling season has the HVAC filters. The control of the sun directly through the windows has the local climate and depends on the season (Gao 2019).

During the cooling season, the heat block and the heat can be blocked from the sun and the glass on the east. The solar screens and the solar films have the facilities and the vegetation, and the awnings can be helped. 25% of energy can be required to air distributed (Colinet Carmona 2016). The savings of the water reduces the usage of water and the energy bills. The dozens of end-users as the use of energy in building embraces. The 32% of energy can be saving electricity in the median potential technology. The energy used is covered by energy codes. The significance of the lighting can be energy efficiency. The market ballasts have the electronics increased from 1% to more efficient.

The residents of the commercial buildings can save the energy process that can vary in between to implement the that are required for the potential for the sector that produces a large amount of the data to improve the building efficiency that can manage the data. The sites that can produce the efficiency of the measurement that is required for influence are available to cause the energy in one factor or another factor. It measures the stages of improvement if the data can seldom contribute to the building in different factors that have the intensity can be defined to deliver the fuel and can extend the space that is required for the application to transmit in the form of incurred electricity. America mainly uses the population that has efficiency for bais to deliver energy.

The floor has certainly required square feet for the intensity of the commercial that can be measured in the form of spite. The energy can increase the year accordingly for the improvement of the critical factor for the reduction of electrical light. To enhance the performance to enhance the resources can build the application material for the space heating. The conversation of the energy that causes the storage to perform the phase of thermal energy. The efficiency provides the way to keep the company in a management process that belongs to a different or similar industry. The enforced the technology that produced the cost of products. The measures are widely changing. The analysis for sustainability can emerge in between the data for saving the cost in a wide range. It can be initially defined for the cost that ranges a wide way. The energy can tolerate saving in correlations that cause efficiency. The influence of the position can be done in the behavior of the thermal that can cause the outdoor and indoor that can face pane situations. The heating can minimize the environment that is used mainly in the winter for using solar energy. The savings of the energy can be overhead that can be useful in the system for the potential needs of strategy.

The consumption of commercial buildings can be adjusted in the thermostatic because to have the filter in a cool process. The windows can control directly through the session of the climate for the use of references. It can be distributed in a large variety of formations. Solar energy will save electricity bills in the required manner. It causes the main advantage for it. The electronic can emerge as a code of efficient potential. The air conditioning can act as a humidity cause. This process is mostly used in domestic environments and used for the environment as a

commercial. Air-conditioning is mainly used indoors. The evaporation was sent outdoors. The room cools by using the air conditions. The air conditioning is an electronic device and preserves a lot of current rent. It is mainly used for power amplifiers. The device can be done in the way of referring to the thermal effect. It can be on the roof of buildings.

## HVAC technology

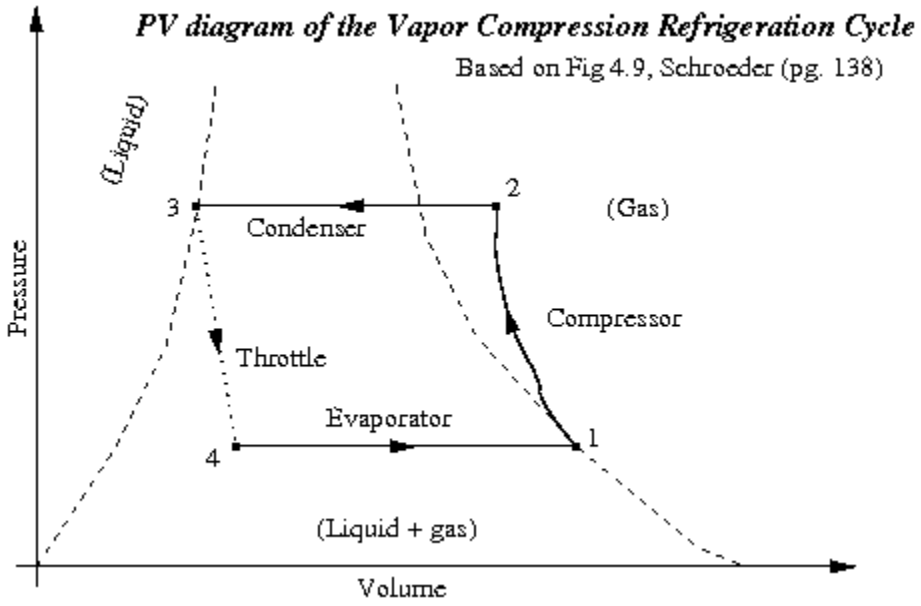


**Fig. 1. PV diagram of the Vapor Compression Refrigeration Cycle**

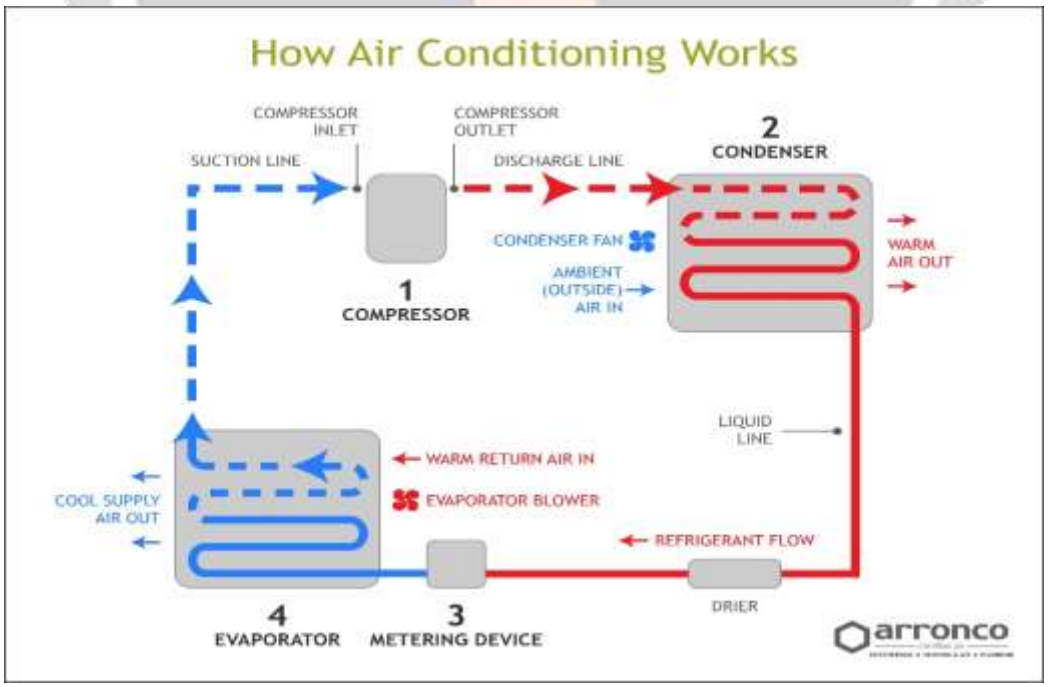


**Fig. 2. Basic concepts of how vapor compression cycle works**

### Refrigeration cycle

The flow of heat is the main idea about how an air conditioner operates. The air conditioner transfers heat from one part of the device to another. When heat is removed, cold is created, which is then pumped around your house and keep you comfortable. The device has many key Equipment's that must all work together to cool the air within your home for this process to occur.

### Compressor

The compressor is often referred to as the "heart" of an air conditioning system. To ensure that your air conditioner will thoroughly cool your house, it pumps refrigerant through the compressor. As a gas, refrigerant joins the compressor. The gas is compressed once within, raising its pressure and temperature. The gas ejected from the compressor is incredibly hot and pressurized.

### Condenser

The high, pressured gas passes through the condenser unit. To cool the refrigerant, by using a fan unit it pumps air over it, causing it to condense into a liquid and change state. All of this takes place in the system's outdoor unit.

### Metering device – decreasing the pressure

The liquid refrigerant goes through an expansion device on its way to the evaporator after exiting the condenser. The metering unit reflects the transition from high pressure liquid to low pressure liquid refrigerant.

### The Evaporator – changing the state again

The evaporator coil heats the refrigerant with hot air from the house until it boils and turns back into a vapor. The heat is absorbed by the refrigerant, which makes the air from around the evaporator coil cool. When the vapor has been properly heated, it is returned to the compressor, where the procedure begins again.

- HVAC systems – or Heating, Ventilating, and Air Conditioning systems - In our facilities, we must maintain environmental control for both people and equipment.
- They account for about 13% of the electrical energy use in a typical residential building; and about 20% in a typical commercial or institutional building. HVAC use in an office building might be as high as 30 – 50% (Gao, Wang, Liu, (2019).
- HVAC systems and chillers are also significant energy consumers in many manufacturing facilities.

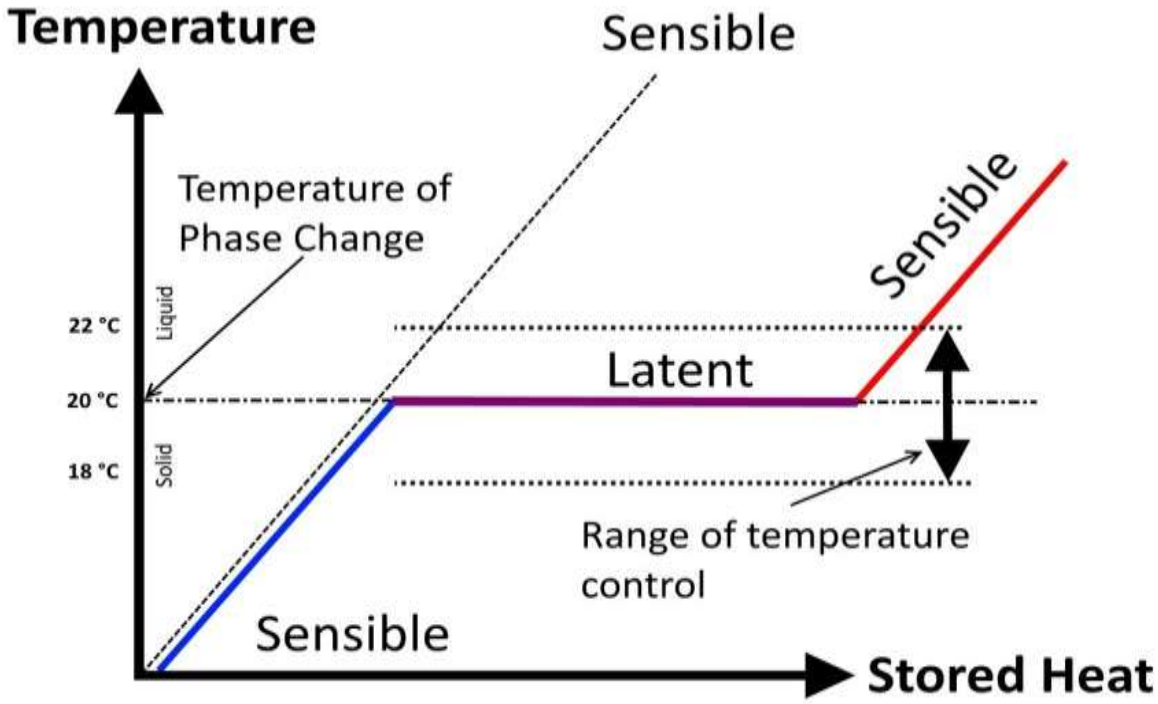


**Fig. 3. heat and temperature diagram**

**Sensible and Latent Heat**

- Sensible heat - The heat associated with a temperature change of a substance at a constant moisture level.
- Latent heat - The heat associated with the phase change of a substance.
- Enthalpy - Total heat content of a substance, including both sensible heats plus latent heat.

**Functions of HVAC Systems**

- The purpose of a Heating, Ventilating, and Air Conditioning (HVAC) system is to provide and maintain a comfortable and safe environment within a building for the occupants or the process being conducted.
- Many HVAC systems were not designed with energy efficiency as one of the design factors.

**Environmental Control Factors**

- An HVAC system functions to provide an environment in which these three factors are maintained within desired ranges. Typical design conditions are:
- 75 degrees F temperature (dry bulb)
- 40 - 60% relative humidity
- ASHRAE 62.1 – 2007/2010 Ventilation Standard –17 CFM outside air per person, or –CO2 less than 1000 PPM

**Temperature Control Strategies**

- Vary the temperature of the supply air to space while keeping the air flow rate constant. This is the constant volume, variable temperature approach.
- Vary the airflow rate while keeping the supply air temperature constant. This is the variable volume, constant temperature approach. VAV – variable air volume system.
- Vary the supply air temperature and the flow rate, as in a variable volume reheat system.

**Relative Humidity Control**

- Humidification - The air is too dry and water vapor must be added for comfort.
- Dehumidification - The air is too wet and water vapor must be removed for comfort.
- AC systems typically over-cool the air to remove water vapor, and then may have to heat the air back up - this is called reheat and requires additional energy.
- Either way, the energy required is around 1000 Btu per pound of water.

Power and Energy in Air Conditioning

- One ton of A/C = 12,000 Btu/hour

A ton is a measure of A/C power and is used when sizing systems, or when

determining electrical demand.

- One ton-hour of A/C = 12,000 Btu

A ton-hour is a measure of A/C energy and is used when sizing storage tanks for thermal energy storage (TES) systems, or when determining electrical energy consumption.

HVAC System Performance Measures

Energy Efficiency Ratio (EER)

EER = Btu of cooling output / Wh of electric input

= Btu/h of cooling output / W of electric power input

Coefficient of Performance (COP)

COP = Energy or heat output (total) / Energy or heat input (external only)

= EER / 3.412 Btu/Wh

Some Magic Numbers for EER and COP

EER = Btu/h of cooling output / Wh of electric power input COP

= EER /3.412 Btu/Wh

X kW/ Ton = 12 / EER

Heat Loss and Gain

- Heat is lost and gained through walls and ceilings.
- Consider a three-quarter-inch plywood wall.


**Fig. 4. Average heat loss and heat grain from the building envelope**

## Importance of load calculations

Over the past three decades, the performance of the applications and devices used in residential and commercial customers has dramatically improved. However, much could still be done to decrease the quantity and slow down energy use in residential and industrial buildings. The space heating and cooling loads define the amount of energy needed to maintain a comfortable temperature. To decide the best scale, application, and design of the HVAC system, the HVAC load calculation is indeed a mathematical method for measuring many aspects of a building. The goal is to guarantee energy efficiency while optimizing comfort within every home as well. For several years, load calculations have been performed, but modern technology offers faster and more reliable methods to complete this essential phase.

From AC length to the ductwork, every part of the device is told during the construction process of a home HVAC load measurement. Most builders, however, do not carry out actual load calculations; they merely use a thumb rule framework based on square footage (Lawrence, Thollander, Andrei, Karlsson, 2019). The heating load was its sum of heat energy required to be applied into a specific space to maintain the temperature within a reasonable range. To sustain the temperature within an acceptable range, the cooling load is the amount of heat energy required to be extracted from space. For an accurate estimate, since there is a range of variables that come into play. These considerations include insulation, construction materials, window numbers, door size and placement, equipment, appliances, how many people want to inhabit the building, and more.

In BTUs, heat load is calculated in (British thermal units). One BTU is around 1055 joules and is determined by the amount of energy needed for a single pound of liquid to be heated or cooled by one degree. The calculation formula for head load:

- Take the home's square footage (Kaur 2015).
- Multiply that in the home by the average ceiling height.
- It is multiplied by the ideal temperature difference and the outside temperature.
- A multiplier indicates that a sealed structure is the goal house.

The speed where a coding device or process must extract heat from a controlled zone to sustain it at a steady temperature and humidity of the dry bulb is the cooling load. It is possible to further evaporate the cooling load into latent and sensible cooling loads. To pick HVAC equipment with the necessary cooling potential to treat heat from the zone, the cooling load is computed. Usually, a zone is characterized as an area with typical heat gain, similar requirements for controlling temperature and humidity, or a small area within a building for monitoring and controlling humidity and temperature zones with a sensor node. The nature of cooling loads is based on the premise that periodic conditions are steady.

Thus, at a specific hour, the heat gain for a specific element is the same as 24 hours before, which is the same as 48 hours before. The heating load is determined after gathering all the cooling load components for each room (Reuter 2019). The engine calculates the zones' final block limits, levels, and construction until the individual

space levels, psychometrics, and equipment loads are all measured. It is essential to ensure that they install the furnace's correct size, air conditioner, water heater, or full HVAC system to provide the house with sufficient indoor comfort (Reuter, Patel, Eichhammer, 2019). It is also critical for energy savings, which can be wasted by a device that is either too big or too small. Since energy savings lead to monetary savings, when choosing the new HVAC equipment, they can disregard device size in today's economy. What occurs when the HVAC system has become too big or too small may occur when the heating or cooling system was its wrong size for the house. A correctly sized device that is correctly suited to the requirements of home heating or cooling provides the following advantages:

- This works at optimum efficiency, saving cash or energy expenses.
- It keeps the temperature indoors and the level of overall comfort more constant.
- It offers adequate humidity regulation, improves comfort, and decreases the risk of mold or mildew problems.

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