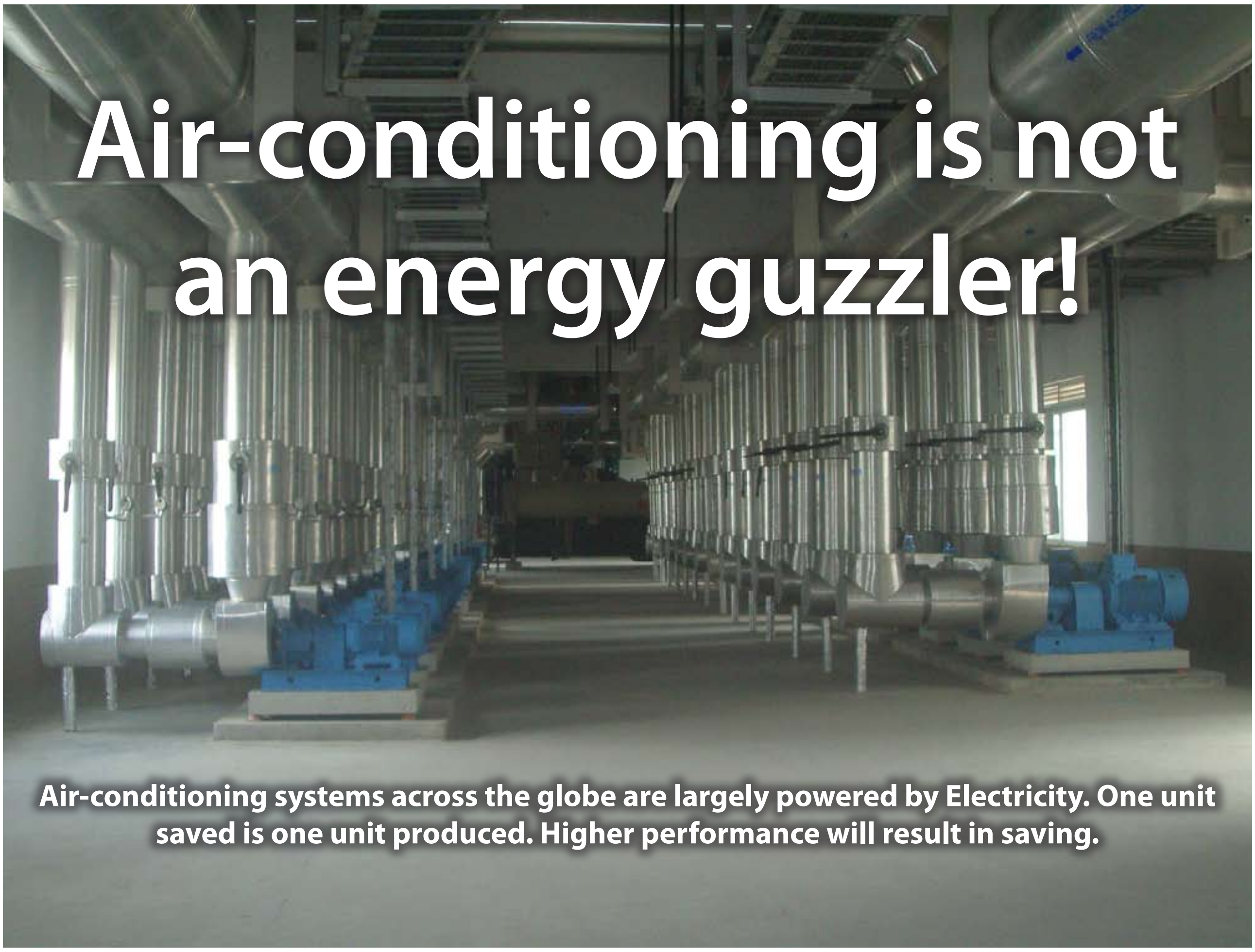
Air-conditioning is not an energy guzzler!



Air-conditioning systems across the globe are largely powered by Electricity. One unit saved is one unit produced. Higher performance will result in saving.

D. Nirmal Ram
Chairman Acrex India 2012
Email: dnirmalram@acrex2012.com

Strategies

There are three fundamental strategies to increase energy performance:

1) Reduce Demand
2) Harvest Site Energy
3) Maximize efficiency

Demand reduction is accomplished by challenging initial use assumptions and by reducing internal loads and gains through the shell and lighting improvements.

Harvesting site energy includes using free resources such as daylight, ventilation cooling and solar heating to satisfy needs for space air-conditioning.

Finally the efficiency of the HVAC system should be maximized.

Orientation

The location of the building with reference to the compass points and avoiding exposure on West and East will result in an economical HVAC Design.

Ventilation

A demand controlled ventilation using CO_2-sensors controlling the dampers which in turn controls the Variable frequency drives for changing the speed of the blower will result in higher energy efficiency .For higher outdoor air quantity, heat recovery by means of heat recovery wheel, Run around coils and heat pipe will result in lesser system capacity.

Inside design conditions

Comfortable temperature is a relative figure and depends on outside temperature and humidity. Selecting a lower temperature than comfortable temperature is direct waste of energy. So compromise the need to use low temperature and humidity.

Equipment selection

Generally it is found that equipment selected on the actual instantaneous peak heat gain is oversized and therefore capable of maintaining much lower room conditions than the original design. One reason for such is the non-simultaneous occurrence of the peak in the individual loads (diversity) Also, if a smaller system is selected, and is based on the extended periods of operation at the peak load, it results in a more economical and efficient system at partially load condition.

Hybrid chilled water system

A hybrid chiller option with a combination of air cooled screw chillers, water cooled centrifugal chillers and absorption chiller with heat recovery boilers from DG sets will enable efficient operation.

The lotus (Nelumbo nucifera) flower is the national flower of India. To Hindus and Buddhists it is a sacred symbol of enlightenment.

Air handling units

Choice of Air handling units with supply and return/exhaust air fans will result in energy saving. During 'free cooling' conditions when the ambient temperature is comfortable, the supply fan will be drawing all outside air, whereas the return/exhaust fan will be exhausting the air from the conditioned area.

Toilet exhaust fans can be hooked with an infrared sensor/timer which will facilitate operation only during occupancy.

Server rooms and data center which are required to function round the clock can be contemplated with dual fluid precision units.

Chilled beams

Chilled beams offer a quiet indoor air free from draught.

Variable air volume units

Variable air volume units coupled with motion sensors will enable closure of the units to the minimum levels will result in energy efficiency.

Ducting

Size ductwork appropriately and install balancing dampers to reduce velocity losses. Ducts with lower aspect ratios offer lower resistance and can reduce fan energy significantly. Ducts should be insulated and sealed but indoor air quality issues should also be considered. Factory made ducts with good workmanship will result in the low leakage losses.

Thermal storage

Power tariffs and rationing during peak load hours - This becomes a potential tool for use by the designer to harness the sleeping giant of thermal storage. Thermal storage systems become handy in areas wherein due to water shortage the usage of water cooled chillers are limited.

Vapour absorption system

Alternate sources of energy particularly waste steam/heat can be used for refrigeration. Heat recovery from solar heat is also a possible option.

Variable speed drives

Variable frequency drives can be used for the primary and secondary chilled water circulation pump sets by sensing the temperature and pressure differential in the chilled water lines. Two way motorized valves in the air handling units can be actuated by a thermostat which will vary the flow according to the loads resulting in pressure changes which can be sensed and used for changing the speed of the pump sets.

Variable speed drives are used for the air handling units. Variable air volume units will regulate the airflow for various zones based on the occupancy and temperature by a variable air volume unit, which will give a pressure signal for the VFD to change the speed of the air handling unit.

A demand controlled ventilation system uses a variable speed drive operating based on the opening and closure of the fresh air dampers controlled by the CO_2-sensors.

A typical basement exhaust system can use a variable speed drive controlled by CO-sensors.

Centrifugal/screw chillers with variable speed drives are also available.

Building automation system

The main objective of the building automation system is to reduce the running and energy costs, improve the quality and supply of information on the air-conditioning system. The system can establish basis which will be good bench mark for energy efficient operation subsequently.

Good installation practices

A good equipment will not serve its purpose if it is not installed properly. Good installation practices with stringent quality control measures will result in easy main-

Case study:

Energy efficient HVAC system for an IT park, Bangalore

Project name: Pritech 2 Sez Park, Bangalore. Commissioned on December 2008

The project involves air-conditioning of Software and Hardware Park, Pritech 2 SEZ having an air-conditioned floor area of 116,043 sq.mt having three blocks namely block 5, 6 & 7. To cater to the air-conditioning needs a combination of water cooled centrifugal, air cooled screw and vapour absorption chillers are contemplated. 3 Nos Water cooled centrifugal chillers each having a capacity of 700 TR (2462 KW), 10 Nos air-cooled screw chillers each having a capacity of 350 TR (1231 KW) and 1 no vapour absorption chiller using waste heat from Diesel Generating Set/Diesel/Compressed Natural gas totaling to a capacity of 6300 TR (22150 KW) are envisaged. All chillers excepting the vapour absorption chillers are installed. The hybrid chiller combination with water cooled centrifugal chiller will use recycled water from Sewage Treatment plant and will run when the ambient is hot, the air-cooled screw chillers again with a combination of High and Normal Efficiency (5 nos of each type) will run during the periods of low/medium ambient temperatures while the vapour absorption chiller is mainly designed to run during the periods when DG sets are functional recovering the waste heat. This hybrid combination strike a perfect balance between energy efficiency and first and running costs. No standby chillers are envisaged owing to multiple chillers with multiple compressors. Further there is no separate critical chiller system (for 24/7 operating areas) as the same set of chillers can cater to the critical needs also thereby simplifying the chilled water distribution system. The chillers are located in the Utility block having the Lower level with DG sets, Middle level with pump sets and water cooled centrifugal and absorption chillers, intermediate level for chilled water and condenser water piping system and the upper level with air- cooled chillers and cooling towers. The Chiller platform is of RCC construction

(compared to conventional metallic structure) which has a longer life span with no rusting/maintenance and lower first cost. The chiller power apportioning is using the state of the art ultrasonic BTU meters with software programming done to the exclusive need of the project. The BTU meters are protected from misuse/faulty operation by communicating the failure through mobile phones.

The system is being hooked with the phase 2 system with another Chiller Plant room with a ring main concept making the system totally failure free and free from sabotage if any thereby offering the combined advantages of the central chilled water and individual chilled water system

Chilled water circulation is with primary and variable secondary pump sets with two way motorized valves for the Air-handling units. The system provides installation of air-handling units and air distribution system by the tenants.

tenance and will pave a way to energy saving. Air leakage if any in the ducting system will result in serious energy loss.

Commissioning and handing over

Commissioning is a systematic process to ensure that the air-conditioning system performs according to the design intent and the owner's operational needs. Commissioning maximizes energy efficiency and thereby minimizes environmental impacts associated with energy production and consumption.

Operation and maintenance

A well drawn-out diligent operation and preventive maintenance schedule really saves energy.

Proper maintaining of inside design conditions does not mean that the system is working efficiently as peak load

The facility has won the LEED Platinum rating

Extraordinary features of the System

- Water cooled centrifugal chiller having a COP of 6.38 and an IPLV of 7.51, High performance Air cooled screw chiller having a COP of 3.05 and IPLV 4.56 and Normal Efficiency air cooled Screw chiller having a COP of 2.88 and an IPLV 4.56 – all installed with a space to install 700 TR Vapour absorption chiller using DG waste heat recovered by Heat recovery boiler. All chillers are with ozone friendly refrigerants.
- All chillers were installed in a multi level utility block – Level 1 DG sets, Level 2 Water cooled chillers and pump sets, Level 3 Chilled and Condenser water Headers and Level 4 with air-cooled screw chillers and cooling towers on RCC platform compared to the conventional Metallic structure free from rusting and maintenance and offering a good maintenance.
  - These chillers are to be hooked to the Phase 2 HVAC Plant room with a ring main concept offering total flexibility and free from any failure.
  - State of the Art Power apportioning with BTU meters with special programming for this project with Auto SMS facility for failure.

Quantifiable and tangible benefits resulting from the innovation.

- There is a first cost saving of 0.6 million Euros with a centralized chilled water system compared to a standalone chiller system installed on the terrace of each blocks (see Annex).
- There is a running cost saving of 60,000 Euros per month with the Hybrid chiller configuration (see Annex).
  - The RCC chiller platform structure has a saving of 24,000 Euros over the metallic structure construction.

will not exist throughout the year and the plant is designed based on the peak load. As such proper preventive maintenance is to be performed for proper upkeep of the system to save electrical energy.

Operation shall be focussed only in areas, which can result energy saving without compromising the design intent. When there is a compromise, it is not a saving but a faulty operation!

Saving is only a relative term. Improvement is possible at every stage on continuous basis and there is no limit for energy saving.

Accompanying article is case study of a project for Energy Efficiency. It won the LEED Platinum rating. 3E

Annex: Advantages of a combined chilled water system

Advantages of installing the chillers in a service block common for all blocks as against chillers on roof top for individual blocks that has the following advantages:

Saving in running cost

Combination of Water cooled Centrifugal chillers, Vapour absorption chillers and air-cooled screw chillers pumping chilled water into a common header will result in a low KW/TR compared to individual block roof top air cooled chillers.

- Combined KW/TR for chiller combinations located in the service block – 1.166 KW/TR
- KW/TR for air-cooled chillers on the roof top for individual blocks – 1.527 KW/TR

Approximate saving in running cost for 12 hours operation/day for 26 days/month with combined chillers will work out to 60,000 Euros per month.

Further chiller operation after office hours for critical area air-conditioning requirements such as UPS, Server room, Data centre will be economical.

No air-conditioning failure

Since there are multiple chillers in a common plant room, one or more chiller failure will not seriously affect the air-conditioning. Incase of individual block air conditioning, failure of 1 or two chillers will affect the air-conditioning.

No chiller/pump noise on the top floor

Since there are no chillers and pumps installed on the roof of the occupied area, there is no issue of vibration and noise. Further the roof is clear for the cafeteria if any.

Maintenance at a single zone

Maintenance is at a single zone. This will result in lower AMC cost. The saving in AMC cost will work out to approximately 40,000 Euros per annum.

Chiller/pump power apportioning

Air-conditioning cost apportioning from common chiller and pump sets will be done for each tenants based on the actual usage in a scientific manner using BTU meters based on the usage and not on area basis.

Building Automation System

The features of the BAS are as follows:

- Remote switching On/Off of various equipments
- Remote adjustment of set points with levels of control
- Timed and event related functioning of equipments
- Run time equalization and sequencing of equipments
- Centralized alarm and maintenance schedules
- Trip indication status and Trouble shooting history
- Electrical power/capacity evaluation based on temperature of water, water flow, airflow and duration of operation.
- Chiller electrical power and other common services power apportioning to multiple tenants in a scientific way based on the actual usage
- Networking with multiple computers for remote operation at multiple locations.