Analysis on Energy-Efficient HVAC System for Buildings

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Abstract HVAC system plays a very important role for the building, as it has captured almost 45–50% of the electrical load of any building. This study shows that how we can make sure conventional HVAC to energy-efficient HVAC system. This study also shows that it will also reduce the carbon footprint as electrical load going down.

Keywords HVAC · AHU · Carbon emission reduction

1 Introduction

Building energy consumption is the major concern nowadays. In 2009, global public building energy consumption was 2 billion TCE, representing 11.4% of total building consumption [1]. The important factor is that office building is almost one-fifth of total building energy use [2].

Air conditioning is 30–40% of the total building energy consumption of office building [3]. Climate is also playing important role in case of air-conditioning energy consumption. The potential impacts on the various types of weather forecast models, weather data and building prototypes have been studied from varied prospective [4–8].

A HVAC system schematic diagram is shown in Fig. 1.

In HVAC, evaporator, condenser, compressor and expansion valve are the main components; principally, evaporator and condenser are the heat exchangers, one circuit for refrigerant acts as a primary circuit, and refrigerant absorbs the heat from return heating load (chilled water return line) and releases on cooling tower side in condenser.

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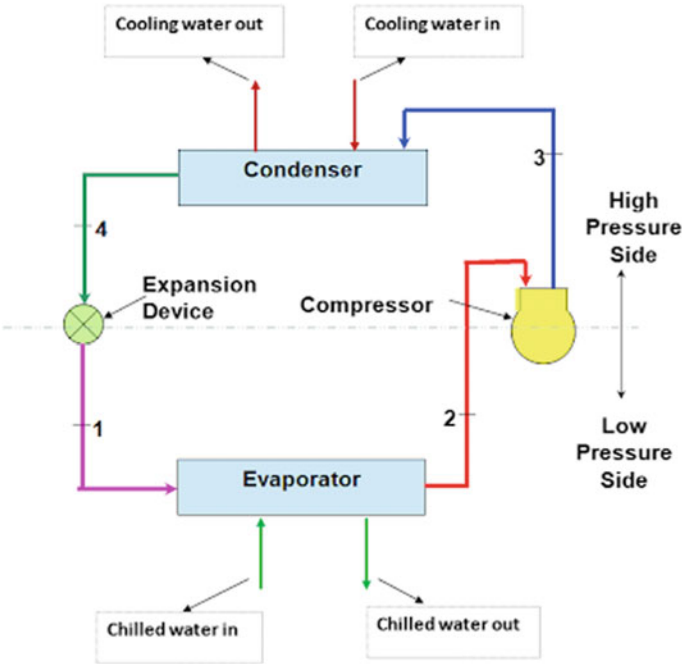


Fig. 1 HVAC schematic diagram

All equipment come under high side of equipment where it will generate the chilled water.

Chilled water and AHU circuit—This circuit is normally known as low side of HVAC system, where generated chilled water has been utilized (Fig. 2).

Standard energy distribution % for building energy consumption clearly shows that maximum consumption has been for chiller machine.

Fig. 2 Chilled water and AHU circuit

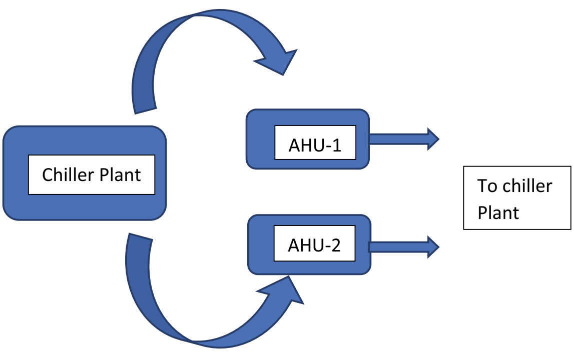


Table 1 HVAC energy distribution

Name	% Consumption (%)
Chiller	48
Primary pump	1
Secondary pump	2
Condenser pump	2
CT	1
AHU	14
Others	32

Table 1 and Fig. 3 have clearly shown that % distribution of HVAC system maximum % consumption has been taking care by chiller machine which is 48%, pumping system has been 5%, and air handling system consumption is close to 14%.

% Reduction on energy consumption through energy conservation measures—

1. Using VFD for chilled water pump;
2. Using VFD for condenser pump;
3. Using On/Off control for cooling tower fan;
4. Using VFD for AHUs with RT air feedback.

Doing all energy conservation measures, the direct impact on chiller machine has been shown.

Working principle of improved infrastructure of HVAC system with energy conservation measures—There are two distributions: One is high side, and other one is low-side improvement on low side with the use of VFD on AHU fan as per heat load inside the building; accordingly, chilled water flow has been controlled

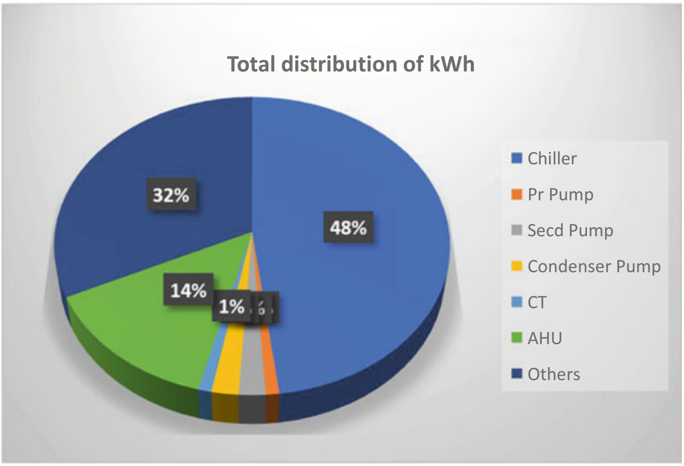
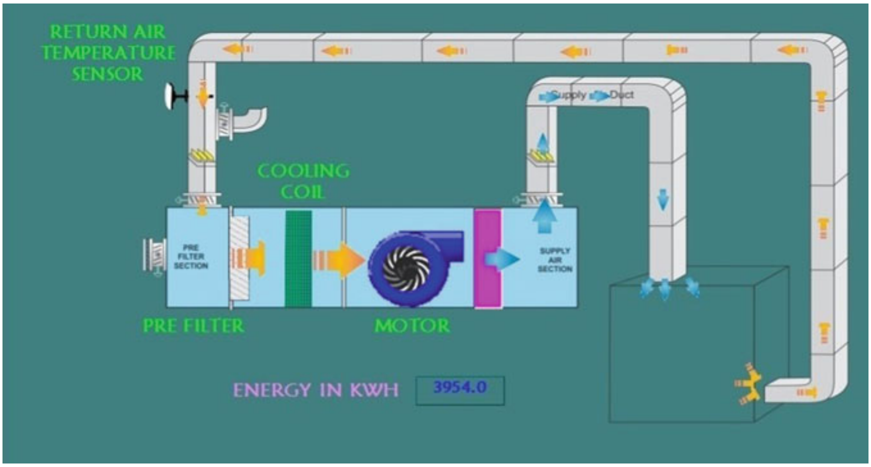


Fig. 3 HVAC energy distribution

through actuator valve on secondary pump; on that reference secondary pump, VFD reduces the speed of pump and at the same time kWh consumption also goes down on both AHU and pumping system.

Now the measured impact comes on chiller machine because when the heating load on building has been less, all variations taking place, and at the same time, generation of chilled water is also going down.



% Reduction on energy consumption in HVAC system (Fig. 4; Table 2).

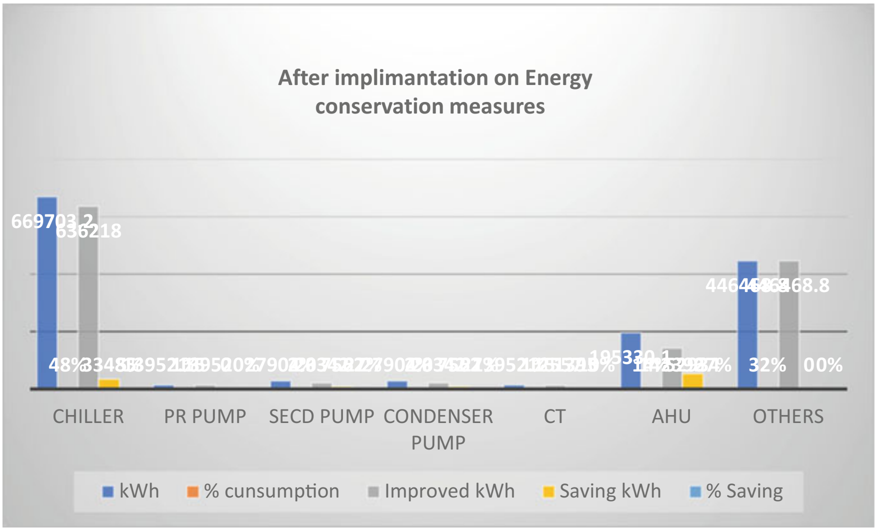


Fig. 4 Reduced energy consumption after implementation of energy conservation measures

Table 2 % Saving in kWh

Name	% Consumption (%)	% Saving (%)
Chiller	48	5
Primary pump	1	0
Secondary pump	2	27
Condenser pump	2	27
Cooling tower (CT)	1	10
AHU	14	27
Others	32	0

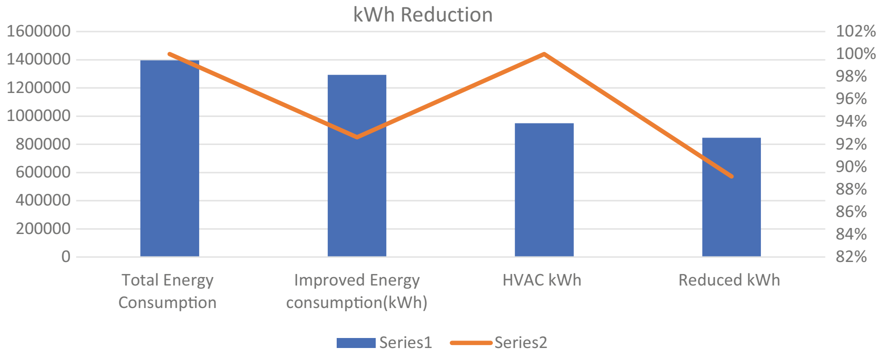


Fig. 5 % Reduction on energy consumption on totality and individual HVAC system

2 Conclusion

Total energy consumption—1,395,215 kWh (100%);
Reduced energy consumption—1,292,276.2 kWh (93%);
Saving in energy on total bill—102,938.96 kWh (7%);
On HVAC energy consumption reduction—845,807 kWh (11%).

After implementation on energy conservation measures, % reduction in totality is 7%, and in separate HVAC, reduction is 7% (Fig. 5).

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