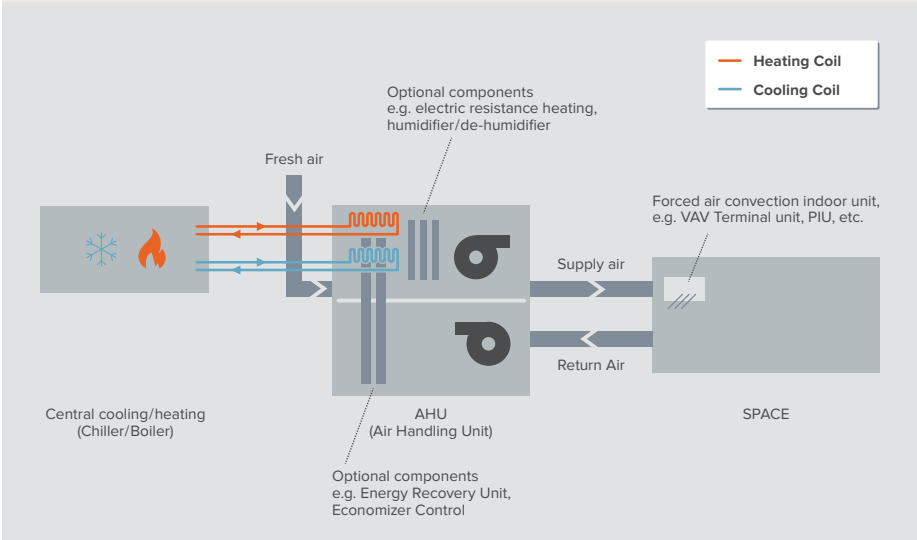
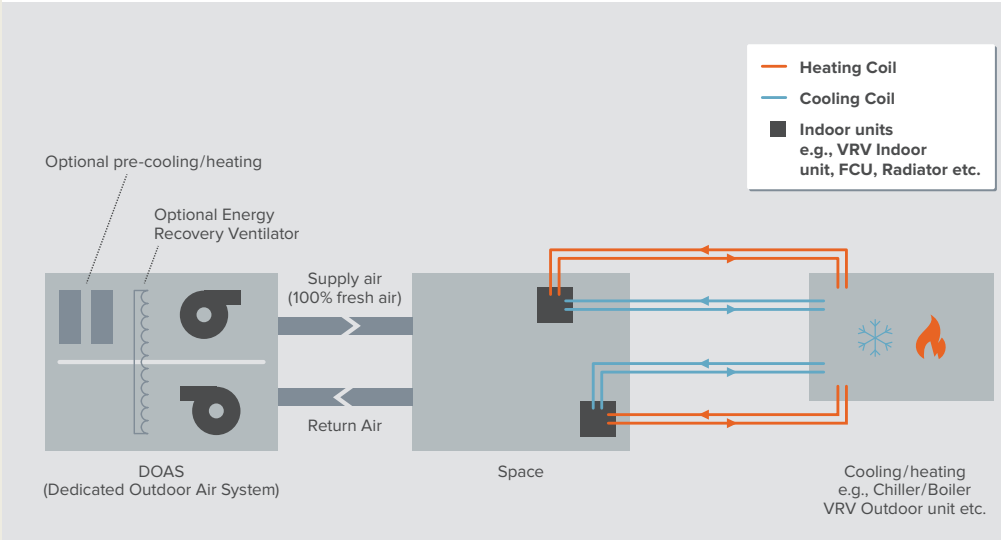
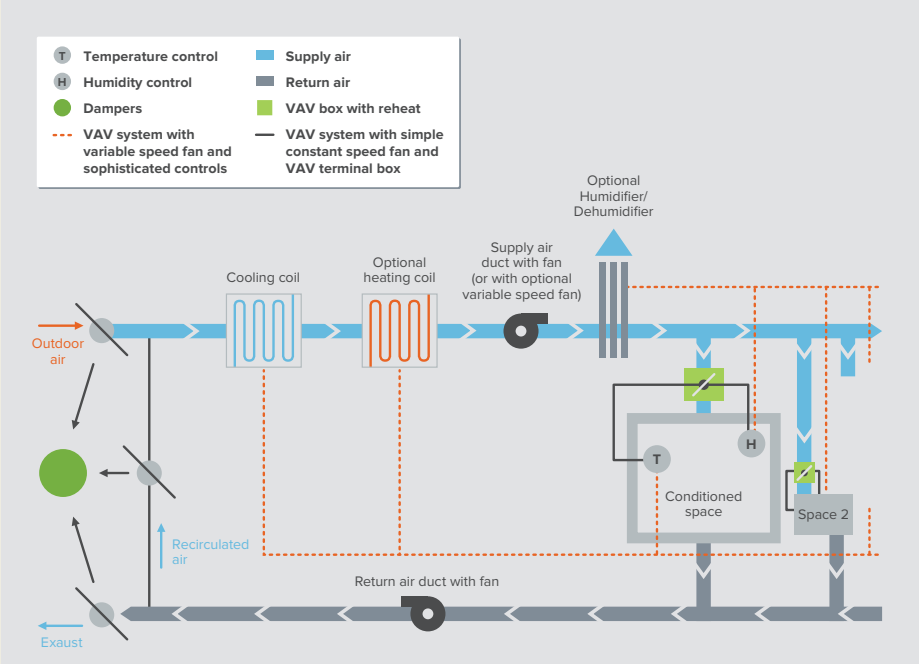
Central Heating, Ventilation and Air-Conditioning systems

Central air conditioning refers to systems, in which a central cooling/heating plant and a central ventilation unit serves all conditioned areas of a single building or serves multiple buildings. Central air conditioning is divided into two broad categories. One is ventilation systems integrated with cooling/heating and doubling up as air conditioning systems knows as All air systems and the other is stand alone ventilation systems with separate cooling/heating systems known as Air-water/refrigerant systems. The latter are usually much more energy-efficient than All air systems, saving up to around 40 % of energy, and may even cost less to install.

	All air systems	Air-water/refrigerant systems
	Figure 1: All air systems	**Figure 2: Air-water/refrigerant systems**
		
Description	When the cooling/heating of the space is primarily done by the forced convection of conditioned air it is referred to as all air system. All air systems typically have a central source for for cooling and heating in the form of chilled/hot water or	Unlike all air systems, air water systems typically have separate central cooling or heating and central/local ventilation systems. Cooling or heating is done at the zone level (typically consisting of central Variable Refrigerant Volume/Flow (VRV/VRF) systems, or

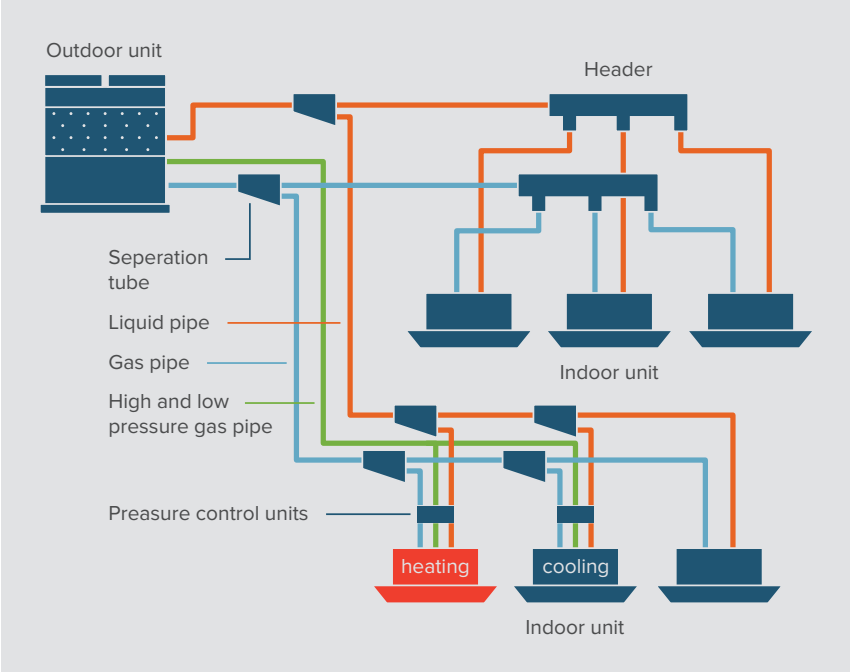
	electric resistance which is carried into special units called Air Handling Units (AHU) through coils . Ambient air is cooled/heated by blowing over these coils and then sent into the space to be conditioned. The return air from the space is mixed with supply air which also includes a component of fresh air for ventilation (see figure above) Typical examples include, packaged HVAC equipment, central chiller assisted with AHUs for space conditioning.	electrical heating, or chilled/hot water) and the ventilation air is drawn from a Dedicated Outdoor Air System (DOAS). Cooling or heating is done through pipes carrying cold and hot water or refrigerant to the zone terminal units and is transferred to the zone by local convection or radiation or by both (see figure above). Typical examples include VRV systems or central chiller + Zone terminal units like Fan Coil Units (FCU) units with DOAS systems for ventilation. For residential Ultra-Low-Energy or nearly-Zero-/Plus-Energy Buildings in colder climates or seasons, a typical energy-efficient solution are radiant heating + local heat recovery ventilator unit.
Application	All air systems are genreally chosen when the rate of space cooling/heating is high. E.g., offices with high internal cooling/heating loads or spaces with a constantly fluctuating loads such as food courts etc., spaces with high infiltration rates such as vestibules, corridors, etc. However, it is more popular form of central air conditioning and is used even in spaces with less cooling/heating demand such as offices with sedentary activity and low internal loads, residential units etc. Though Air-water systems suit spaces with low rates of cooling/heating All air systems are still being widely used. This is because they are the earlier and still more popular form of central air conditioning and perceived to be chepaer than Air-water/refrigerant systems.	Air-water/refrigertion systems are generally chosen when the rate of space cooling/heating is low. They typically suit offices with sedentary to moderate activity, residential buildings, places with a typically constant internal loads such as data centres, hotel rooms etc. **Air water systems are in general more energy efficient than all air systems** because the cooling/heating is done through radiation/passive convection rather than forced air convection. This is because of drastic reduction in the amount of conditioned air that is required to maintain space temperature which inturn reduces the required supply temperature of cool/hot water. Further, air-water systems with Heat Recovery Ventilation augment the energy savings.
Cooling/heating production a.k.a High side	Typically heating/cooling is produced in a central location with the use of DX refrigerant systems like packaged AC systems (see Room AC for more information) or central chilled water systems using chillers (see Central AC and Solar cooling for more information) or boilers. See bigEE ‘recommendations’ for best measures on energy efficiency in heating and cooling systems.	Typically heating/cooling is produced through DX systems like split AC or VRV/VRF systems (see Room AC for more information) or central chilled water systems using chillers (see Central AC and Solar cooling for more information) or boilers, or heat pumps. See bigEE ‘recommendations’ for best measures on energy efficiency in heating and cooling systems.
Cooling/heating distribution a.k.a. Low side	Cooling or heating distribution in All air systems is typically done through **Air Handling Units (AHU)**. An AHU typically consist of a supply fan, air filters, cooling coil, heating coil, humidifier or a dehumidifier, economizer, heat recovery unit and	The chilled or hot water/refrigerant is carried through from the central cooling or heating source to the space to be conditioned through specially insulated copper pipes and the heating or cooling is distributed to the space using special room terminal devices such as

a return fan. The function of an AHU is to draw in air from the outside, filter the air, condition the air appropriately and circulate the air in the space. Fresh air is drawn periodically depending on the fresh air requirement. AHU mixes some amount of fresh air with the return air and supply it to the zones. The excess return air is exhausted. A Heat Recovery Ventilator unit can also be added between the supply and return air streams. Air systems can be further classifed as **Constant Air Volume (CAV)** systems and **Variable Air Voluem (VAV)** systems with a single duct or a dual duct operation for both systems.



Typical Variable Air Volume system

FCUs, radiators etc.



Typical VRV/VRF unit configuration

/entilation system

Special ventilation is system is not required as AHU takes care of both fresh air requirements and space conditioning. AHU either draws fresh air directly from outside or from a **Dedicated Outdoor Air System (DOAS)** when the air quality of the outdoor air is to be improved significantly or the individual AHUs in the building are not capable to access fresh air directly from outside. The zone level sensors like the temperature sensor; Co2 sensor, humidity sensor etc. control the temperature of supply air, the flow of supply air and outside air mixing. The air from the AHU is circulated in space through insulated ducts.

Central

A **Dedicated Outdoor Air System (DOAS)**, a.k.a. **Treated Fresh Air unit (TFA)** is a system used for ventilation in Air-water/refrigeration systems. A DOAS is like a typical AHU but without cooling and heating coils and takes in 100 % fresh air (though some form of pre-cooling or pre-heating, or humidification or dehumidification is done as per the climate and demand).

Decentral

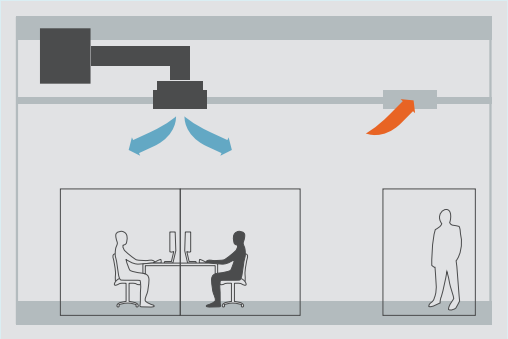
In decentral systems Ventilation is don through a spot ventilation system integrate with the room terminal unit like special FCU or HR units. They are typcailly through th wall units. It could also contain an option Heat Recovery Unit and a return air fan. Th fan speed in decentral ventilation system can be regulated locally or can b automated.

\ir Circulation

Air circulation system are common to both All air systems and Air water systems

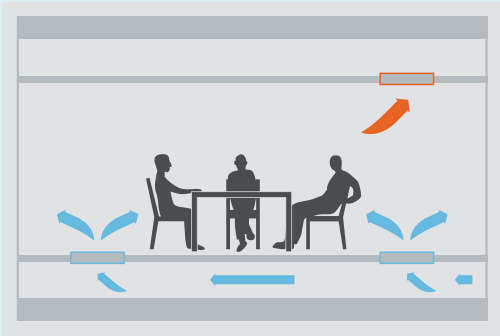
Ceiling supply and plenum/duct return

This type of distribution consists of supply air ducts by forcing air through the diffusers in the ceiling. This system operates through forced air convection. The return air either circulates back through a return air duct within the ceiling or a pressured plenum, which acts as a return air path.



Floor supply and plenum/duct return

Under Floor Air Distribution (UFAD) system as the name suggests provides the supply air from beneath the false floor. The hot air rises up and is collected at the top for return. This system can be operated as all air system or integrated with air water systems such as chilled beam or chilled ceiling technology through the use of DOAS systems. Typically UFAD systems have multiple stand alone AHUs, which pressure the false floor and have a separate DOAS system.



Room terminal units

Room terminal units – Combined ventilation cum heating and cooling

Room terminal units – Combined ventilation cum heating and cooling

Room terminal units – Separate Ventilation & heating and cooling

1.1.1.1 Diffuser/terminal box

A terminal box is a zone terminal unit in all air VAV systems. It could also contain a reheat coil to control the temperature and a damper to control the flow of air.

1.1.1.2 Power induction units

Power induction units are zone terminal boxes used for VAV systems. They consist of a heating coil and a secondary fan in either parallel or series with variable volume valve.

1.1.1.3 Underfloor air distribution boxes

Under floor air distribution box are similar to terminal boxes except that they are located on the floor instead at ceiling level. They also do have a reheat element for local temperature control and occasionally contain a fan as well.

Ducted system

Ducted systems have room ventilatin air passing through the room terminal unit which contains heating or cooling elements. Forced air **convection** occurs locally through which space is conditioned.

1.1.1.4 Fan coil units

The fan coil units are zone terminal units being supplied by chilled water or hot water pipes. The cooling in the zone is assisted by a fan attached to the unit which blow air over the coils into the space. The chilled water or hot water in the coils is supplied from a central plant (for more see cooling). FCU can be either floor mounted or window mounted or ceiling mounted. Since FCU is an air water system, a separate ventilation system has to be used for providing adequate ventilation to the space.

Non-Ducted

Non ducted systems have separate zone terminal unit for heating and cooling and a separate terminal unit for ventilation. In this kind of systems heating or cooling occurs through passive **radiation**. These and similar terminal (cooling delivery) approaches are common for commercial buildings but rarely used in residential applications. Cooling radiators temperature must stay above the local dewpoint to avoid condensation, which limits their application to low humid climate zones.

1.1.1.6 Wall mounted radiators

Radiators are room terminal units and are general used for heating. Heating distribution throug radiation is typically done through radiators mounte on the wall. Hot water from a central boiler circulated trough insulated pipes to radiators.

1.1.1.7 Radiative floor heating/cooling

Under floor heating works on the principle radiation. Hot water is circulated throug sophisticated layout of pipes beneath the floorin The warm floor then warms up the space throug radiation. Special piping and flooring requiremen make under floor heating an expensive optic

1.1.1.5 Cassette units

Cassette units are zone terminal units being supplied by refrigerant. They are typically split heat pump with a central VRV unit and are being capable of both heating and cooling. Few of them work with cold and hot water pipes also in a similar fashion to the fan coil unit. It fits into the ceiling and have diffusers in two, three and four directions.

compared to radiators.

1.1.1.8 Chilled beam/chilled slab

Chilled water or hot water is circulated through pipes located in a suspended false beam or slab through which space is conditioned using radiative heat transfer.

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