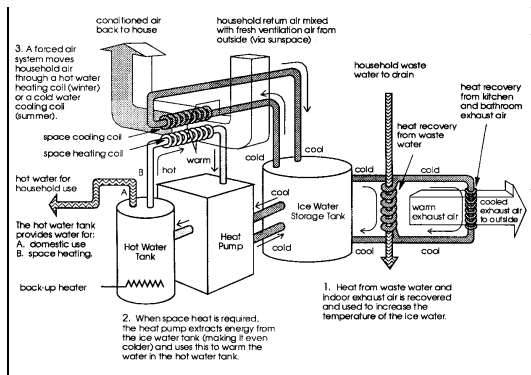


## Heating, Cooling, and Ventilation

In new construction there is an increasing push towards using an integrated mechanical system. This means that space heating and cooling, water heating, ventilation, and heat recovery work together as one unit. The reason for doing this is the increased efficiency offered by the systems. There are many different approaches being used to combine these various elements into one unit as numerous prototypes hit the market. Furthermore, energy efficient airtight homes require a ventilation system to retain high indoor air quality.

### Integrated Mechanical System

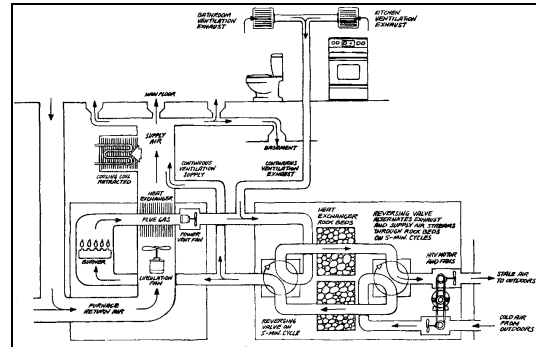
- The Brampton Advanced House uses a product called Solmate™, developed by Allen Associates
- The Solmate™ provides space heating, water heating, passive solar storage, heat recovery from grey water, and partial cooling. It is based on a heat recovery pump that moves heat between an ice water storage tank and a hot water tank. In the winter, heat is extracted from the ice water and delivered to the hot water tank. Space heating requirements are met via a fan coil unit.



Schematic of the integrated mechanical system in the Brampton Advanced House [1]

- The Waterloo Region Green Home uses a system developed by John Overall at Canadian Gas Research Institute (CGRI). As indoor air leaves, it passes through a small, screened metal box full of stones, warming up the stones. Outdoor air is then

drawn in through a valve system and directed over the warm rocks before it enters the combustion chamber. Two rock beds are used, continually being switched from cooling to warming. This switching prevents freezing of the rock beds. The HRV recovers about 83% of the heat in the outgoing air. This boosts the efficiency of the furnace above 90%, making it at least as efficient as more expensive high-efficiency furnaces. [2]



Schematic of the integrated mechanical system in the Waterloo Region Green Home [3]

- Ontario Hydro estimates 18500 kWh/a are used for space heating the average residential home in Ontario. The Waterloo Region Green Home uses only 1000 kWh/a. [4]

### Cooling

- Passive cooling: prevent the sun's rays from hitting the building by planting shade trees
- In hot climates, use awnings, porches, shades, etc. to prevent the sun from penetrating into the building
- Cold water can be circulated throughout the building to provide cooling
- The Prince George Native Friendship Centre makes use of a night "flush" of cool air to help remove the daytime heat stored in the thermal mass of the building

### Ventilation

- Due to better building envelopes, ventilation, not heating, often becomes the main focus of the mechanical systems
- Ceiling and portable fans are much more cost effective than air conditioner units

- Natural ventilation with a few fans can eliminate the need for a conventional system
- Operable windows and fresh air vents under windows allow fresh air to enter the building
- As the fresh air warms, it rises and exits through louvres, simultaneously drawing in fresh air
- Natural ventilation eliminates the need for refrigerated coolants
- Copy machine areas need to be directly ventilated to maintain healthy indoor air standards

### **Heating**

- A heat recovery unit should be used to preheat incoming fresh air with outgoing exhaust air
- Natural gas is a cleaner and more efficient way of heating
- The main duct leaving a furnace should not be the same size throughout its length. As secondary ducts shoot off the main line, the main line should become smaller in order to maintain an adequate pressure in the line. This allows for a smaller and less expensive furnace fan to be installed.
- With high-efficiency windows, there is no longer a need to locate heating vents directly below windows, along exterior walls. They can be located along interior walls instead, allowing for shorter duct lengths. This will save material, installation costs, and material costs.
- Warm air entering a room and cool air being drawn out of a room should not be mixed. This means having the warm air enter at one level, either the ceiling or floor, and the cool air leaving by the opposite level. This helps to maintain the highest possible efficiency of the furnace.

### **Heat Recovery Ventilator**

- Incoming air passes through alternating membranes in the opposite direction of the outgoing air, recovering some of the heat in the exhaust air stream

### **Solar Thermal Energy**

- Solar thermal energy systems are used to heat indoor air and water and for air conditioning as well

- Solar collectors trap the sun's rays to produce heat
- Most collectors contain:
  - clear covers that let solar energy in
  - dark interior surfaces that absorb heat
  - insulation material that prevent the heat from escaping
  - vents or pipes that carry heated air or liquid from inside the collector to the storage area

### **Passive Solar Systems**

- A passively heated building collects solar radiation, converts and stores it as thermal energy, and uses the natural design and ventilation features of a building to circulate the heat throughout the structure
- Windows in a passive building serve to admit solar energy, provide daylight, and capture a view of the outdoors
- A tile floor or masonry/concrete wall provides an excellent medium to store energy for use after the sun has set
- Roof eaves, awnings, light shelves, etc., when sized and oriented properly, provide shade for windows during hot summer days but allow sunlight to fall on them during the colder months
- In a Direct Gain System, sun passes directly into the living area itself. The energy from the sun is then absorbed and stored in the walls, floors, and other surfaces that exist in the room. These walls and floors are made of materials such as concrete, adobe, brick, etc. (good at storing thermal energy).
- Systems such as these typically consist of large expanses of glass on the south facing wall and roof
- In a Solar Wall System, a solar energy collection surface is placed between the glazing and the living space
- These systems function by collecting solar energy in the sunspaces (enclosed areas that supply thermal energy to adjacent buildings) walls and floor. This energy is stored temporarily before entering the adjacent structure.
- Secondary functions of sunspaces include use as a green house, additional living space, enclosure for a pool, etc.

*Note: Check to see if government loan and/or incentive programs exist within your region, for installing such systems*

- Installing solar space heating systems is simple, whether you are retrofitting or incorporating it into an initial design. The

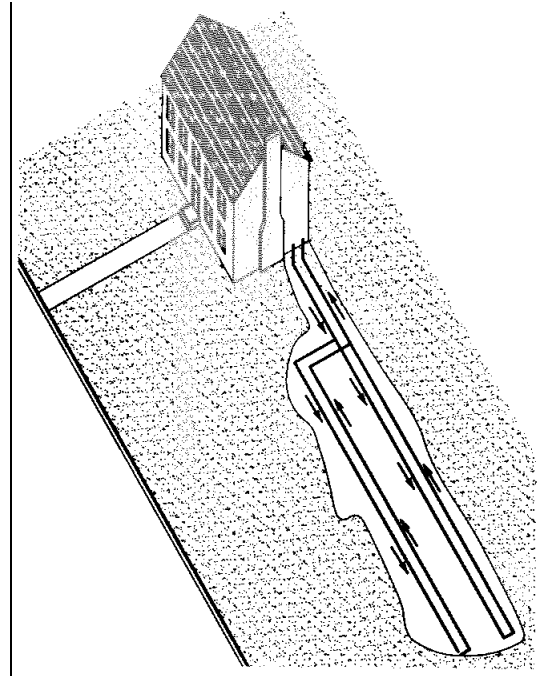
systems are relatively inexpensive and have payback periods for initial investments of 3-6 years [5]

#### Active Solar Systems

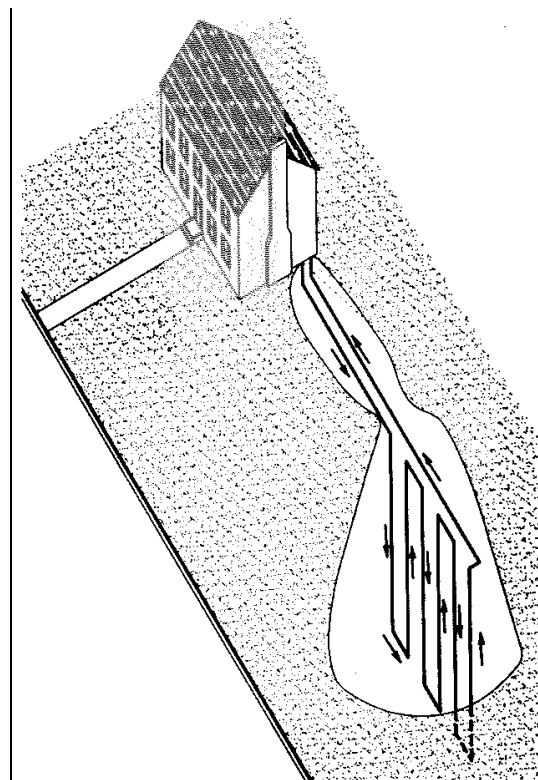
- Active solar systems use pumps or fans to move heated air or water through a building
- In today's systems, the medium being heated is either water or air
- Sunlight passes through the glass surface of the collector, across an air space, and is absorbed by the black-painted metal panels
- Air flowing under the absorbers is heated by contact with it and then blown into a gravel thermal storage bin (located under the building)
- If water is the medium flowing under the absorber, it too is heated by contact with it and drained into a storage tank (typically located in the basement of the structure)

#### Geothermal

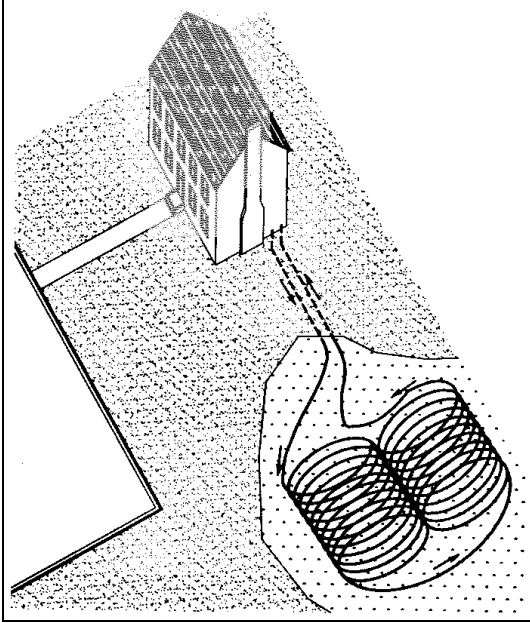
- According to the Environmental Protection Agency, geothermal is the most efficient and least polluting system available
- It is 400-500% more efficient than conventional fossil fuel heating and 25-30% more efficient than conventional air conditioning [6]
- In both applications, it produces much less mechanical noise
- Operating costs are 25-35% less than conventional systems [7]
- The three main components are:
  1. The heat pump
  2. The ground heat exchanger
  3. The air delivery system
- Three types of underground networks are commonly used: horizontal, vertical, and pond



Horizontal Loop System [8]



Vertical Loop System [9]



Pond Loop System [10]

- The horizontal loop runs about 5-6' underground
- The horizontal and pond piping systems are subject to greater seasonal variation
- Vertical pipes are typically installed 75-300' underground
- The pond loop system uses a pond, lake, or retention basin as the heat sink and source
- The vertical loop system is the most efficient, but also the most costly to install
- The absorption and supply of heat is affected by the soil porosity, rock content, moisture content, and soil type

#### Geothermal Reservoirs

- Geothermal reservoirs of hot water can be used to provide heat to a building
- To do this, a well is drilled into a geothermal reservoir to establish a steady stream of hot water. Water is brought up through a well, and a mechanical system (piping, heat exchanger, and controls) delivers the heat directly for its intended use.
- Current uses include heating buildings, drying crops, and a number of industrial processes
- A disposal system then injects the cooled water underground or disposes of it at the surface

#### Geothermal Heat Pumps

- The shallow ground (upper 10ft of earth's surface) maintains a nearly constant temperature between 10-16°C. This is warmer than the air above ground level in

the winter, and cooler than the air above it in the summer

- In the winter, a heat pump removes heat from the heat exchanger and pumps it into the indoor air delivery system. In the summer, the process reverses and warm indoor air moves back into the heat exchanger.
- The heat removed from the indoor air can also be used to heat water
- Geothermal heat pumps use considerably less energy than conventional heating systems and reduce air pollution

#### Filtering

- Artificially generated ultraviolet light, in the C band (UVC), can be used for disinfecting
- The system does not produce ozone or other harmful products
- It can kill or neutralize certain:
  1. Viruses
  2. Bacteria
  3. Mold
  4. Spores and toxins from microbes
  5. Volatile organic compounds
  6. Musty odours

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