ISSN 2395-695X (Print)
ISSN 2395-695X (Online)
International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST)
Vol. 2, Special Issue 15, March 2016

Energy Conservation in Telecom Buildings using Economizer control in Air Conditioning System – A study.

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***Abstract*— Telecom buildings / Data enters require cooling all year long. Temperature inside the building i.e. the conditioned space is to be maintained within a specified limit which is due to the operating requirements of the equipments installed. Temperature limit is achieved by providing air conditioning systems. If the outdoor air is colder than indoors, it makes sense by bringing in outdoor air to reduce the load on the mechanical cooling system, which is called Economizer. The energy saving that could be achieved with Economizer control is estimated using Energyplus Simulation software.**

Keywords—Energy Conservation, Economizer, Energyplus, Building Energy.

I. INTRODUCTION

This paper presents the energy saving options available with the adoption of Economizer control in the air conditioning systems run for maintaining the internal ambient conditions in Telecom buildings / data centers. The economizer control in air conditioning systems is adoptable in places where the temperature outside is less than the temperature to be maintained inside the conditioned area. Generally the electronic equipments in Telecom buildings / data centers can operate at an ambient temperature up to 26 Deg. C and the outside temperature in most of the Indian cities fall below 26 Deg. C especially during winter and night periods. Under that conditions it is possible to mix the outside cold air along with the return air of the air conditioning plant so that the load on the air conditioning system is partially reduced and thus energy saving could be achieved. To prove the realizable saving, a building with load is simulated and inside temperature is maintained with and without economizer control and the resulting savings are calculated.

II. ENERGYPLUS SIMULATION SOFTWARE

EnergyPlus is a powerful whole-building simulation program used to predict energy use and and occupant comfort in both commercial and residential buildings. EnergyPlus energy modeling helps inform the design process in regards to comfort, energy efficiency, mechanical system options and daylighting.

EnergyPlus is an energy analysis and thermal load simulation program. Based on a user's description of a building from the perspective of the building's physical make-up, associated mechanical systems, etc., EnergyPlus will calculate the heating and cooling loads necessary to maintain thermal control setpoints, conditions throughout an secondary HVAC system and coil loads, and the energy consumption of primary plant equipment as well as many other simulation details that are necessary to verify that the simulation is performing as the actual building would.

All major power sources such as Generators, Transformers, Solar Power systems etc. and all Electrical loads such as Lighting loads, Equipment loads, Human occupancy, Air conditioning systems are present in the Energyplus package.

III ECONIMIZER IN AIRCONDITIONING

Telecom buildings / Data enters require cooling all year long. Temperature inside the building i.e.

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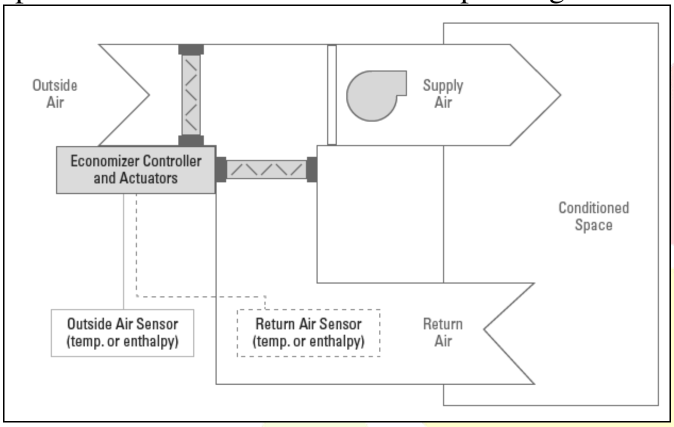

Fig.1. Economizer scheme

requirements of the equipments installed. Temperature limit is achieved by providing air conditioning systems. If the outdoor air is colder than indoors, it makes sense by bringing in outdoor air to reduce the load on the mechanical cooling system.

A typical mixed-air, air handler includes dampers for outdoor air, return air, and relief air. These dampers can be controlled to provide airside economizing. Usually, an air handler with economizer controls has four operating modes.

i) Heating mode: During very cold weather, the air handler brings in minimum outdoor airflow and mixes it with return air. The mixed air is then heated as necessary to maintain the desired space temperature. This minimum may be reset downward from the design value to save heating energy using various dynamic reset approaches. But when it's cold outside, no more than minimum outdoor air enters the building, whether or not the system includes airside economizer controls.

ii) Modulated economizer mode: During cool weather (1°C to 13°C]), the required space temperature can be maintained without any mechanical cooling or heating by simply adjusting the mix of outdoor air and return air. In this mode, the economizer system adjusts both the outdoor- and return-air dampers, modulating these airflows to match cooling capacity with cooling load—without mechanical cooling. Intake airflow varies between the minimum setting and a maximum value of 100% of supply airflow to maintain the space temperature at set point .

iii) Integrated economizer mode: During mild weather (13°C to 24°C), outdoor air can provide some cooling capacity, but not enough to satisfy the load, so mechanical cooling supplements the economizer cooling provided by the wide-open outdoor-air damper. We refer to this mode as integrated economizer because it combines free cooling i.e.100% outdoor air with mechanical cooling to meet the required cooling capacity. The system stays in integrated economizer mode until outdoor conditions reach the high limit shutoff setting, or until the outdoor conditions fall to the point where modulated economizer operation can handle the cooling load.

iv) Mechanical cooling mode. Economizer operation is disabled during warm weather, when outdoor conditions exceed the high-limit shutoff setting. Minimum outdoor air for ventilation mixes with return air. The mixed air then is mechanically cooled as needed to maintain the space temperature at setpoint. As in the heating mode, the minimum outdoor airflow may be reset downward from its design value to save cooling energy. But, when it's hot outside, no more than minimum outdoor air enters the building whether the system includes an airside economizer or not.

Design capacity: Airside-economizer systems must include outdoor- and return-air dampers that are sized and modulated so that up to 100% of design supply airflow can be outdoor air. In other words, the system must be designed to allow outdoor airflow ranging from the minimum required for ventilation to the maximum delivered by the supply fan. For VAV systems, the supply fan usually delivers less than cooling design airflow during the

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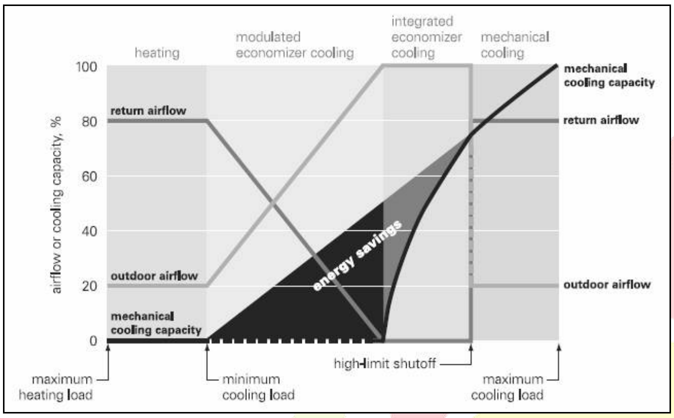

Fig.2. Economizer operating modes.

integrated economizer mode, even though the outdoor air damper is wide open. Supply fan airflow and therefore, intake airflow increases if the control resets the supply-air temperature upward at part load.

Control signal: Airside economizer operation must be appropriately sequenced with mechanical cooling to maximize energy savings while avoiding wasteful simultaneous cooling and heating. To help assure proper sequencing, control of the economizer dampers shouldn't be based on mixed-air conditions alone. In heating mode, minimum outdoor-air intake flow enters the system. Heating capacity decreases as the outdoor-air heating load decreases.

As the weather warms, when the system no longer needs heating, it enters the modulated economizer mode. Outdoor air and re-circulated return air modulate to maintain space temperature at set-point. Outdoor air provides the needed cooling capacity without any mechanical cooling. The black area in Figure represents the mechanical cooling energy that's saved during modulated economizer operation or free cooling.

As the cooling load increases, the outdoor-air damper eventually opens to 100% and the return-air damper closes completely. The system enters integrated economizer mode, where 100% outdoor airflow provides part of the required cooling capacity and mechanical cooling provides the balance, modulating or cycling as necessary to maintain the required space temperature. The system stays in integrated economizer mode until the outdoor-air condition reaches the high-limit shutoff setting.

At this point, the controls disable economizer operation and the system enters the mechanical cooling mode, where a water valve modulates or a compressor cycles to provide all cooling capacity needed to maintain space temperature. In this mode, the outdoor-air damper closes to allow only minimum intake airflow.

If 100% outdoor air is unable to provide the required cooling capacity, then the outdoor-air damper closes to its minimum position and mechanical cooling modulates to provide all of the needed cooling capacity.

High-limit shutoff: Integrated airside-economizer operation must be disabled i.e. that is, the outdoor-air damper must reduce intake airflow from maximum to the minimum airflow required for ventilation, whenever outdoor air exceeds a prescribed high-limit condition.

Conversely, economizer operation must be enabled when outdoor conditions are equal to or below the high-limit shutoff. In other words, the prescribed high-limit shutoff setting acts as an economizer enable/ disable setting. Airside economizer systems must be designed so that excess building pressure can be relieved.

When more-than-minimum outdoor air enters the building during economizer cooling modes, more-than minimum relief air must leave the building. Excessive building pressure can cause doors to stand open, creating a potential security risk. Building pressure can be controlled (for example) using barometric relief dampers, modulated relief fans, or return fans with modulated relief dampers. Each approach has its advantages and disadvantages, but using an airside economizer necessitates some method of building pressure control.

III SIMULATED BUILDING

A building of size 25 m X 20 m X 4.5 m has been simulated. The building is constructed with 250 mm thick brick wall 150mm thick cement

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concrete roof. Typical engineering properties of the wall and roof are entered. The building houses telecom equipments the air conditioning system is expected to maintain the inside temperature at 26 Deg.C.

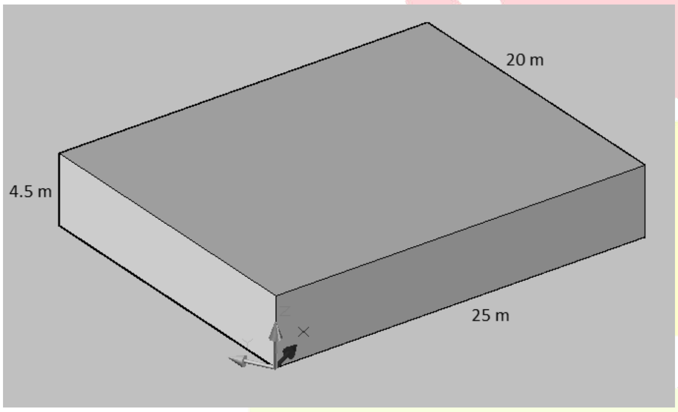

Fig.3. Simulated Building

Following are the settings.

Telecom equipment capacity: 588 KW

Lighting load : 10 KW

Occupancy: 50 Persons

Cooling Set-Point: 26 Deg.C

Economizer Control type: Fixed Dry Bulb

Economizer Max. Temp Limit: 20 Deg.C

Economizer Max. Temp Limit: 4.6 Deg.C

With the above settings, the simulation program was run for an year. A weather data file of Delhi was associated with the simulation run . The weather data file contains the details of Location, Temperature, Humidity, Rainfall, Sky clearness, Wind speed and other parameters impacting energy.

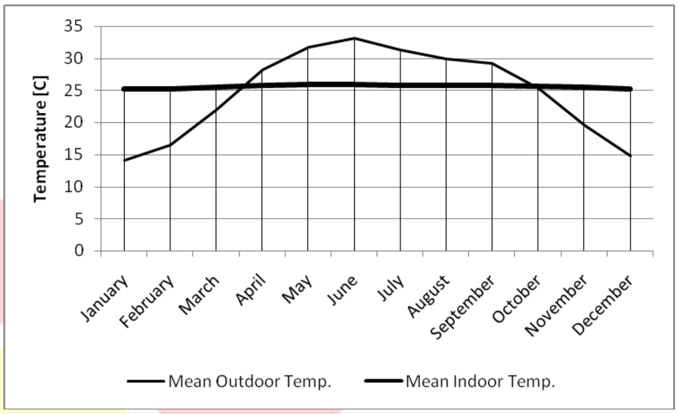

Fig.4. Monthly mean temperature.

TABLE .1 Outside & Inside Temperatures.

Month	Mean Temp. Deg.C		
	Outdoor Temp.	Indoor W/O Economizer	Indoor With Economizer
January	14.05	25.28	25.27
February	16.50	25.33	25.32
March	21.94	25.56	25.55
April	28.25	25.84	25.83
May	31.78	25.92	25.91
June	33.18	25.89	25.89
July	31.29	25.79	25.79
August	29.98	25.76	25.76
September	29.30	25.76	25.76
October	25.35	25.64	25.63
November	19.50	25.48	25.47
December	14.76	25.32	25.32

Simulation was run without and with economizer and some of the readings obtained are;

i) Monthly energy for lighting loads
ii) Monthly energy for Telecom Equipment
iii) Monthly energy for HVAC system
iv) Mean outdoor temperature
v) Mean Inside temperature

It was found that the inside temperature (Table 1) was within limits during without and with Economizer modes.

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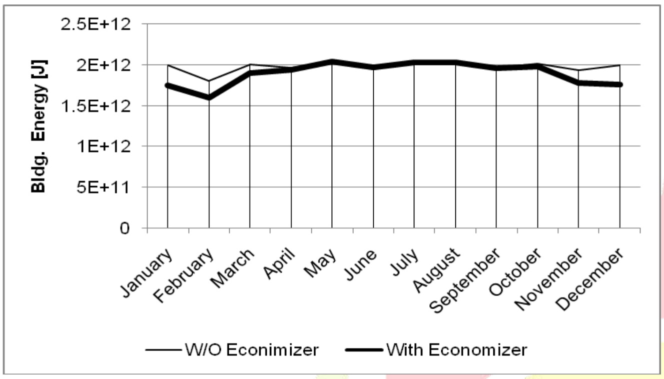

Fig.5. Building Energy Consumption

It was found that the saving in net building energy varies from 12.28% in the month of January to 0% in Summer periods (Fig 5). There is a net annual energy saving of 4.22% which is 1.00E +12 Joules for this building.

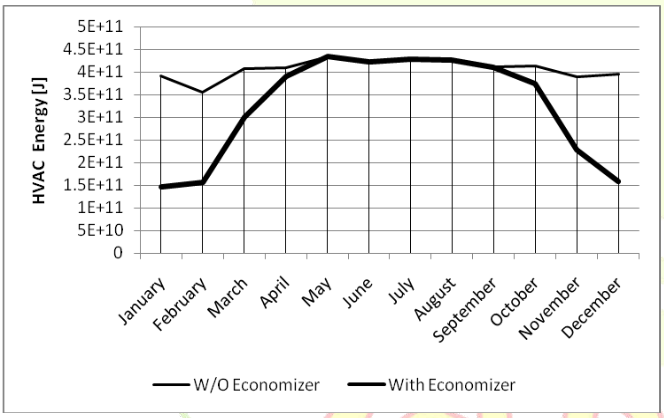

Fig.6. HVAC Energy Consumption

It was found that the saving in HVAC energy varies from 62.54% in the month of January to 0% in Summer periods (Fig 6) .
There is a annual HVAC energy saving of 20.52% which is 1.00E +12 Joules for this building.

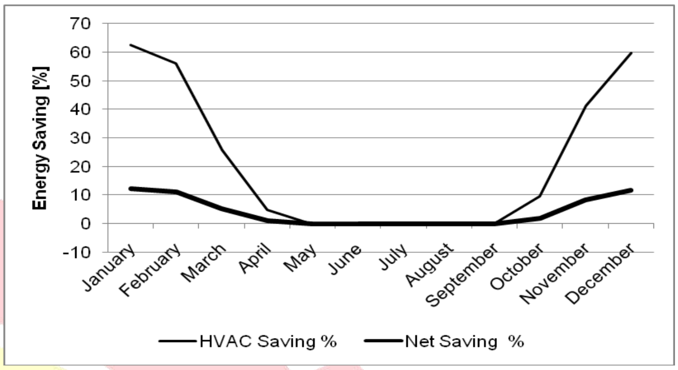

Fig.7. Energy saving Vs Month

It is found that the energy saving achieved varies with the climate i.e. month of the year. Maximum saving is achieved during winter period i.e. during the months of December and Janauy. The energy saving decreases in the preceeding and the months following the winter season and the energy saving is zero during the summer months and the same is depicted in the Fig.7.

TABLE 2. Energy Consumption Readings.

Month	Bldg. Energy		HVAC Energy	
	W/O Econimizer	With Economizer	W/O Eonomizer	With Economizer
January	1.99E+12	1.75E+12	3.91E+11	1.47E+11
February	1.80E+12	1.60E+12	3.56E+11	1.56E+11
March	2.01E+12	1.90E+12	4.07E+11	3.02E+11
April	1.96E+12	1.94E+12	4.10E+11	3.91E+11
May	2.04E+12	2.04E+12	4.34E+11	4.35E+11
June	1.97E+12	1.97E+12	4.23E+11	4.23E+11
July	2.03E+12	2.03E+12	4.30E+11	4.30E+11
August	2.03E+12	2.03E+12	4.27E+11	4.27E+11
September	1.96E+12	1.96E+12	4.11E+11	4.11E+11
October	2.02E+12	1.98E+12	4.14E+11	3.75E+11
November	1.94E+12	1.78E+12	3.89E+11	2.29E+11
December	2.00E+12	1.76E+12	3.95E+11	1.59E+11

IV CONCLUSION

From the above it can be seen that with the availability of natural resource i.e. cold air for meeting the part of our cooling energy demand it is always prudent to go for economizer system in telecom buildings located especially in cities where the temperature falls below the specied temperature of the conditioned area.

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