

Air Conditioner Selection for a Home in the Era of Energy, Economy, Technology & Comfort

Rajinder Singh

(B.Tech, M.Tech, P.G.D.B.M, M.B.A, MSc. , PhD*)

Research Scholar, Turiba University, Riga, Latvia

Productionme2008@gmail.com

Abstract

Air conditioner selection is vital for ensuring energy efficiency and cost savings in both homes and workplaces. An appropriately sized AC reduces electricity consumption, as an oversized unit wastes energy while an undersized one overworks, driving up bills. Opting for a higher-rated energy-efficient model, like a 5-star inverter AC, ensures long-term savings by consuming significantly less power. Additionally, efficient ACs minimize wear and tear, reducing maintenance costs and extending the unit's lifespan. Proper selection enhances cooling performance, ensuring comfort without overuse. It also reduces environmental impact by lowering carbon emissions and using eco-friendly refrigerants. Energy-efficient ACs lower monthly utility costs, making them a wise investment. Thoughtful selection prevents frequent breakdowns, saving on repair expenses. By choosing the right AC, you balance comfort, energy savings, and environmental responsibility.

Keywords

Split AC, Window AC, Power consumption, Noise level, Vibration level, EER, Star rating, Cooling capacity.

Introduction

Air Conditioning System

An air conditioning system is a system designed to control the temperature, humidity, and air quality within an indoor space. It provides comfort by cooling or heating air, removing excess humidity, and filtering airborne particles.



Basic Function

Cooling: The system removes heat from the indoor air and releases it outside.

Heating (for some systems): Reverses the cooling process to bring heat indoors.

Dehumidifying: Reduces moisture levels in the air to improve comfort.

Air Filtration: Removes dust, allergens, and pollutants from the air.

Cooling Cycle Overview

Air Intake: Warm air from the room is pulled into the system.

Heat Absorption: The refrigerant in the evaporator coil absorbs the heat.

Heat Release: The heat is expelled outside via the condenser coil.

Cooled Air Circulation: The blower sends the cooled air back into the room.

Types of Air Conditioning Systems

Central Air Conditioning: Cools an entire building using ductwork.

Split-System Air Conditioners: Consists of an indoor unit and an outdoor unit.

Window Units: Compact systems that fit into a window or wall opening.

Portable Air Conditioners: Freestanding units that can be moved from room to room.

Ductless Mini-Split Systems: Similar to split systems but without ductwork.

Calculations:

Cooling Capacity (Tonnage)

The capacity of an AC is measured in tons. It indicates the amount of heat an AC can remove in an hour. Selection depends on the size of the room:

Room Size (Sq. Ft.)	AC Capacity (Tons)
Up to 120 Sq. Ft.	0.8 – 1.0
120-180	1.0 – 1.5
180-250	1.5 – 2.0
250-400	2.0 – 2.5

Table No. 1

Table shows AC cooling capacity required against room size

Star Ratings (Energy Efficiency)

Star ratings (1 to 5 stars) are issued by the Bureau of Energy Efficiency (BEE) and indicate the energy efficiency of the AC:

5-Star AC: Highest efficiency, lower electricity bills.

3-Star AC: Moderate efficiency, balanced cost and performance.

1-Star AC: Low efficiency, less upfront cost but higher operating costs.

Power Consumption by Split AC Vs Window AC

Formula to Estimate Power Consumption:

Power Consumption (kWh) = AC Capacity (kW) × Usage Hours

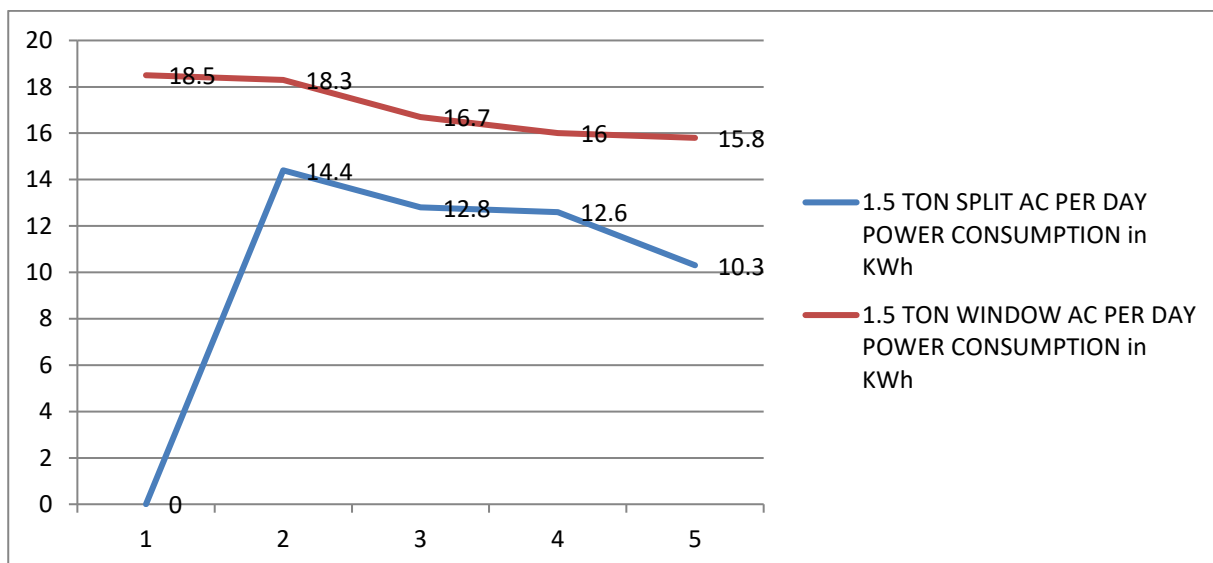
For example:

A 1.5-ton AC (1.5 kW) running for 10 hours: Power Consumption=1.5 kW×10 hours=15 kWh

STAR RATING	SPLIT AC PER HOUR POWER CONSUMPTION IN KWh	WINDOW AC PER HOUR POWER CONSUMPTION KWh	1.5 TON SPLIT AC PER DAY POWER CONSUMPTION in KWh	1.5 TON WINDOW AC PER DAY POWER CONSUMPTION in KWh
1	X	1.85	X	18.5
2	1.44	1.83	14.4	18.3
3	1.28	1.67	12.8	16.7
4	1.26	1.6	12.6	16
5	1.03	1.58	10.3	15.8
Assuming AC working 10 hours per day				

Table No. 2

Table shows power consumption by split AC Vs Window AC with different star ratings



Graph No: 1

Graph shows per day power consumption by window AC Vs Split AC values against star ratings

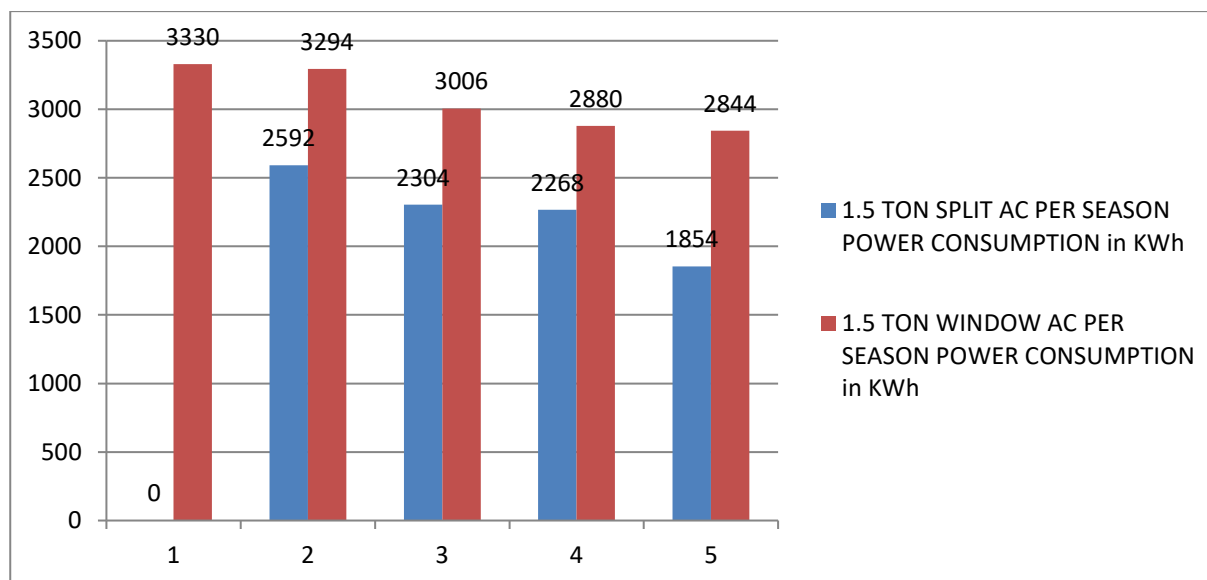
Power consumption in a season by Split & Window AC:

STAR RATING	SPLIT AC PER HOUR POWER CONSUMPTION IN KWh	WINDOW AC PER HOUR POWER CONSUMPTION KWh	1.5 TON SPLIT AC PER DAY POWER CONSUMPTION in KWh	1.5 TON WINDOW AC PER DAY POWER CONSUMPTION in KWh	1.5 TON SPLIT AC PER SEASON POWER CONSUMPTION in KWh	1.5 TON WINDOW AC PER SEASON POWER CONSUMPTION in KWh
1	X	1.85	X	18.5	X	3330
2	1.44	1.83	14.4	18.3	2592	3294
3	1.28	1.67	12.8	16.7	2304	3006
4	1.26	1.6	12.6	16	2268	2880
5	1.03	1.58	10.3	15.8	1854	2844

Assuming AC working 10 hours per day and run for 6 months in a season

Table: 3

Table shows the power consumption by Split AC & Window AC Vs Star ratings of AC



Graph No: 2

Graph shows between Star Rating & Power consumption
Seasonal power consumption in KWh in Split AC Vs Window AC

Noise Level Comparison between Split AC Vs Window AC

Five experiments are performed for finding the calculation of noise level in window AC and split AC used in a home. A calibrated Decibel meter is used for performing the experiment. The average of noise levels of those five experiments is presented in this research paper.

Split AC:

Noise Levels: Quieter operation.

The noisy components (compressor and condenser) are located outside the room in the outdoor unit. The indoor unit only contains the fan and evaporator, which are relatively quiet.

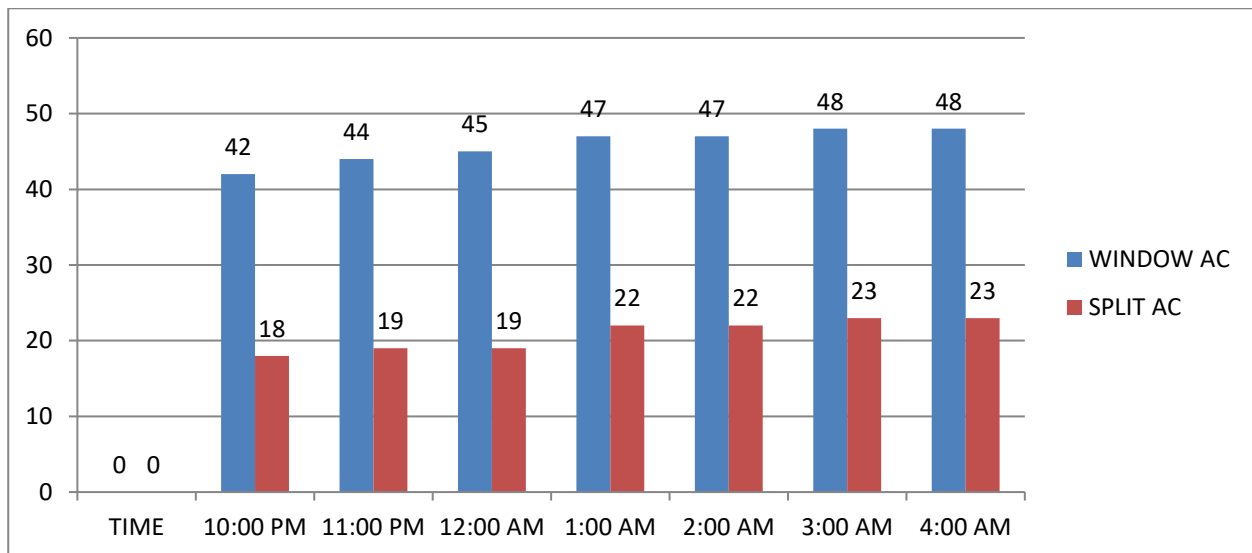
Noise Range: 18–23 dB indoors.

Window AC:

Noise Levels: Louder operation.

All the components (compressor, fan, condenser, and evaporator) are housed in a single unit installed in a window or wall. This creates more vibration and noise within the room.

Noise Range: 42–48 dB or more indoors.



Graph No:3

Graph shows the Noise Level comparison between Split AC Vs Window in a room in Db

Structural transmission of Vibrations level comparison between Split AC Vs Window AC

Split AC:

Vibrations are confined to the outdoor unit, which is typically mounted on a wall bracket or placed on the ground. Proper installation minimizes the transmission of vibrations to the building structure. The indoor unit does not produce significant vibrations, ensuring no disruption inside the room.

Window AC:

Vibrations are often transmitted to the window frame, walls, or mounting brackets, especially if the installation is not perfectly level or the frame is weak. Over time, continuous vibrations can lead to loosened screws, gaps, or rattling noises.

EER comparison of Split AC Vs Window AC

The Energy Efficiency Ratio (EER) is an important metric when comparing air conditioners, as it indicates the cooling efficiency of the unit. It is calculated as:

$$\text{EER} = \text{Cooling Capacity (in BTU/hr)} / \text{Power Consumption (in Watts)}$$

EER Range for 1.5-Ton Split AC

Higher EER Range: Split ACs generally have a higher EER compared to window ACs, especially inverter split ACs, which can adjust compressor speed based on cooling requirements. EER values for split ACs typically range between 3.5 to 5.5.

Technology Advantage:

Split ACs often use advanced technologies like inverter compressors, which improve efficiency.

Better cooling distribution reduces energy consumption over time.

1 ton = ~12,000 BTU/hour of cooling capacity.

A 1.5-ton split AC has a cooling capacity of 18,000 BTU/hour.

Star Rating	EER Range	Avg. EER	Approx. Power Consumption
5-Star (Inverter)	4.0 - 5.5	4.75	1,000W to 1,200W
4-Star (Inverter)	3.5 - 4.0	3.75	1,200W to 1,400W
3-Star (Non-Inverter)	2.8 - 3.5	3.15	1,400W to 1,700W

Table No: 4

Table shows EER range in Split AC & Power consumption in different star rating ACs

EER Range for 1.5-Ton Window AC

Moderate EER Range: Window ACs typically have EER values ranging between 2.8 to 3.5. These units are generally less efficient than split ACs due to their design and single-unit structure.

Limited Technology:

Most window ACs lack inverter technology, making them less efficient during prolonged or varying cooling demands.

The compact design makes it harder to incorporate advanced cooling and energy-saving mechanisms.

A 1.5-ton window AC has a cooling capacity of 18,000 BTU/hour (similar to split ACs).

Star Rating	EER Range	Avg. EER	Approx. Power Consumption
5-Star (Inverter)	3.0 – 3.3	3.15	1,300W to 1,500W
4-Star (Inverter)	2.8 - 3.0	2.90	1,500W to 1,600W
3-Star (Non-Inverter)	2.5 – 2.8	2.65	1,600W to 1,800W

Table No: 5

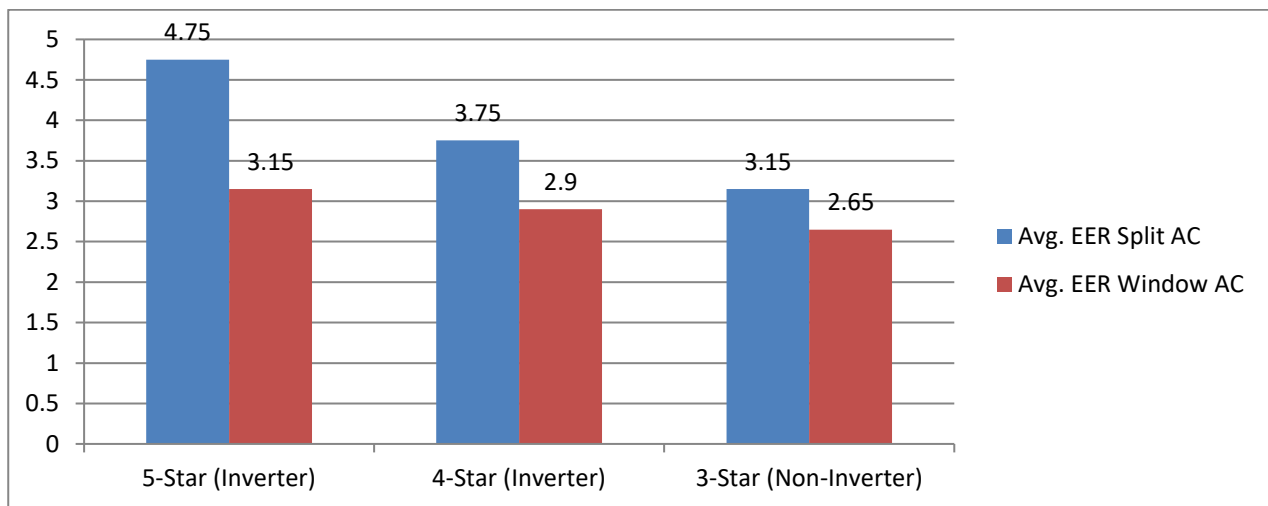
Table shows EER range in Window AC & Power consumption in different star rating ACs

EER Comparison:

Star Rating	Avg. EER Split AC	Avg. EER Window AC
5-Star (Inverter)	4.75	3.15
4-Star (Inverter)	3.75	2.90
3-Star (Non-Inverter)	3.15	2.65

Table No: 6

Table shows average EER in Split AC & Window AC in different star rating Acs



Graph No:4

Graph shows average EER in Split AC & Window AC in different star rating ACs

Factors affecting EER value in AC

Factor	Split AC	Window AC
Compressor Technology	Inverter compressors offer better energy efficiency.	Fixed-speed compressors are less efficient.
Heat Exchange	Larger outdoor units improve heat exchange.	Compact design limits heat exchange efficiency.
Cooling Distribution	More even cooling reduces energy usage over time.	Limited air throw and uneven cooling.
Installation Impact	Professional installation minimizes energy loss.	Improper sealing can reduce cooling efficiency.

Conclusion

Match the tonnage to room size.

Opt for 5-star rated AC for long-term energy savings.

Consider inverter technology for consistent use.

Ensure the AC has a suitable warranty and after-sales support.

Check for additional features like anti-bacterial filters, smart controls, and fast cooling modes.

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