

Carbon Credit Earning Model for a University Based on Replacing 1 Star with 5 Star Air-conditioner: a Case Study

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Abstract: Controlled energy expenditure leads to saving in emission of CO₂ in atmosphere. Members of society must be educated and informed about the means and ways by which our mother earth will be more livable and conserve our planet for our future generation. An academic institution can play a pivotal role in dissemination of knowledge and educating the society for accepting new energy efficient technologies and thus emission of green house gases can be checked. In this work a case study has been presented for an academic institution about achieving the CO₂ mitigation on adopting the energy efficient air-conditioners. In this study, Deenbandhu Chhotu Ram University of Science and Technology Murthal, Haryana, India has been considered and in university 1 star air-conditioner (A/C) has been theoretically replaced with 5 star A/C and thus net reduction achieved in a green house gas (CO₂) has been presented. It has been found that 161 tCO₂ / year can be saved from emitting to the atmosphere by consuming less electrical energy. Work also highlight the economic viability of the study with the revenue generation model by selling carbon credits thus earned through Clean Development Mechanism (CDM) and it has been found out to be four lakh rupees per annum.

Keywords: Energy efficient air-conditioner; CO₂ emission; Carbon credits.

I. INTRODUCTION

India is a growing economy and this is manifested by the total installed electrical generating capacity as on 31-1-2015 was 2,58,701 MW [1] and expected to cross 950000 MW by 2030 [2]. India with its 4th largest share of world's coal reserves [3] largely relying on fossil fuel for generating electricity and its power plant are responsible for releasing large chunk of CO₂ in to the atmosphere. Any means of energy conservation leads to reduction of CO₂ emission. So, there is a urgent need of environment friendly fossil fuel based electrical energy generation technologies and simultaneously thrust on opting for energy saving.

Heating ventilation and Air-conditioning (HVAC), a comfort industry is a leading energy consumer which improves user's working efficiency. This industry is blamed for using ozone depleting and global warming substances. International treaties like Montreal Protocol [4] and Kyoto Protocol [5] are come into being to address both the issues. In India, this issue is taken up at government level by Bureau of Energy Efficiency (BEE). BEE has come up with star rating [6] for air-conditioners; urging the consumers to replace their energy inefficient A/C with star rated more energy efficient A/C. These norms talks of high coefficient of performance (COP) of these machines and less power consumption. Table 1 presented the energy requirement for different star rated unitary A/C as stated by BEE [7].

According to Kyoto protocol one can opt with newer technologies and means to reduce global warming gases, a need of the hour and this, will even, earn some monetary gains. The Kyoto Protocol [5] put limit on the green house gas (GHG) emission for the industrialized countries and countries with economies in transition grouped as Annex I countries [8] e.g. Australia, United State of America, United Kingdom etc. Protocol gives three cooperative mechanisms i.e. International Emission Trading, Joint Implementation and Clean Development Mechanism (CDM). These mechanisms offer countries and private sector companies the opportunity to reduce emissions anywhere in the world wherever the cost is lowest and they can also count these reductions towards their own targets. This reduction should be supplementary to the domestic actions for emission reduction in the host countries [8, 9]. The CDM allows an incumbent[8] to implement a project that reduces GHG emissions or, removes greenhouse gases by carbon sequestration or sinks in the territory of a non-Annex I [10] countries like India, Israel, Brazil etc. The resulting certified emission reductions (CERs), can then be used by the Annex I party to help meet its emission reduction target. Carbon credit is the term used in this regard. Each carbon credit represents one metric ton of CO₂ either removed from the atmosphere or saved from being emitted. The carbon credit market attaches a monetary value for carbon credits and allows the credits to be traded.

Table 1. Star level valid for unitary type air conditioners (From 01-01-2014 to 31-12-2015)

Star level	Energy Efficiency Ratio (Watt/Watt)	
	Minimum	Maximum
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	-

Since, society needs to be trained, told and cajoled by setting example to change the bad habit of using non energy efficient practices. Using no star A/C is one such practice which is still in vogue. Considering this a case study has been presented by taking DCRUST Murthal as entity by theoretically replacing all operating single star A/C of the university with 5 Star A/C. Study presented the reduction in GHG emission and also presented the economic model which proves to be viable option. Carbon credit thus earned by upgrading to 5 star rated A/C can be traded and it has been shown that in a lifespan of an A/C results prove to be beneficial for the university.

II. ENERGY SAVING CALCULATIONS

Carbon credit earning study is presented in this section for the university. Carbon credits can be earned by DCRUST Murthal by reducing its energy demand on employing new energy efficient A/C. This saving in energy is converted to equivalent amount of reduction in CO₂ emission to environment.

University, DCRUST is situated in Murthal of Sonapat district of Haryana and spreads over 273 acres. For the study a survey has been conducted to know the number of air conditioners operating in the DCRUST. Number of air conditioners operating in different block of university campus including residential area was found out to be 180 [11]. It was found that A/Cs are of different capacities are in use in university but majority are of 1.5 tonne range. For this work common assumptions have been made and summarized in table 2.

Table 2. Assumptions for carbon credit earning model

Type of A/Cs	Unitary type
Refrigerant	R-22
Cooling Capacity	1.5 tonne
Initially all A/Cs are	1 Star
Working hours	8 hours per day
Working days	240 days per year
All A/Cs upgraded to	5 Star

For the base line study A/Cs are assumed to be at 1 Star. These single star A/Cs are upgraded to 5 Star A/Cs. Power consumption and respective energy efficiency ratio (EER) is as per BEE norms and taken from table 1. Table 3 summarizes various useful data and calculation for energy savings obtained after conversion to 5 star rated A/C i.e. energy efficient air conditioning systems.

Table 3. Energy saving calculations

Total No. of A/Cs	180
Tonnage of existing ACs	1.5 tonne(5.25 kW)
Power consumed by 1 Star A/C	2.10275 kW
Power consumed by 5 Star A/C	1.5909 kW
EER of existing 1 Star A/C	2.5 kWh/kWh
EER of 5 Star A/C	3.3 kWh/kWh
Energy consumption 1 Star A/C	$180 \times 8 \times 240 \times 2.1028 = 726728$ kWh
Energy consumption 5 Star A/C	$180 \times 8 \times 240 \times 1.5909 = 549815$ kWh
Energy saving	176913 kWh

III. CARBON CREDIT EARNING

Energy saving is obtained as 176913 kWh. Amount of electrical energy saved is converted to amount of reduction in CO₂. International Energy agency [12] gives the conversion for India as 912.3916 grams of CO₂ - prevented per kW of electrical energy saved. Estimated reduction in emission of CO₂ for the obtained energy saving is 161413.9 kg of CO₂. Since, 1 carbon credit equivalent to 1 metric ton of CO₂ saved from being emitted in environment. Thus numbers of credits earned are obtained as 161. Price of one carbon credit depends upon market conditions and in this study it is assumed on upper side as 25 Euros [13] and 40 US dollars [14]. Whereas \$ 1 = 62.25 INR [15] and 1 Euro = 70.9 INR [16]. So, amount of earning per year when credits sold in Euros is obtained as 2, 85,373 INR and when sold in Dollar it is obtained as 4, 00,890 INR.

IV. RESULTS, DISCUSSION AND CONCLUSION

By replacing 1 Star A/C with 5 Star A/C the 161 tCO₂/year is prevented from being escaped to atmosphere. 161 carbon credits can be earned by university. On trading these carbon credits university can earn 4 lakh Indian rupees approximately. Now the amount of money incurred on university on buying 5 Star A/C equipment as compared to 1 Star A/C is INR 9, 90,000. As INR 5500 reportedly rise [17] in prices of the 5 star A/Cs in up gradation from 1 star A/C of per unit is observed. The pay back is obtained as based on Euros is 3.5 years and as based on US dollars is 2.5 years. Average age of A/C is expected to be 8 years [18]. So, for the period of 4.5 years earning will be INR 12,841,79 (Euro based) and for the period of 5.5 years earning would be INR 22,04,895 (US dollar based). In India there are 687 Universities [19]. It is imaginable that there is potential to save huge amount of electrical energy and in turn CO₂ reduction in the atmosphere by simply up-gradation to existing non efficient A/C to energy efficient air-conditioning systems.

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