3encult

EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

Efficient active solutions
HVAC systems for historic buildings

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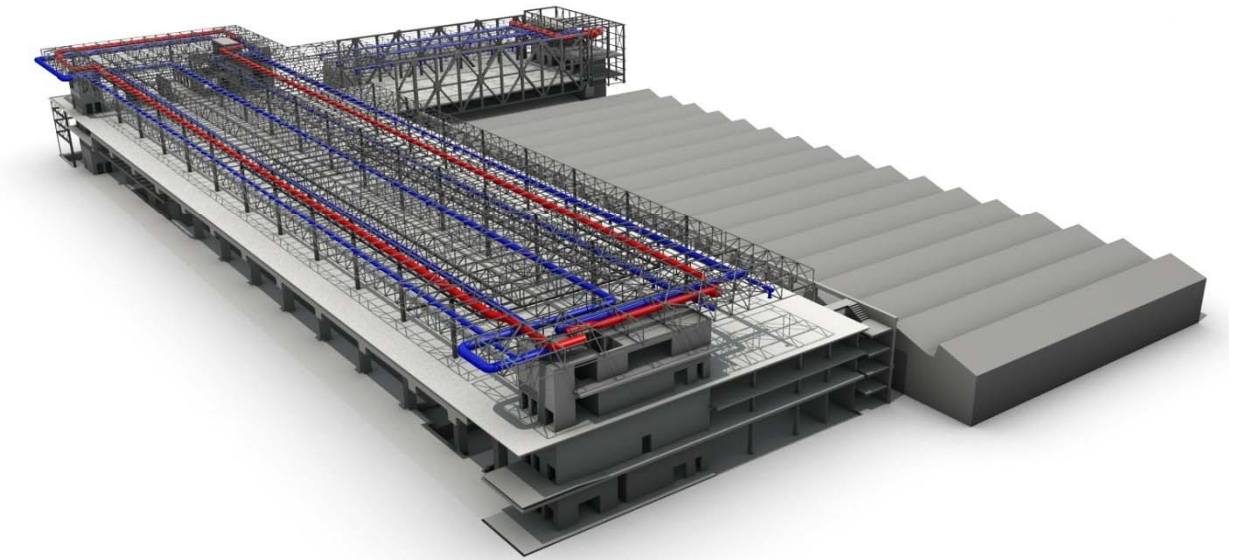
HVAC System

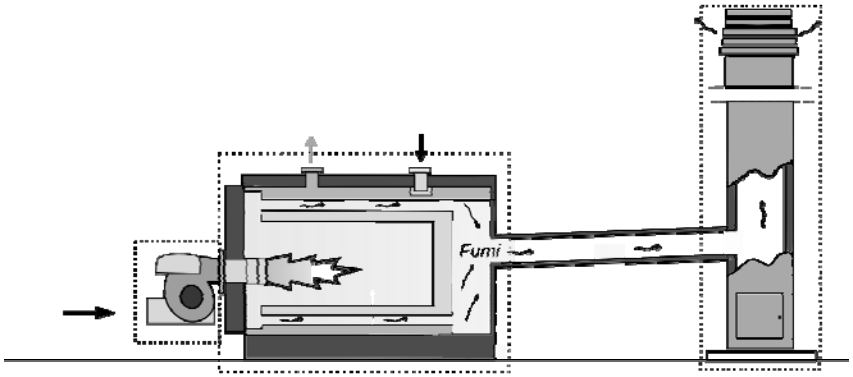
- Building system subdivided in:

1. **Generation**
2. **Ventilation**
3. **Emission**



1. Generation

Gas Boiler



Cost

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Energy Efficiency Improvement

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Gas Boilers are characterized by a gas burner and the boiler itself. Most recent burners are able to modulate their heating power following the requested heat, with a range from 10% to 100% of their nominal power, increasing efficiency and reducing gas consumption.

Material: In some case, the chimney exhaust could deteriorate the façade.

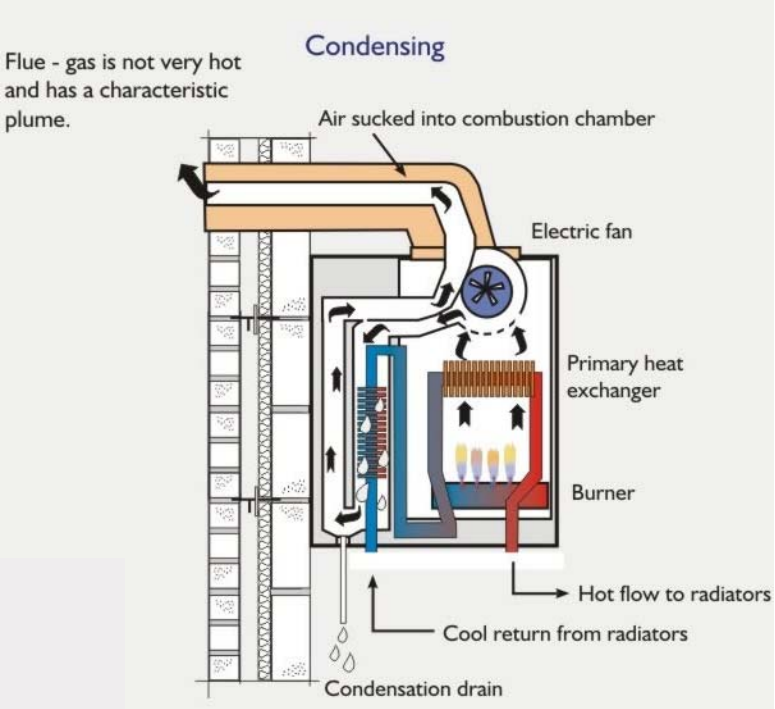
Aesthetic: Excepting the chimney, all the equipment could be placed in the basement.

Reversibility: This system is commonly used because it is easy to install and repair.

Visibility: the chimney can be integrated with the architecture. The boiler is usually hidden in the basement.

1. Generation

Condensing boiler



Condensing boilers are composed by the same component of a traditional gas boiler. Their high efficiency is guaranteed by the energy recovered from the latent heat due by the condensation of the vapor contained in the combustion gases

Material: In some case, the chimney exhaust could deteriorate the façade.
Aesthetic: Excepting the chimney, all the equipment could be placed in the basement.
Reversibility: This system is commonly used because it is easy to install and repair.
Visibility: the chimney can be integrated with the architecture. The boiler is usually hidden in the basement.

Cost

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Energy Efficiency Improvement

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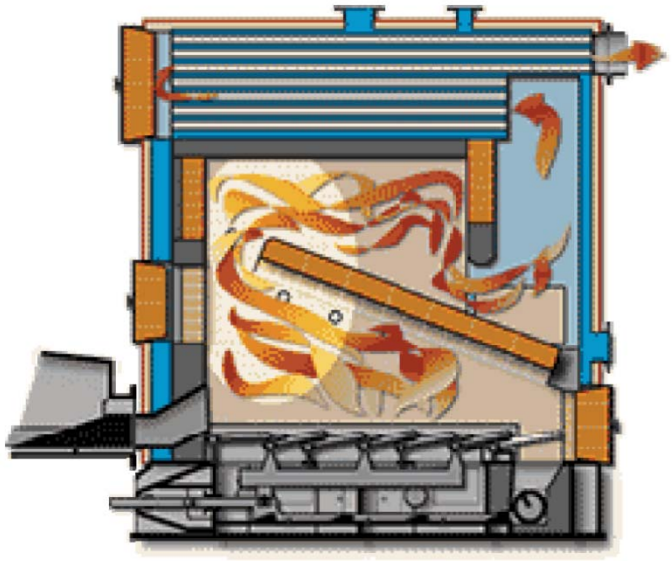
1. Generation

Wood fired boiler



© Binder

Wood fired boilers are physically much larger, have a greater thermal inertia and less responsive fuel control supply systems than conventional gas fired boilers.

Material: In some case, the chimney exhaust could deteriorate the façade.
Aesthetic: Excepting the chimney, all the equipment could be placed in the basement.
Reversibility: This system is commonly used because it is easy to install and repair.
Visibility: the chimney can be integrated with the architecture. The boiler is usually hidden in the basement but a storage space is needed.

Cost

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Energy Efficiency Improvement

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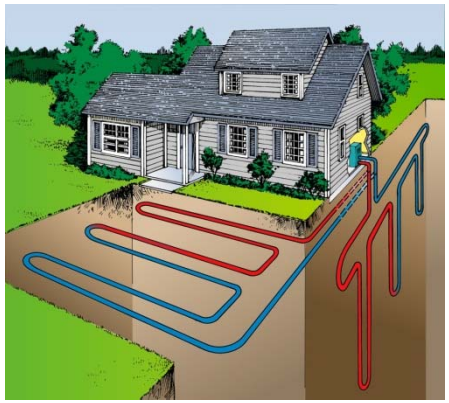
1. Generation

Ground heat pump (close loop)



Shallow geothermal energy systems also known as ground energy systems, normally linked to a Ground Source Heat Pump (GSHP) are used as source of low CO2, low enthalpy energy to provide cooling and/or heating to buildings.

Material: Building materials are not affected by this system.
Aesthetic: the aesthetic of the building should not be affected.
Reversibility: 150 m deep pipes are placed into the ground. They cannot be replaced or repaired once they are positioned.
Visibility: This solution is not visible from the outside

Cost
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Energy Efficiency Improvement
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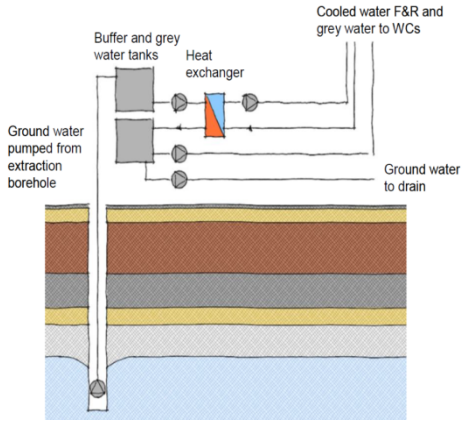
1. Generation

Ground heat pump (open loop)



Open-loop use of ground water extracted from underground aquifers through boreholes, for cooling, or cooling and heating (using heat pumps). A typical borehole installation is hole with a steel pipe casing.

Material: Building's material is not affected by this system**.**
Aesthetic: the aesthetic of the building should not be affected.
Reversibility: a well is needed to extract the ground water. The HP pump can be replaced or repaired.
Visibility: This solution is not visible from the exterior, a chimney is not needed

Cost ●●○○○

Energy Efficiency Improvement ●●●●●

1. Generation

Heat pump (air condensed)

Heat pumps are hydraulic mechanical systems that are used to produce hot water through an inversion of the chilled circuit. Air condensed heat pumps always operate on mechanical energy driven by electricity.

Material: building's material is not affected.
Aesthetic: Air HPs are usually placed outside. They require fans that could be noisy. Moreover, depending on the power needed, their dimension can be relevant.
Reversibility: they are easily removable and replaced.
Visibility: they are usually placed on the roof.

Cost

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Energy Efficiency Improvement

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1. Generation

Heat pump (water condensed)

Heat pumps are hydraulic mechanical system that are used to produce hot water through an inversion of the chilled circuit. Water condensed heat pumps are compression chillers driven by electrical energy where the refrigerant is condensed thanks to circulating water.

Material: building's material is not affected.
Aesthetic: HPs are usually placed outside. They require fans that could be noisy. Moreover, depending on the power needed, their dimension can be relevant.
Reversibility: they are easily removable and replaced.
Visibility: they are usually placed on the roof.

Cost

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Energy Efficiency Improvement

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1. Generation

Heat pump (absorption)

The absorption chillers/heat pumps have an absorber, and they have a heat generator that works as concentrator. This kind of heat pumps are classified in accordance to the refrigerants used, to the heating generators or from the number of heating generators. The heating source can be for example a more conventional burner or the district-heating or (more innovative) solar panels.

Material: building's material is not affected.
Aesthetic: HPs are usually placed outside. They require fans that could be noisy. Moreover, depending on the power needed, their dimension can be relevant.
Reversibility: they are easily removable and replaced.
Visibility: they are usually placed on the roof.

Cost
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Energy Efficiency Improvement
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1. Generation

Micro CHP

In this kind of systems there is a combined production of heating and electricity. The heating produced while producing electrical energy is used for heating or for DHW. With co-generation the resulting efficiency is even more than the 90% with a primary energy saving compared with the separated production of around 28%.

Material: The chimney exhaust could deteriorate the façade in some case.
Aesthetic: Except the chimney, all the equipment can be placed in the basement.
Reversibility: Depending on the size, this system could need to be controlled regularly.
Visibility: the chimney can be integrated with the architecture. This system is usually placed in dedicated technical room.

Cost

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Energy Efficiency Improvement

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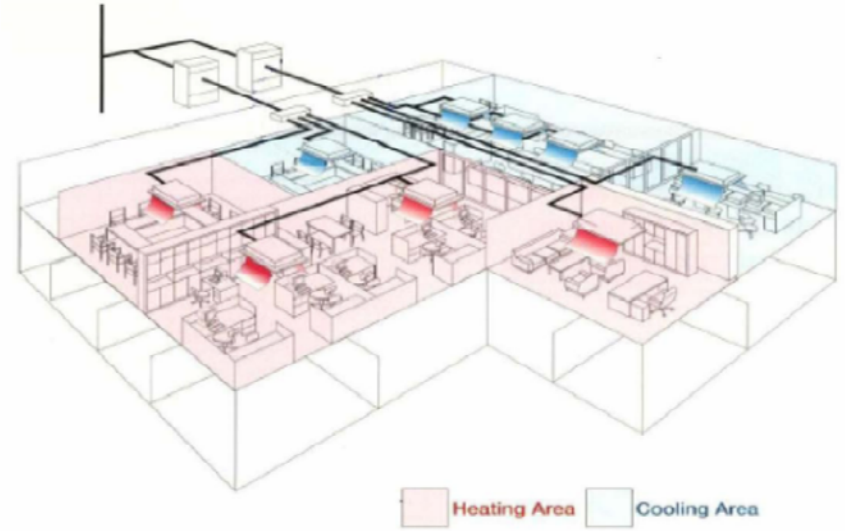
1. Generation

VRF System



Variable refrigerant flow (VRF) systems, also known as variable refrigerant volume (VRV) systems, are essentially a multi-split DX system in which a number of indoor units are connected to a single outdoor unit.

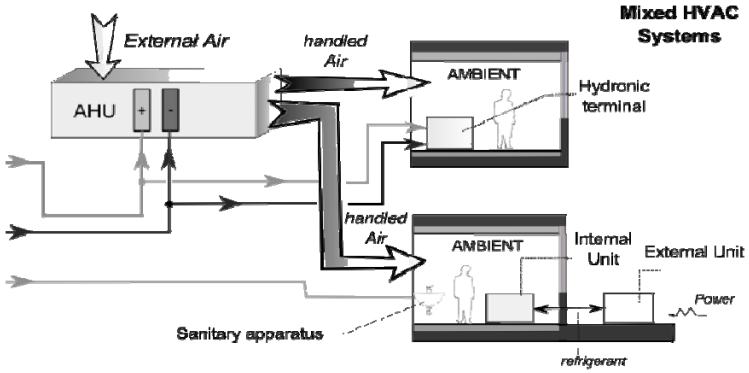
Material: building's material is not affected.
Aesthetic: VRF system is usually placed outside. They require a fan, that could be noisy.
Reversibility: they are easily removable and they can be replaced one by one.
Visibility: they are usually placed on the roof.

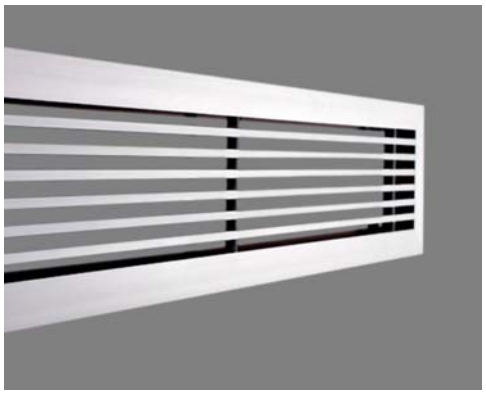
Cost ●●●●○

Energy Efficiency Improvement ●●●○○

2. Ventilation

Mixed ventilation





Mechanical ventilation is used to guarantee adequate ventilation rate of primary air. Furthermore in order to minimize the ventilation losses an heat recovery system from the exhaust air can be introduced.

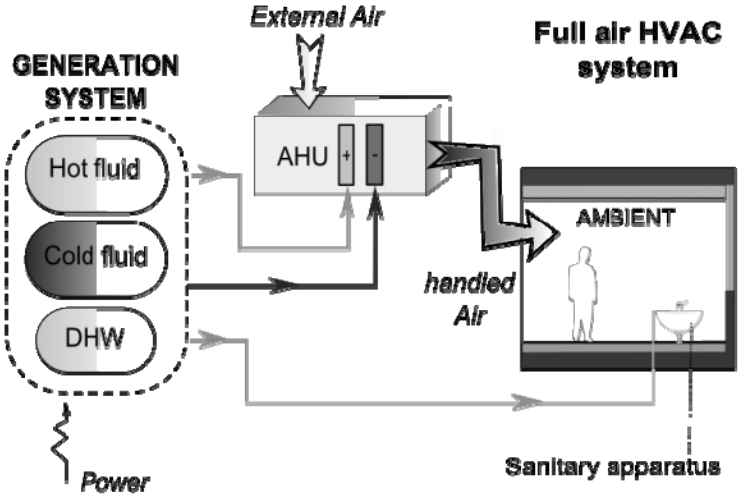
Material: a mixed ventilation mode requires the installation of relatively small diffusers inside each room (see pictures).
Aesthetic : It is not always easy to integrate this system in existing building.
Reversibility: This system need to be refurbished about every 20 years.
Visibility: It depends on the building type, however it is usually visible.

Cost ●●●●○

Energy Efficiency Improvement ●●●○○

2. Ventilation

Full air



This ventilation systems are commonly used in crowded spaces where there are high internal thermal loads and there are high primary air ventilation rate requirements. All air system is composed by an Air Handling Unit (AHU) where the air is treated and then diffused into the rooms through ducts and air vents.

Material: the main component of this system is: Air Handling Units (see picture above), linked with ducts to air diffuser. This system requires a lot of space.
Aesthetic: In historical buildings, sometimes, ducts are visible and made of cupper. In this case they can be well integrated with the architecture.
Reversibility: This system need to be refurbished about every 20 years.
Visibility: It depends on the building type, however it is usually visible.

Cost
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Energy Efficiency Improvement
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3. Emission

Radiators

Radiators are the most common and traditional emission system. They are classified in accordance with the material in which they are produced. Their efficiency is strictly linked with the control system and with the inlet and outlet temperature.

Material: Radiators are heat exchangers used to transfer thermal energy from one medium to another for the purpose of cooling and heating.
Esthetic: this is the most common solution in historic buildings. Their choice is enormous.
Reversibility: Some installed radiators are 50 years old.
Visibility: They need to be visible to work properly.

Cost

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Energy Efficiency Improvement

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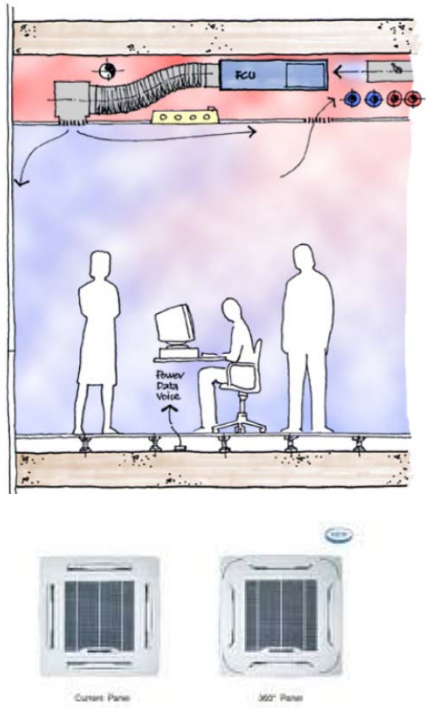
3. Emission

Fan Coil Unit



Fan coil unit ventilation systems are the most common form of air conditioning in many parts of the world. The popularity of FCU systems is due to the relatively low installation cost, flexibility of use, ability to deal with high heat loads, simple local control and reduced plant space.

Material: fan coil units are usually installed in office buildings.
Esthetic: They usually are hidden inside the false ceiling or below the window.
Reversibility: Fan-coils Units need regular maintenance (at least two times per year).
Visibility: They can be hidden, a part from the air diffuser.

Cost

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Energy Efficiency Improvement

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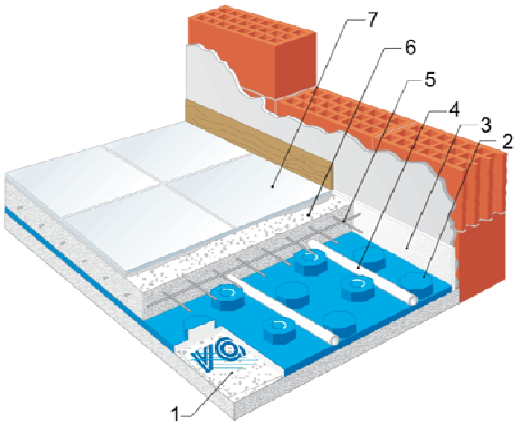
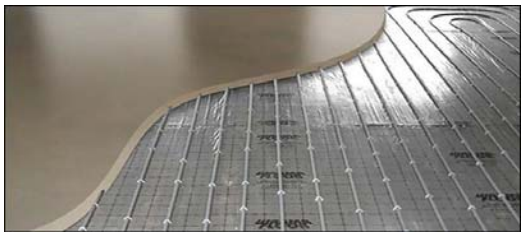
3. Emission

Underfloor heating





Underfloor heating UFH/Radiant floor works by passing low temperature hot water through pipework embedded in, or attached to, the floor. Heat is radiated from the floor and heats surfaces and objects in the room or space above.

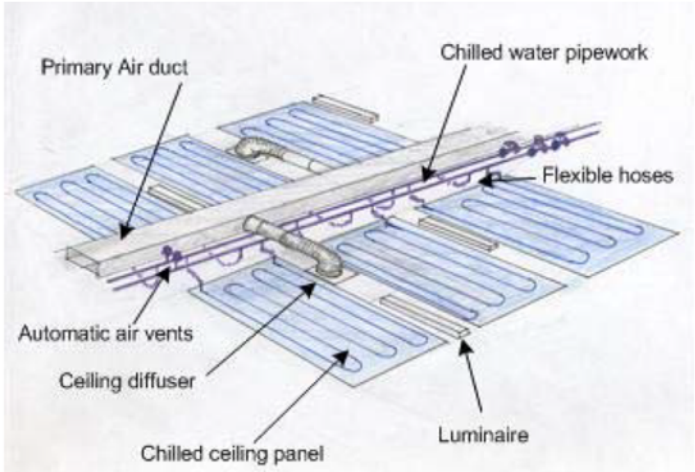
Material: plastic pipes are immersed in the screed. (see picture). Floor needs to be demolished for the installation.
Esthetic: They are not visible.
Reversibility: Material: the main component of this system is: Air Handling Units (see picture above), linked with ducts to air diffuser. This system requires a lot of space.
Aesthetic: In historical buildings, sometimes, ducts are visible and made of cupper. In this case they can be well integrated with the architecture.
Reversibility: This system need to be refurbished about every 20 years.
Visibility: It depends on the building type, however it is usually visible.

Cost ●●●●○

Energy Efficiency Improvement ●●●●●

3. Emission

Chilled ceiling



The chilled ceiling system is sometimes described as a static cooling system in that it transfers cooling to the room by natural convection and radiation in roughly equal proportions. It is a simple device that can offer an energy efficient solution in that distribution of cooling is principally by water and not air.

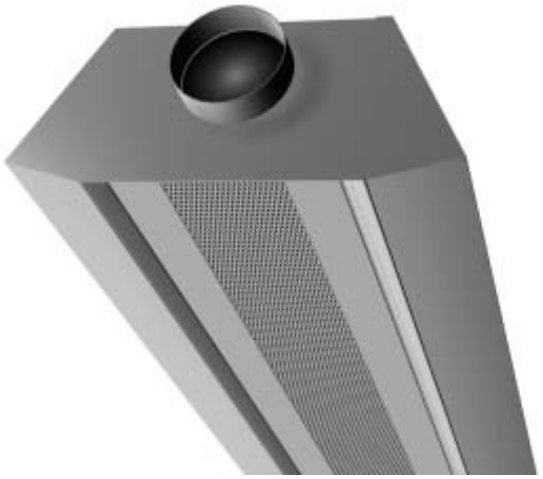
Material: A false ceiling is needed.
Esthetic: They are behind the false ceiling. So it depends on the false ceiling choice.
Reversibility: this system can be replaced .
Visibility: They are behind the false ceiling. So it depends on the false ceiling choice.

Cost ●●●○○

Energy Efficiency Improvement ●●●●●

3. Emission

Chilled beams



Chilled beams consist of water cooled finned tube convectors which make use of natural and/or induced convection to provide cooling. This is still a relatively new technology and only a small number of these systems have been installed.

Material: Chilled beams are attached to the ceiling.
Esthetic: they usually are considered aesthetically Good.
Reversibility: this system can be replaced and maintained easily.
Visibility: see pictures above.

Cost

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Energy Efficiency Improvement

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3. Emission

CAV (Constant Air Volume)

The inlet air is mixed with the ambient air and extracted through other air-vent. For this kind of system it is really important to control and design the position of the air-vents in order to assure good air quality and homogenous thermal conditions in the ambient.

Material: the main component of this system is: Air Handling Units, linked with ducts to air diffuser. This system requires a lot of space.
Aesthetic: In historical buildings, sometimes, ducts are visible and made of cupper. In this case they can be well integrated with the architecture.
Reversibility: This system need to be refurbished about every 20 years.
Visibility: It depends on the building type, however it is usually visible.

Cost

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Energy Efficiency Improvement

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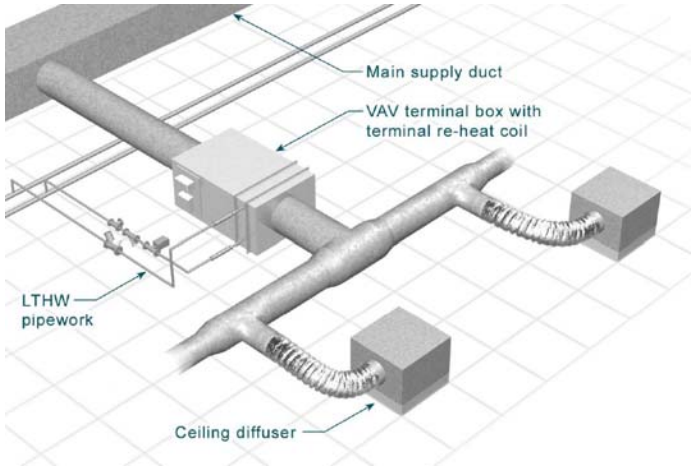
3. Emission

VAV (Variable Air Volume)



VAV is an all-air system with air supplied at a constant temperature with modulation of supply volumes to match the room sensible load. VAV is primarily to provide cooling and requires supplementary systems for heating typically perimeter heating or terminal re-heat.

Material: the main component of this system is: Air Handling Units (see picture above), linked with ducts to air diffuser. This system requires a lot of space.
Aesthetic: In historical buildings, sometimes, ducts are visible and made of cupper. In this case they can be well integrated with the architecture.
Reversibility: This system need to be refurbished about every 20 years.
Visibility: It depends on the building type, however it is usually visible.

Cost	Energy Efficiency Improvement
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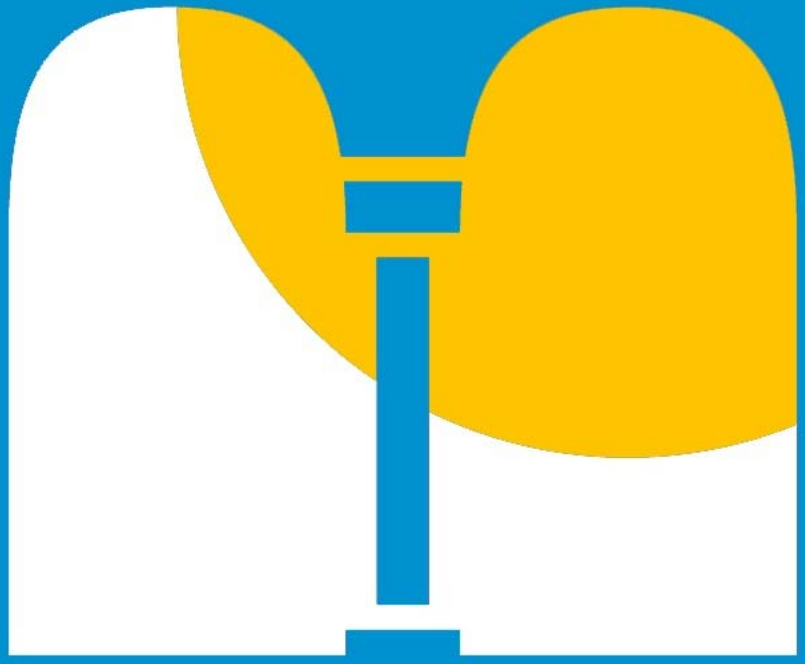

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