



Preliminary Energy Audit Report of Air Conditioner

Amity University

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1. Introduction

The cBalance Solutions Hub conducted a preliminary energy audit of a Godrej Eon air conditioner which uses R 290 refrigerant and a window/Split air conditioner which uses conventional refrigerants such as R 22, R 34.

The overarching objective of the energy audit was:-

1. Determine the energy savings achieved through use of air conditioner using hydrocarbon refrigerant over air conditioner using conventional refrigerant.

2. Project Scope

The investigative scope of the project comprised a 2 day energy audit at the staff quarters of Amity University campus situated in Jaipur, Rajasthan. The appliances audited were a 1.5 TR Godrej Eon Split Air Conditioner and a 1.5 TR Videocon Window Air Conditioner.

3. Methodology

The equipments used in the study were:-

- 1) **MECO Power Guard:** - The MECO Power Guard was used to measure the electrical parameter of the individual air conditioner such as voltage, current, power (kW), power factor, energy (kWh).
- 2) **Infrared Digital Thermometer:** - Digital Thermometer was used to measure the temperature of the conditioned space and temperature outside the conditioned space.
- 3) **Measuring Tape:** - Measuring Tape was used to measure the dimensions of the rooms.

A data collection form was created to record the values of the electrical parameters, dimensions of the room and temperature.

Thermostats of both ACs were set at 22°C and the same Power Meter was used to conduct energy consumption studies on two consecutive days during the same corresponding time periods on both days. Weather conditions on both days were nearly identical as witnessed by the approximately equal outdoor ambient air temperature and humidity conditions on both days. Readings of electrical and temperature parameters were taken at intervals of 10 minutes over a 3 hour period.

Table 1 Data Collection Form

Sr.no		VARIABLE	VALUE	UNIT	REMARKS
1		Auditors Name			
2		Date			
3		Air Conditioner Type			
4		Star Rating			
5		Tonnage Of Air Conditioner		TR	
6		Brand of Air Conditioner			
13		Model Number Of Air Conditioner			
7		Refrigerant Used			
8		Area Of Windows		Sq. Ft	
9		Floor Number			
10		City			
11		Initial Room Temperature		°C	
12		Initial Outside Room Temperature		°C	
14	Dimensions Of Room	Length		Meter	
		Breadth		Meter	
		Height		Meter	
15	Time:	Voltage		Volts	
		Current		Ampere	
		Power		kW	
		Power Factor			
		Energy Consumed		kWh	
		Inside Room Temperature		°C	
		Outside Temperature		°C	
16	Time:	Voltage		Volts	
		Current		Ampere	
		Power		kW	
		Power Factor			
		Energy Consumed		kWh	
		Inside Room Temperature		°C	
		Outside Temperature		°C	
17	Time:	Voltage		Volts	
		Current		Ampere	
		Power		kW	
		Power Factor			
		Energy Consumed		kWh	
		Inside Room Temperature		°C	
		Outside Temperature		°C	

4. Air Conditioner Performance

4.1 Air Conditioner Characteristics

The details of air conditioners chosen for the study are:

Table 2 Air Conditioner Characteristics

AC Type	Company	Machine Model	Refrigerant	Rated TR	Rated EER ¹	Star Rating
Split Unit AC	Godrej EON	GSC 28 FG 7 WMG	R 290	1.5	3.70	5
Window AC	Videocon	VW5P2.WE1	R 22	1.5	2.58	2

The R22 Refrigerant based AC was chosen as the business-as-usual scenario for comparison against the R290 AC which represented the energy efficiency, low Total Equivalent Warming Impact (TEWI) intervention.

4.2 Air Conditioner Performance

The energy consumption of the Godrej Eon Air Conditioner and Videocon Window Air Conditioner was assessed through technical performance data collected from the MECO Power Guard meter. The resulting information related to energy consumption, power consumption and dimensions of the room are presented below.

The readings were taken at 10 minutes interval for over 3 hours. The results are as follows:-

Table 3 Air Conditioner Performance

Sr. No	AC Type	Operation Period (Hrs)	Energy Consumed (kWh)	Room Volume (m ³)	Efficiency Parameter (kWh/m ³ /hr)	Efficiency Parameter (kWh/hr/TR)
1	Split AC (R290)	3.18	4.53	32.21	0.044	0.94
2	Window AC (R22)	3.58	7.22	34.26	0.059	1.34

¹ Obtained from Technical Specifications of Godrej AC and Videocon AC

5. Results and Conclusion

A summary of the ambient, room (before, without AC) and conditioned-space temperatures is presented in the Table below.

Table 4 Summary of Ambient Temperature, Room(without AC) Temperature and Conditioned Space Temperature

Date	AC Type		Ambient Outside Temperature	Room Temperature (Without AC)	Conditioned Spaced Temperature
29/5/2013	Split AC	Minimum	42.5	29.60	22.43
		Median	44.90	30.20	23.53
		Maximum	45.3	31.10	25.65
30/5/2013	Window AC	Minimum	42.40	30.30	22.63
		Median	44	31.20	23.20
		Maximum	44.30	31.50	25.03

As indicated in the above table, the cooling effect (considered to be proportional to the difference in 'before' and 'after' indoor room temperatures) provided by both ACs was similar. Furthermore, the shading/insulation effect of the building envelope contributed equally in the case of both conditioned spaces; the temperature difference between the ambient outdoor temperature and indoor room temperature prior to start of the studies was 15 °C in the case of the R290 AC and 11 °C for the R22 AC space.

Upon commencement and stabilization of AC performance, the R290 EON Split Unit AC provided approximately 7 degrees of cooling provided to 32.21 m³ of cooled space, while the R22 Window AC provided approximately 8 degrees of cooling provided to 34.26 m³.

The raw data was normalized for conditioned space volume and hours of AC operation. Since the cooling effect was approximately equal, normalization for that parameter was not considered necessary.

The result of the energy audit study demonstrated that Godrej Eon Air Conditioner with **R 290** refrigerant consumes approximately **25%** less energy than a Videocon BEE 2-Star Rated Window Air Conditioner with **R 22** refrigerant when compared on a kWh/m³ of conditioned space/hr basis This comparison is in alignment with the theoretical efficiencies of a EER 2.58 rated AC vs. a 3.7 EER

rated AC; a 3.7 EER rated AC would consume approximately 30 % lesser energy than a 2.5 EER rated AC.²

Table 5 Energy, Cost and GHG Emissions Conservation Summary

Sr. No.	Parameter	Baseline	Intervention
1	Air Conditioner	2 Star Window AC(R 22)	5 Star Split AC (R 290)
2	Annual Energy Consumption (kWh/year/TR)³	4,840	3,419
3	Annual Conservation Potential (kWh/TR)	NA	1,421
4	Annual Cost Savings(INR/TR)	NA	13,972
5	Annual GHG Mitigation Potential (tons CO₂e/TR)⁴	NA	1.72

In Summary:-

- The annual energy conservation potential will be 1,421 kWh/TR
- The annual cost savings will be 13,972 INR/TR
- The annual GHG mitigation potential will be 1.72 tons CO₂e/TR

² Energy consumption of a AC is inversely proportional to EER. Hence, since (1/3.7) is approximately 30.3% lower than (1/2.58), the anticipated energy savings are estimated to be 30%

³ Assuming 3600 hours of operations per year

⁴ The above GHG assessment is based on a Rajasthan-specific GHG Emission Factor of 1.21 kg CO₂e/kWh for 2010-2011 for grid electricity. This accounts for the state-specific fuel mix, India-specific Net Calorific Values (NCVs) for coal as well as the Load Generation Balance data and statistics of inter-state energy transfer provided by the Central Electrical Authority (CEA) of India.

APPENDIX

Table 6 Split AC (5 Star) Data

Sr.no		VARIABLE	VALUE	UNIT
1		Auditors Name	Nimit Khungar	
2		Date	29-05-2013	
3		Air Conditioner Type	EON AC	
4		Star Rating	5	
5		Tonnage Of Air Conditioner	1.5	TR
6		Brand of Air Conditioner	Godrej	
13		Model Number Of Air Conditioner	GSC 28 FG 7 WMG	
7		Refrigerant Used	R 290	
8		Area Of Windows		Sq. Ft
9		Floor Number	2	
10		City	Jaipur	
11		Initial Room Temperature	31.10	°C
			29.60	°C
			29.80	°C
			30.60	°C
12		Initial Outside Room Temperature	45.3	°C
14	Dimensions Of Room	Length	11	Feet
		Breadth	11	Feet
		Height	9.4	Feet
15	Time:14:34	Voltage	240	Volts
		Current	4.067	Ampere
		Power	1.455	kW
		Power Factor	0.98	
		Energy Consumed	2.71	kWh
		Inside Room Temperature	30.28	°C
		Outside Temperature	45.30	°C
16	Time:14:44	Voltage	232.6	Volts
		Current	6.656	Ampere
		Power	1.488	kW
		Power Factor	0.98	
		Energy Consumed	2.95	kWh
		Inside Room Temperature	27.43	°C
		Outside Temperature	45.30	°C
17	Time:14:54	Voltage	235.24	Volts
		Current	6.473	Ampere
		Power	1.485	kW
		Power Factor	0.98	
		Energy Consumed	3.17	kWh
		Inside Room Temperature	26.68	°C
		Outside Temperature	45.3	°C

18	Time:15:10	Voltage	231.00	Volts
		Current	6.52	Ampere
		Power	1.49	kW
		Power Factor	0.98	
		Energy Consumed	3.60	kWh
		Inside Room Temperature	25.80	°C
		Outside Temperature	45.30	°C

19	Time:15:20	Voltage	230.00	Volts
		Current	6.62	Ampere
		Power	1.49	kW
		Power Factor	0.98	
		Energy Consumed	3.83	kWh
		Inside Room Temperature	25.3	°C
		Outside Temperature	45.3	°C

20	Time:15:30	Voltage	232.00	Volts
		Current	6.56	Ampere
		Power	1.48	kW
		Power Factor	0.98	
		Energy Consumed	4.09	kWh
		Inside Room Temperature	25.43	°C
		Outside Temperature	45.3	°C

21	Time:15:40	Voltage	228.00	Volts
		Current	6.63	Ampere
		Power	1.48	kW
		Power Factor	0.98	
		Energy Consumed	4.34	kWh
		Inside Room Temperature	25.65	°C
		Outside Temperature	44.9	°C

22	Time:15:50	Voltage	226.00	Volts
		Current	6.71	Ampere
		Power	1.48	kW
		Power Factor	0.98	
		Energy Consumed	4.58	kWh
		Inside Room Temperature	25.13	°C
		Outside Temperature	44.9	°C

23	Time:16:05	Voltage	238.00	Volts
		Current	6.42	Ampere
		Power	1.48	kW
		Power Factor	0.98	
		Energy Consumed	4.97	kWh
		Inside Room Temperature	24.68	°C
		Outside Temperature	44.9	°C

24	Time:16:15	Voltage	237.00	Volts
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		Current	6.42	Ampere
		Power	1.48	kW
		Power Factor	0.98	
		Energy Consumed	5.20	kWh
		Inside Room Temperature	24.23	°C
		Outside Temperature	44.9	°C

25	Time:16:25	Voltage	238.90	Volts
		Current	6.35	Ampere
		Power	1.48	kW
		Power Factor	0.98	
		Energy Consumed	5.41	kWh
		Inside Room Temperature	24.15	°C
		Outside Temperature	44.9	°C

26	Time:16:35	Voltage	233.00	Volts
		Current	6.45	Ampere
		Power	1.48	kW
		Power Factor	0.98	
		Energy Consumed	5.68	kWh
		Inside Room Temperature	23.40	°C
		Outside Temperature	42.5	°C

27	Time:16:45	Voltage	232	Volts
		Current	6.497	Ampere
		Power	1.468	kW
		Power Factor	0.98	
		Energy Consumed	5.98	kWh
		Inside Room Temperature	23.53	°C
		Outside Temperature	42.5	°C

28	Time:16:55	Voltage	238.00	Volts
		Current	6.31	Ampere
		Power	1.47	kW
		Power Factor	0.98	
		Energy Consumed	6.19	kWh
		Inside Room Temperature	23.5	°C
		Outside Temperature	42.5	°C

29	Time:17:05	Voltage	246.00	Volts
		Current	6.20	Ampere
		Power	1.48	kW
		Power Factor	0.98	
		Energy Consumed	6.37	kWh
		Inside Room Temperature	23.28	°C
		Outside Temperature	42.5	°C

30	Time:17:15	Voltage	250	Volts
		Current	6.11	Ampere

		Power	1.48	kW
		Power Factor	0.97	
		Energy Consumed	6.56	kWh
		Inside Room Temperature	23.18	°C
		Outside Temperature	42.5	°C

31	Time:17:25	Voltage	251.00	Volts
		Current	6.10	Ampere
		Power	1.48	kW
		Power Factor	0.97	
		Energy Consumed	6.84	kWh
		Inside Room Temperature	22.80	°C
		Outside Temperature	42.5	°C

32	Time:17:35	Voltage	253.50	Volts
		Current	6.06	Ampere
		Power	1.47	kW
		Power Factor	0.96	
		Energy Consumed	7.01	kWh
		Inside Room Temperature	22.50	°C
		Outside Temperature	42.5	°C

33	Time:17:45	Voltage	256	Volts
		Current	6.04	Ampere
		Power	1.48	kW
		Power Factor	0.964	
		Energy Consumed	7.24	kWh
		Inside Room Temperature	22.43	°C
		Outside Temperature	42.5	°C

Table 7 Window AC (2 Star) Data

Sr.no	VARIABLE	VALUE	UNIT
1	Auditors Name	Nimit Khungar	
2	Date	30-05-2013	
3	Air Conditioner Type	Window AC	
4	Star Rating	2	
5	Tonnage Of Air Conditioner	1.5	TR
6	Brand of Air Conditioner	Videocon	
13	Model Number Of Air Conditioner	VW5P2.WE1	
7	Refrigerant Used	R 22	
8	Area Of Windows		Sq. Ft
9	Floor Number	0	
10	City	Jaipur	
11	Initial Room Temperature	32.10	°C
		32.30	°C
		32.50	°C
		32.00	°C

12		Initial Outside Room Temperature	43.5	°C
14	Dimensions Of Room	Length	11	Feet
		Breadth	11	Feet
		Height	10	Feet
15	Time:12:25	Voltage	227	Volts
		Current	9.763	Ampere
		Power	2.141	kW
		Power Factor	0.971	
		Energy Consumed	7.48	kWh
		Inside Room Temperature	26.48	°C
		Outside Temperature	42.40	°C
16	Time:12:35	Voltage	227	Volts
		Current	9.735	Ampere
		Power	2.153	kW
		Power Factor	0.97	
		Energy Consumed	7.81	kWh
		Inside Room Temperature	25.28	°C
		Outside Temperature	42.40	°C
17	Time:12:50	Voltage	182	Volts
		Current	12.017	Ampere
		Power	2.12	kW
		Power Factor	0.97	
		Energy Consumed	8.29	kWh
		Inside Room Temperature	24.88	°C
		Outside Temperature	42.4	°C
18	Time:13:05	Voltage	228.00	Volts
		Current	9.64	Ampere
		Power	2.11	kW
		Power Factor	0.98	
		Energy Consumed	8.64	kWh
		Inside Room Temperature	25.03	°C
		Outside Temperature	42.40	°C
19	Time:13:15	Voltage	228.00	Volts
		Current	9.86	Ampere
		Power	2.19	kW
		Power Factor	0.98	
		Energy Consumed	9.00	kWh
		Inside Room Temperature	24.45	°C
		Outside Temperature	42.5	°C
20	Time:13:25	Voltage	208.00	Volts
		Current	11.09	Ampere
		Power	2.19	kW

		Power Factor	0.98	
		Energy Consumed	9.27	kWh
		Inside Room Temperature	24.7	°C
		Outside Temperature	44.3	°C
21	Time:13:35	Voltage	201.00	Volts
		Current	10.88	Ampere
		Power	2.14	kW
		Power Factor	0.98	
		Energy Consumed	9.60	kWh
		Inside Room Temperature	23.65	°C
		Outside Temperature	44.3	°C
22	Time:13:45	Voltage	198.00	Volts
		Current	11.08	Ampere
		Power	2.17	kW
		Power Factor	0.98	
		Energy Consumed	10.10	kWh
		Inside Room Temperature	23.40	°C
		Outside Temperature	44.3	°C
23	Time:13:55	Voltage	197.00	Volts
		Current	10.81	Ampere
		Power	2.11	kW
		Power Factor	0.98	
		Energy Consumed	10.32	kWh
		Inside Room Temperature	22.95	°C
		Outside Temperature	44.3	°C
24	Time:14:05	Voltage	199.00	Volts
		Current	10.69	Ampere
		Power	2.11	kW
		Power Factor	0.98	
		Energy Consumed	10.70	kWh
		Inside Room Temperature	23.15	°C
		Outside Temperature	44.3	°C
25	Time:14:30	Voltage	202.00	Volts
		Current	10.55	Ampere
		Power	2.07	kW
		Power Factor	0.98	
		Energy Consumed	11.57	kWh
		Inside Room Temperature	23.075	°C
		Outside Temperature	44	°C
26	Time:14:50	Voltage	204.00	Volts
		Current	10.66	Ampere
		Power	2.02	kW
		Power Factor	0.98	

		Energy Consumed	11.89	kWh
		Inside Room Temperature	23.35	°C
		Outside Temperature	44	°C

27	Time:15:00	Voltage	212	Volts
		Current	10.15	Ampere
		Power	2.076	kW
		Power Factor	0.98	
		Energy Consumed	12.27	kWh
		Inside Room Temperature	23.33	°C
		Outside Temperature	44	°C

28	Time:15:10	Voltage	207.00	Volts
		Current	12.10	Ampere
		Power	2.10	kW
		Power Factor	0.98	
		Energy Consumed	12.57	kWh
		Inside Room Temperature	23.175	°C
		Outside Temperature	44	°C

29	Time:15:20	Voltage	208.00	Volts
		Current	10.67	Ampere
		Power	2.13	kW
		Power Factor	0.98	
		Energy Consumed	12.94	kWh
		Inside Room Temperature	23.35	°C
		Outside Temperature	44	°C

30	Time:15:30	Voltage	201	Volts
		Current	10.71	Ampere
		Power	2.10	kW
		Power Factor	0.98	
		Energy Consumed	13.36	kWh
		Inside Room Temperature	22.75	°C
		Outside Temperature	44	°C

31	Time:15:40	Voltage	200.00	Volts
		Current	10.74	Ampere
		Power	2.09	kW
		Power Factor	0.98	
		Energy Consumed	13.68	kWh
		Inside Room Temperature	22.625	°C
		Outside Temperature	43.2	°C

32	Time:15:50	Voltage	202.00	Volts
		Current	10.56	Ampere
		Power	2.09	kW
		Power Factor	0.98	
		Energy Consumed	14.01	kWh

		Inside Room Temperature	22.9	°C
		Outside Temperature	43.2	°C

32	Time:16:00	Voltage	198	Volts
		Current	10.59	Ampere
		Power	2.065	kW
		Power Factor	0.979	
		Energy Consumed	14.47	kWh
		Inside Room Temperature	22.73	°C
		Outside Temperature	43.2	°C