HVAC HESS

PEOPLE

PRACTICES

SYSTEMS

Factsheet

# Basics of HVAC Energy Efficiency

## HVAC System Components

A typical Heating, Ventilation and Air Conditioning (HVAC) system consists of plant equipment (chillers, boilers etc.) which transfer energy via air, water or a refrigerant to air distribution systems consisting of a series of fans and coils. These distribution systems are usually called air handling units (AHUs). The AHUs then use this energy to warm or cool the air that is supplied to the office space.

Air is warmed or cooled as it flows over the heating or cooling coils in the air distribution system. Heat rejection is also required at this point, to reject excess heat collected from the space, to the atmosphere. Heat rejection can also occur through plant equipment such as cooling towers or evaporative coolers.

The main thermal loads in a commercial building are a combination of:

- heat produced by people
- heat generated by computers and equipment
- solar radiation through windows
- heat conduction through walls, windows and roof
- heat generated by lighting.

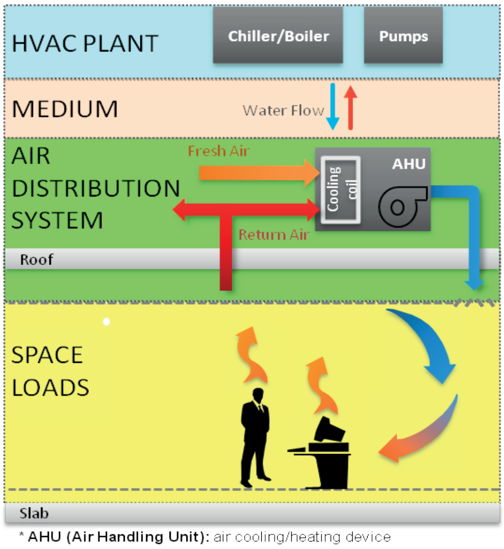
To provide comfortable indoor conditions, an amount of fresh outdoor air must be supplied to the building. The quantity is proportional to the number of people in the space. Air from outside is usually warmer in summer and cooler in winter than the desired indoor conditions; hence this air must be conditioned. Conditioning this fresh air increases the load on the system.

Generally, air is transported through ductwork while water and refrigerants are distributed through pipework. The entire process is energy intensive - the main users of this energy being the HVAC plant, fans and pumps. Pumps and fans require energy in the form of electricity to distribute water and air through the building. Chillers and boilers can run on either electricity or gas.

Figure 1 shows the schematics of a HVAC system and the interactions between plant, medium, systems and loads.

All systems in a building are linked via a Building Management System (BMS), which monitors the systems and provides a point at which issues can be diagnosed, and systems tuned and optimised.

**Figure 1: HVAC System Schematic (NDY Management Pty Ltd)**




## Energy Efficiency Opportunities in HVAC

Figure 2 shows the typical energy consumption breakdown in an office building, with HVAC systems consuming the greatest portion (39%)[1]. A further breakdown of the typical energy consumption associated with these HVAC system components is shown in Figure 3.

For further information regarding HVAC energy consumption please see the *HVAC Energy Breakdown Factsheet* on the Heating Ventilation and Air Conditioning High Efficiency Systems Strategy (HVAC HESS) website[2].

1 *Lecamwasam, L. (2012) Wilson, J. (2012) Chokolich, D. (2012). Guide to Best Practice Maintenance & Operation of HVAC Systems for Energy Efficiency. Department of Climate Change and Energy Efficiency, p 36-37.*

2 http://ee.ret.gov.au/

**Figure 2: Typical Energy Consumption in an Office Building[3]**

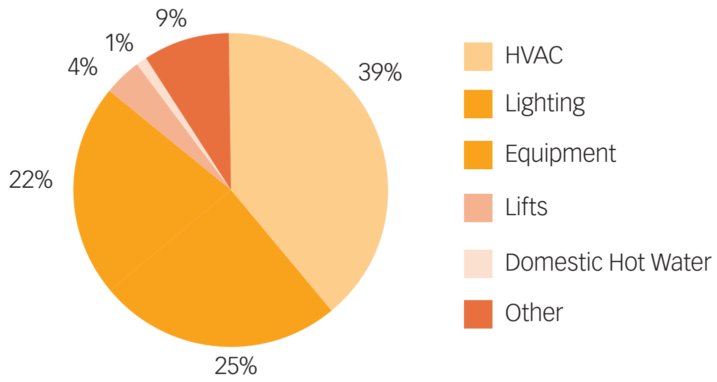
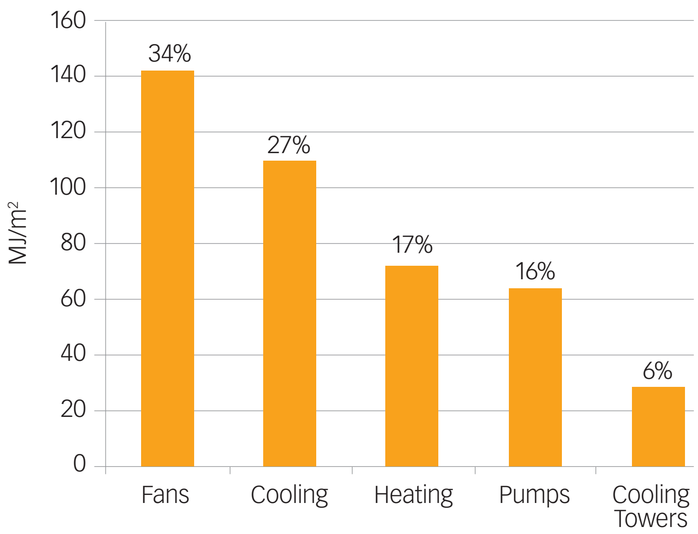



**Figure 3: Typical Energy Consumption of HVAC Systems[3]**




It is important to reduce overall energy use and increase energy efficiency, while delivering a comfortable environment. Optimum comfort for sedentary work is between 20°C and 26°C, depending on the time of the year and clothing worn[4]. Generally the temperature in office buildings should vary according to the outside temperature and should be changed month to month.

In order to maintain a comfortable temperature and humidity level within a building, the HVAC system must overcome all of the different loads in the building that work against the desired conditions. The methods to improve energy efficiency in a building's HVAC system can be broken down into two categories:

1. reduction of the loads within a space that the HVAC system has to overcome
2. improve efficiency of HVAC equipment and systems.

## 1. Reduce Loads Within Space

- Reduce Equipment Load – Reducing usage of heat-producing equipment such as computers, printers and lights will reduce the need for HVAC systems to condition a space. Simple things such as turning off monitors, computers or lights when they are not in use will reduce conditioning loads.
- Improvements to Façade (Walls) – Increasing the insulating properties of the building fabric will generally decrease the amount of cooling or heating required, and hence reduce overall energy usage.
- Improvements to Façade (Windows) – Window loads occur in the form of solar radiation and conduction. Solar radiation refers to the heat created as direct sunlight comes through a window and hits a solid surface in an internal space absorbing the electromagnetic radiation. Conduction refers to the movement of heat from the hotter side of the window to the cooler side. Shading devices minimise the solar load from the windows and reduce loads in the space. A typical double-glazed window will conduct significantly less heat into a room than a typical single glazed window. Another aspect to be considered is air sealing, a lack of which can lead to increased conditioning requirements.

  For further information see the *Revolving Doors Factsheet*[2].
- Demand Based Ventilation – Conditioning fresh air requires considerable energy as it is often at a significantly different temperature to that desired in the space. A minimum quantity of fresh air is required in a space based on occupancy in accordance with Australian Standards. Carbon dioxide ($CO_2$) sensors can be used to determine the minimum amount of fresh air required and lower the fresh air supplied, saving energy.

## 2. Improve HVAC System Efficiency

- System Selection – Significant energy savings can be realised through optimal system selection. For example, a Variable Air Volume (VAV) AHU regulates the volume of the supply air to the spaces depending on the amount of heating or cooling required. This system allows for greater control and reduces airflow rates, which reduces overall fan energy consumption. This greater control may also reduce energy wastage associated with re-heating, where the heating system counteracts the cooling system.

  For further information see the *Air Handling Unit Factsheet*[2].
- Plant Selection – Plant selection can greatly affect the overall energy consumption of a building. For example, condensing boilers - used for the provision of heating hot water - can have gross efficiencies over 90%.

3 *Guide to Best Practice Maintenance and Operation of HVAC Systems for Energy Efficiency (January 2012).* http://ee.ret.gov.au/energy-efficiency/non-residential-buildings/heating-ventilation-and-air-conditioning-hvac

4 WorkSafe Victoria, Compliance Code for Workplace Amenities and Work Environment, 2008

Evaporative pads can be used on air cooled chillers to pre-cool air prior to reaching chiller condensers, improving efficiency. Accurate plant sizing also has a large impact on energy efficiency. Chillers generally work most efficiently at a particular load, so they should be sized to operate at or near this load most of the time.

For further information see the *Boiler Efficiency and Chiller Efficiency Factsheets*[2].

- Building Tuning and Commissioning – Energy savings can be achieved through the commissioning and tuning process. After a HVAC system has been installed, commissioning and on-going tuning of the system will allow the system to function as per the original design intent, optimise its operation and obtain maximum energy savings.

  For further information see the *Commissioning and Building Tuning* and *Coil Cleaning Factsheets*[2].

- Energy Recovery – Energy recovery involves capturing waste energy and recycling it. Exhaust air is generally closer to the desired space temperature than the outside fresh air being introduced into the system. Heat or 'coolth' can be drawn from the exhaust air and used to pre-warm or cool the fresh air entering the system prior to it reaching the AHU. This lowers the energy used by the AHU to condition the fresh air.

  For further information see the *Heat Pump and Heat Recovery Factsheet*[2].

- Smart Control Strategies – There are many examples of smart control strategies achieved through optimisation of the BMS and building information available to it. One option is to install smart control software that allows the BMS to determine optimum operating conditions for the entire HVAC system to achieve the lowest energy consumption. To achieve this it is important to optimise consumption information for separate parts of the HVAC system. This can be achieved through installation of sub-metering and sensing.

  For further information see the *Wireless Metering* and *Building Management Systems Factsheets*[2].

- Economy Cycle – Economy cycle involves using 100% outdoor air to supply air to the space. This occurs at times of the year when the outdoor conditions are cooler than the return air temperature in cooling mode. This allows the plant to turn off the cooling coils and reduces chiller energy consumption.

  For further information see the *Retrofit of 4 Mort St Canberra Case Study*[2].

## HVAC HESS

HVAC HESS is a ten year strategy under the National Strategy on Energy Efficiency that aims to drive long term improvements in energy efficiency of HVAC systems Australia-wide. Under the Energy Efficiency Working Group, the Buildings Committee manages the implementation of the HVAC Strategy. This committee is comprised of representatives from Australian, State and Territory Governments.

The Strategy takes a whole of life perspective in targeting HVAC efficiency improvement, encompassing the design, manufacture, installation, operation and maintenance stages of the HVAC lifecycle. The Strategy consists of a number of complementary measures that fall under three broad initiatives – People, Practices and Systems. This Basics of HVAC Energy Efficiency factsheet relates to all three categories. It is one of a suite of factsheets developed to provide a quick overview and reference to inform, educate, and encourage energy efficiency in the HVAC industry.

**A series of HVAC HESS factsheets can be found at:**
http://ee.ret.gov.au/

## Acknowledgements

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