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Reducing Energy Costs and Environmental impacts through Optimal Control of Air Conditioners

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Abstract - *Air conditioning is one of the common technology to use everywhere in domestic levels. The most common air conditioning technologies are in the form of window and split air conditioning systems. If they are not used in proper way, they consume more energy and leads to high electricity bills.*

For the purpose of reducing the room air-conditioners energy consumption, an energy saving regulator scheme is anticipated. In this project an energy saving analysis has been studied through experiments by considering room conditions, it's placing and other technical parameters by using RETScreen software simulation for Environmental pollution and Energy efficiency performance by using BE opt 6.0 tool.

Key Words: HVAC, Simulation, Thermal Comfort, RETSCREEN, Green buildings

1. INTRODUCTION

Air conditioning is the development of shifting the properties of air (predominantly temperature and humidity) to supplementary satisfactory conditions, typically with the aim of distributing the inured air to an working space to progress thermal comfort and indoor air quality. In common use, an air conditioner is a stratagem that lowers the air temperature. The cooling is stereotypically achieved through a refrigeration cycle, but sometimes desertion or free cooling is castoff.

2. Case study reports

Total no. of Air conditioners in GIET campus in block wise has indicated in below table

Table 1: Location of AC's in GIET campus

Location	No. of AC's
CSE Block	26
MBA Block	8
ECE&EIE Block	4
EEE&EE Block	8
Library Block	26
BSH Block	6
BTB Block	3
ADMIN Block	30
MECH Block	15
CIVIL Block	5
Guest Houses	27
Staff Quartets	5
SBI & ATM	4
GPS	1
Total	**168**

According to the survey; following AC's are identified and categorized according to 3 star label and without star label.

Table 2: Total Air conditioners in GIET campus with their size and Star rating

Configuration of ACs	Quantity	Wattage	Approximate operating hours in a Year 3 months@6hrs per day	Total No, of units
1 Ton Split AC (3 Star)	01	1600 W	540	864
1.5 ton Split AC (3 Star)	54	2100 W	540	61236
1.5 ton Window AC (Without Star Rating)	109	2300 W	540	135378
2 Ton Split AC	4	2800 W	540	6048
	168	**Total consumption of AC load**		**203526 units**

According to BEE star labeling and up gradation of the technology in ACs the energy consumption of is decreasing rapidly to around 20 to 30 %. By implementing Insulation, Thermostat settings and room sealing the consumption can still to be decreased to 10 %.

Yearly wise BEE star rating performance enhancement:

	EER (W/W)	
Star Rating	**Min**	**Max**
1 Star *	2.50	2.69
2 Star **	2.70	2.89
3 Star ***	2.90	3.09
4 Star ****	3.10	3.29
5 Star *****	3.30	

Star Rating Band Valid from 01 JAN 2010

	EER (W/W)	
Star Rating	Min	Max
1 Star *	2.70	2.89
2 Star **	2.90	3.09
3 Star ***	3.10	3.29
4 Star ****	3.30	3.49
5 Star *****	3.50	

Star Rating Band Valid from 01 JAN 2010 to 31 December 2014

3. Technical and economical analysis

Below table will highlight the savings in AC's by considering EER and star ratings. Before to analyze technical and economical features of AC's the following parameters are important to calculate the savings.

1. Star Rating: The sum of stars presented on the energy label. The existing stars are between a lowest of one and a extreme of five shown in one star pause. The star rating is premeditated from the Star Rating Band

2. Star Rating Band: The Star Rating Band is a assortment of energy efficiency ratio (W/W) which is here by calculations, and is cast-off for influential the sum of stars displayed on the energy label.

3. Family of models: Family of models is the series of models of solitary particular brand, to which a lone set of test reports is pertinent and where every one of the models has the equivalent relevant physical characteristics, comparative energy intake, and energy efficiency rating and concert characteristics. The term 'model' is tantamount with 'family of models'.

Table 3: Specification of AC's with and without star rating with power consumption

Specifications	Action to be taken	No. of units can be saved	Total savings in INR
Replacing non star rated AC s with 3 star rated ACs	110 Ac's to be replaced @ 2200 W to 1580 W	110 × 540 × 620 = 36, 828 units @ 10 Rs (By considering Diesel)	3,68,280 INR
Old 3 star rated ACs with New 3 Star Rated Ac's	30 Ac's to be replaced @ 2000 W to 1580 W	30 × 540 × 420 = 6804 units @ 10 Rs (By considering Diesel)	68,040 INR
Proper maintenance of thermostat Settings @ 5 % savings are possible	Motivating the concerned persons to put thermostat settings at 24^{0}C	**203526 @ 5 %** **10176 units** @ 10 Rs	1,01,760 INR
By using door closers and preventing air leakage at door and windows@ 5 % savings are possible	concerned authorities to be instructed	**203526 @ 5 %** **10176 units** @ 10 Rs	1,01,760 INR
Total savings			6,39,840 INR

Table 4: Pay back calculations

Total cost of the replacing Acs	140 × 26, 000 INR = 36,40,000
Cost of Old AC's with buyback option	140 × 8, 000 INR = 11,20,000
Total Investment	25,20,000 INR
Payback Period	3 years and 9 months

4: SIMULATION RESULTS

4.1 Introduction

Designing of Cooling and air conditioning systems involves many key parameters. A badly sized or estimated capacity of Air conditioning system causes to produce more electricity bills.

Manually calculated results are available in chapter 3. But, manual calculations will not give accurate results. An analysis has been given in Air conditioners case taken for simulation and analyzed with RETScreen software.

4.2 Staring procedure

An analysis has been considered for GIET campus situated in Gunupur; Odisha with latitude of 19.2^0 and longitude of 83.49^0.

Step 1: Starting worksheet

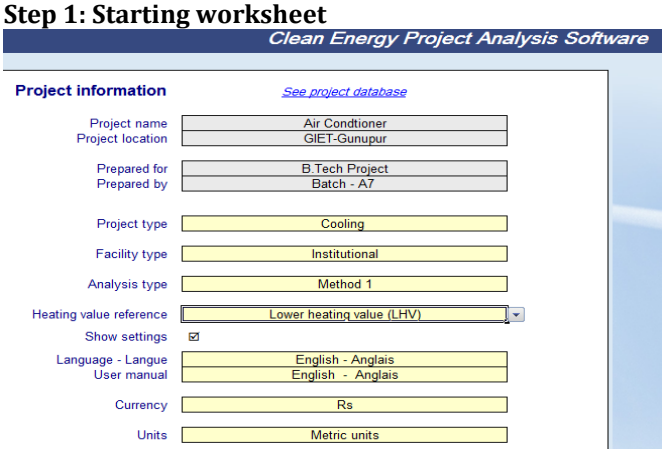

Fig.4.1 preparatory worksheet of Software

The project type to be particular Cooling, this is of organized facility type and the investigation method is painstaking as method 1. The Cooling value position is well-thought-out as LHV. This is of Universal wide software later we can get the exchange what we required. Here exchange to

be chosen as INR. The climatic data settings are obtained for this location which is included in Site situation conditions.

Step 2: For selecting climate location:

To access the RETScreen Climate Database click on the "Select climate data location" hyperlink or use the RETScreen menu or toolbar.

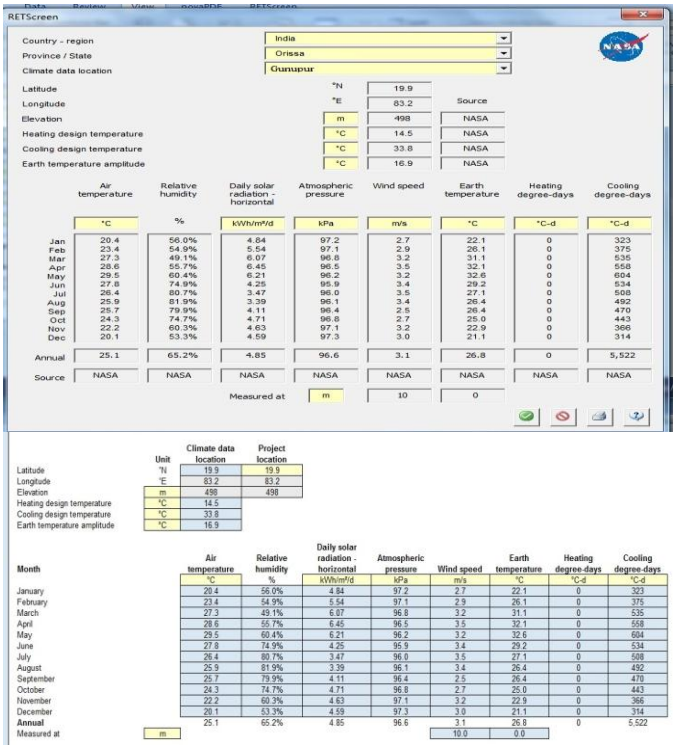

Fig.4.2: Gunupur Climate data sheet

Fig. 4.2 is the leeway of first window which show the data of climatic settings of the considered location. While the latitude and longitude values are irritable the threshold, the ethics of Air temperature, Relative humidity, Diurnal radiation-horizontal, Atmospheric, wind speed, Earth temperature, Heating Degree livings, Cooling degree times are found for monthly basis. The data gained is only for reference resolve not to run the model.

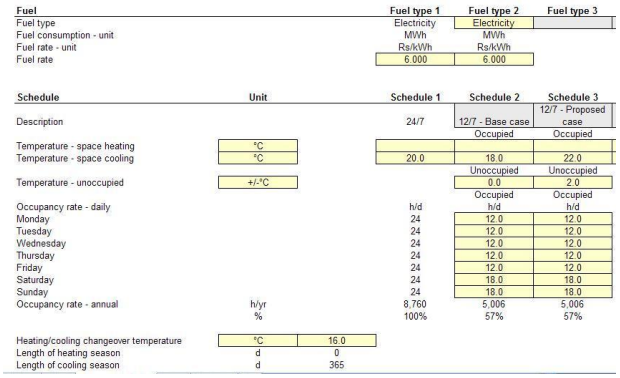

Fig.4.3: Energy model worksheet

The fuel type is of Electricity at a unit rate of 6.00 Rs/Kwh. The scheduled working days are of 24 days on an average for a month. The base case and proposed cases have working hours of 12 per a day. Therefore, out of 100%, 57 % occupancy is utilized. The climatic conditions are always hotter as described in the previous worksheet; hence the cooling temperatures are required for 365 days.

Step 3: Facility characteristics

In this section, enter the information about the facility features, for the base situation and the planned case facilities. The manipulator clicks on the blue hyperlinks (e.g. Heating arrangement, Cooling arrangement, Building covering, ventilation, lighting etc.) to entree the data entry forms castoff to pronounce the competence. In accumulation, the key results of the typical are displayed in this section (e.g. fuel saved, unassuming payback, etc.).

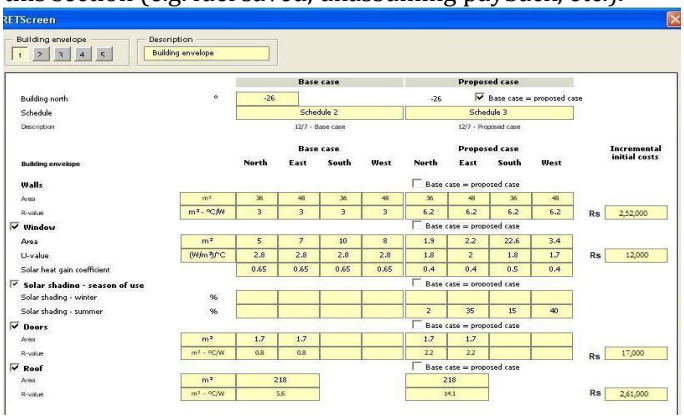

Fig.4.4: Facility Characteristics of Building

In this analysis the electrical equipment's like fans, tube lights besides computer are reserved. Intended for these equipments the base case and proposed case are considered.

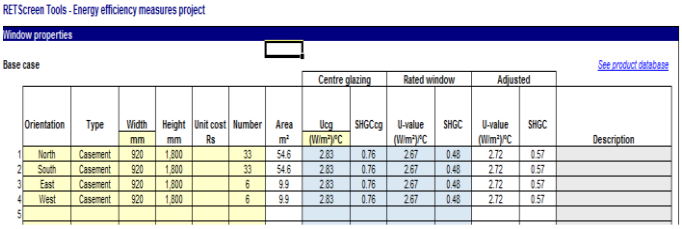

Fig. 4.5: Window dimensions & materials tools

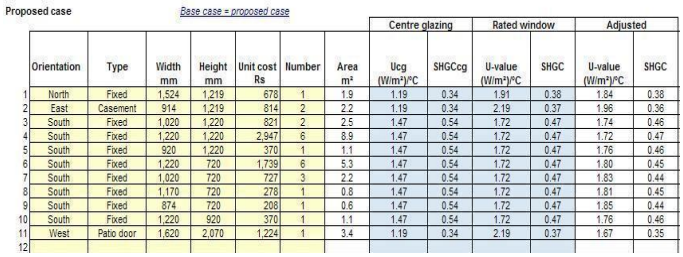

Fig. 4.6 : Comparison of windows with base case and proposed case

Windows belongings are painstaking as tools and nearby total number of windows in a building are contemplate in all commands with the dimensions in equally base case and wished-for case and U-value is calculated for all direction as per area of every single window.

The results gained by spending RETSCREEN software It be able to be very authentic and gives very auspicious results for Energy Efficient Buildings.

The building simulation grades, found that how several parameters in energy dependence can be diminished by step by step and to finish gives the reduction in energy needs. However, as the contemplation of equipments was done optimistically for the desired edifice load and net profits will be higher than the domino effect in simulation by considering carbon credits and aids from government officialdoms.

Step 3: Energy Model

RETScreen Energy Model - Cooling project

Cooling project

		Base case	Proposed case
Cooled floor area for building	m²	40	
Energy efficiency measures			
Cooling load for building	W/m²	40	
Non-weather dependant cooling	%	0%	
Total cooling	MWh	10	
Base load cooling system			
Technology		Reciprocating	Co
Capacity	kW	1.6	
Cooling delivered	MWh	10.2	
Fuel type		Electricity	El
Coefficient of performance - seasonal		3.50	
Fuel consumption - annual	MWh	3	2 MWh
Fuel rate	Rs/kWh	6.000	6.000 Rs/kWh
Fuel cost	Rs	17,403	12,182

Fig.4.7: Energy model worksheet

The fuel nature is of Electricity at a unit rate of 6.00 Rs/Kwh. The scheduled salaried days are of 24 days on an usual for a month.

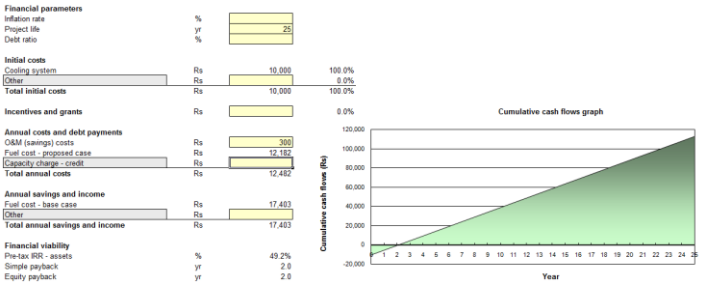

Fig.4.8: Payback analysis

From fig. 4.7 and 4.8 the remuneration analysis has been scrutinized and without bearing in mind and debt/loan. The payback period is 2 years only by since COP for base case 3.5 to proposed case 5.0

4.3: Environmental analysis:

R22 or HCFC-22 is a lone component HCFC refrigerant with low ozone diminution potential. It has extensive been used in a variability of air-conditioning and refrigeration submissions in a variation of markets, together with appliance, construction, food processing, and also supermarkets. Making of R-11, R-22 frozen in many countries

The idyllic refrigerant would partake favorable thermodynamic properties, be noncorrosive to automatic components, and be safe, plus free from toxicity and flammability. It would not root ozone exhaustion or climate change. In the meantime changed fluids have the desired traits in different degree, choice is a matter of trade-off.

The desired thermodynamic assets are a boiling point somewhat beneath the target temperature, a high heat of vaporization, a temperate mass in liquid form, a relatively high density in gaseous form, and a high critical temperature. Then boiling point and gas density are unnatural by pressure, refrigerants possibly will be made more apt for a exact application by optimal of operating pressures.

As shown in fig. 4.9 by using RET Screen tool; an breakdown has certain to compare the unadventurous harmful refrigerant CFC-11 and HFC-152.

Refrigerant

Type		CFC-11	HFC-152a	Incremental initial costs
Global warming potential	tCO2/t	4750	124	
Quantity	kg	1.5	1.5	
Annual refrigerant losses	%	2	2	
Refrigerant rate	Rs/kg	1,500	3000	
Incremental initial costs	Rs	2,250	4,500	2,250
Incremental O&M savings	Rs	45	90	-45

Fig. 4.9: Refrigerant comparison

As per the replication result; the release of CO_2 is partial to 124 tons per year thru base case of 4750 tons. Henceforward as per the "clean development mechanism" the certified emission reduction (CER) reduction willpower be quite high. CER value is equal to 4626 tons.

5. Conclusion

Domestic air conditioning is furthermost common and used all over in all levels of users in the form of window and split air conditioning systems. But then the bad side of the home air conditioners is that they chomp substantial amount of energy. Drop of energy consumption is a major apprehension in the vapor looseness refrigeration system especially in the area with same hot weather settings where air-conditioners are habitually used to cool homes. Utilizing more efficient central air conditioning equipment is one approach to curb residential energy consumption. The typical efficiency of air conditioning units sold tends to increase increasingly over time, so replacing old units can reduce energy consumption during job, but these energy savings requirement be weighed compared to the energy add-on with the creation of a new unit and disposal of the existing unit.

For the purpose of falling the GHG emissions, an analysis has been given with RETScreen 4.0, by since the refrigerants used in the assignment. An energy saving analysis has been studied through BE opt 6.0 by considering room conditions, it's engaging and other technical parameters.

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