Solar House Project Glengarriff Co. Cork

Youngfield Workshop Ltd.

For their good work and input, I am grateful to:

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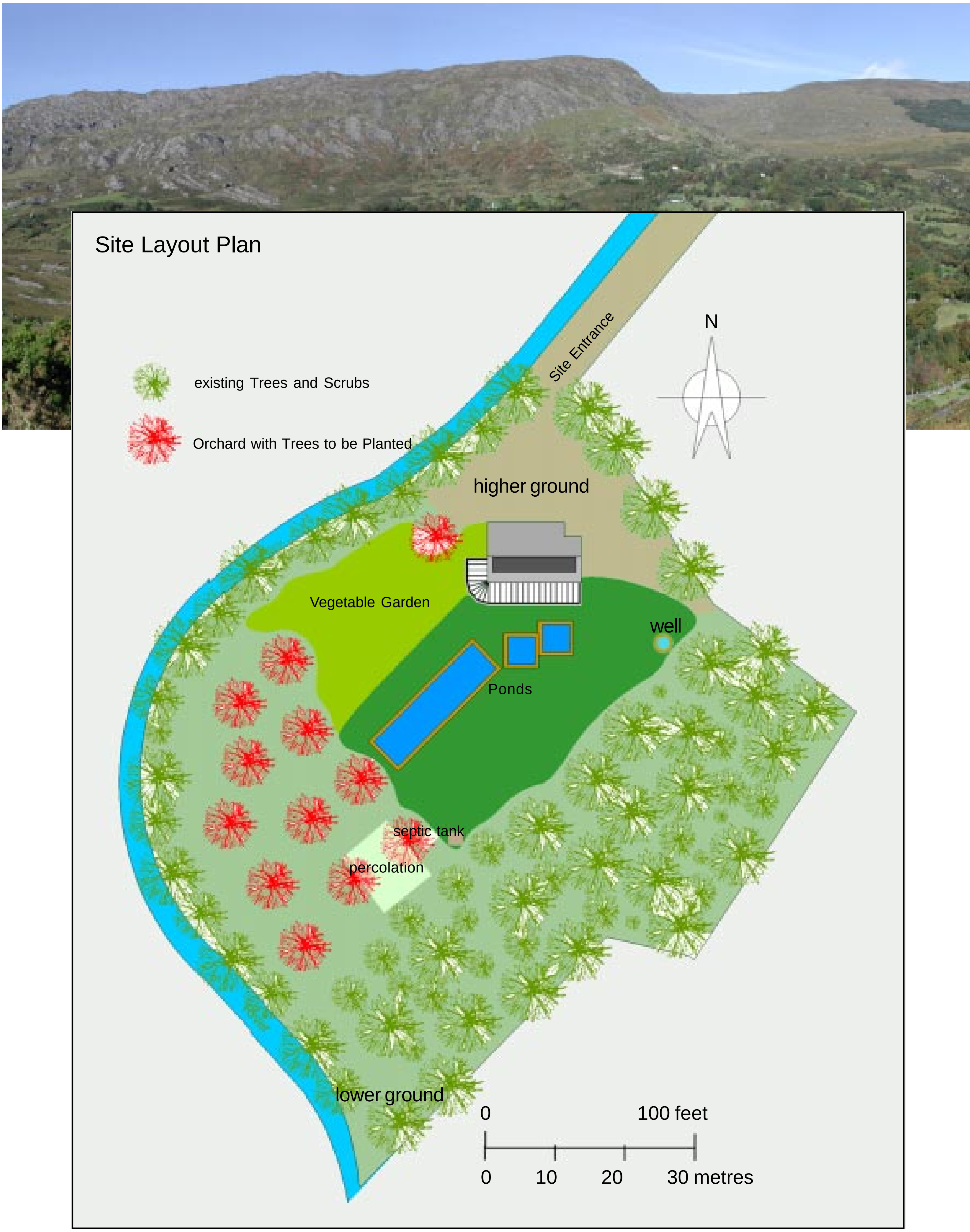
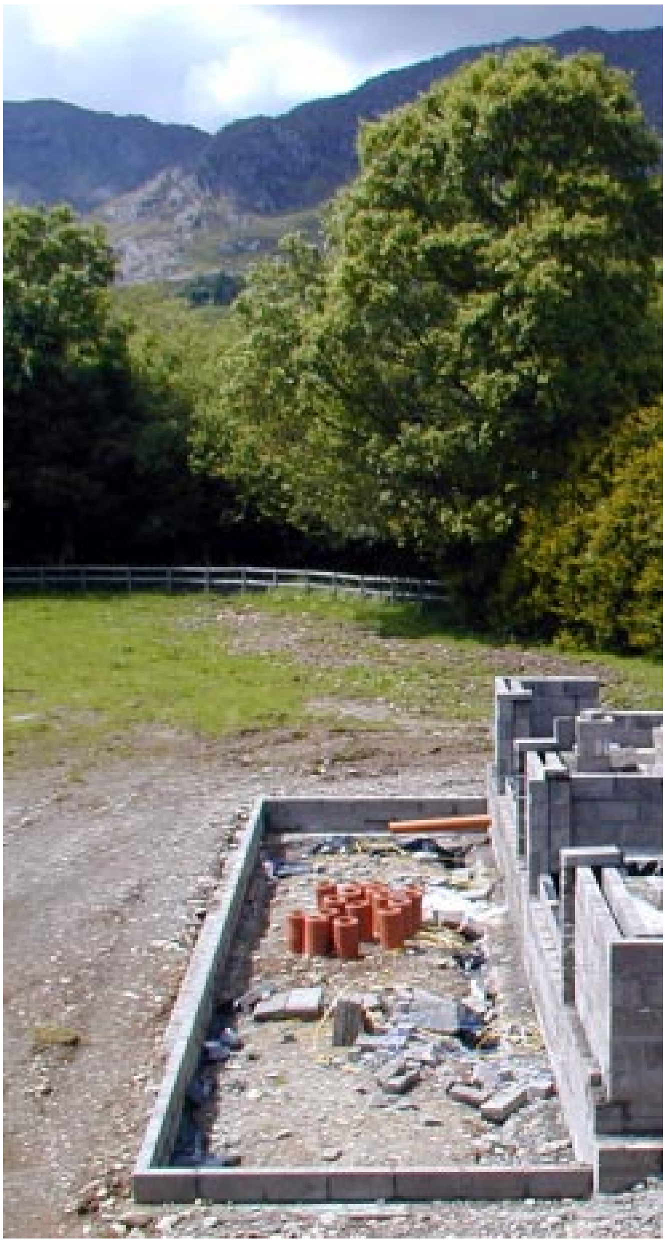

Site Layout Plan
existing Trees and Scrubs
Orchard with Trees to be Planted
Site Entrance
N
higher ground
Vegetable Garden
well
Ponds
septic tank
percolation
lower ground
0
100 feet
0
10
20
30 metres

The Site and Site Layout

The Site at Rossnagreena, Glengarriff, Co. Cork was chosen because it had been in our possession with outline planning permission since 1985. The close proximity to our current home, the flat ground and open space made it in some ways ideal for the project. It is situated at the bottom of the Glen at the meeting point of two mountain streams and reasonably well protected from storms while allowing sun exposure all year round.

The near coastline and mountain ranges of the area, however, constitute a certain drawback, as humid Atlantic air masses, entering mainly from the south west, are forced upwards and tend to create clouds. Clear sunny days are therefore not as frequent as they might be in other parts of the country.

The spectacular country side and views from the house compensate for the unpredictable and often cloudy weather. To put an energy efficient home in these settings is a very special challenge.



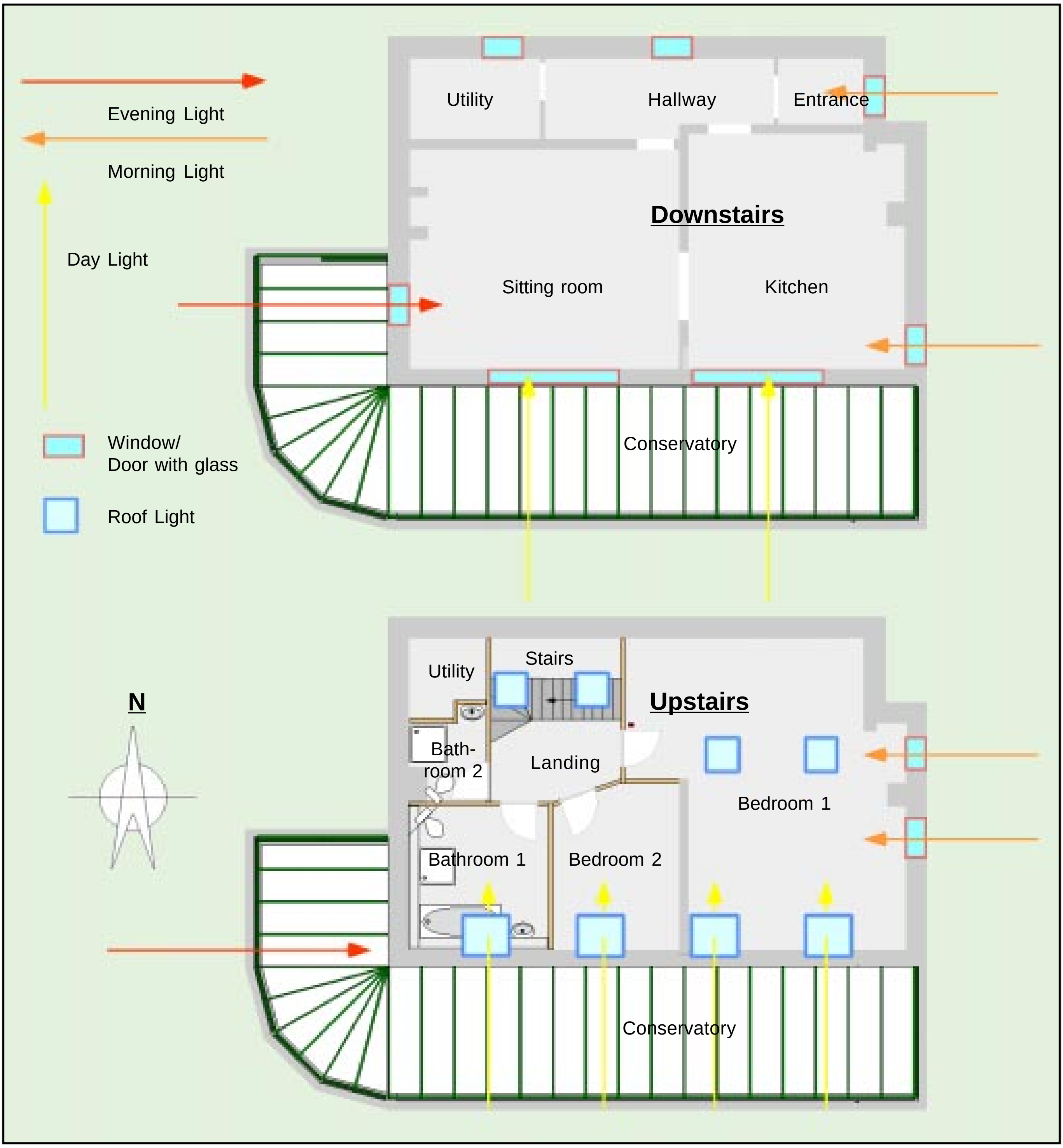
This picture is taken from the east to the west at an early stage of the construction showing the base of the conservatory and the fantastic mountain panorama

Orientation and Day Light

The orientation of the building is strictly south. All major rooms and the conservatory are on the south side and receive main daylight from this direction. The main Bedroom and the Kitchen receive light also from the east, while the Sitting room and the larger section of the Conservatory gain from the light in the later hours of the day, they are on the south-west side of the building.

The Hallway and Utility Rooms downstairs have their own windows on the north side. The sizes of these are carefully choosen to allow enough light in to avoid the necessity of electrical lighting during the day, while being small enough to retain heat. All windows not facing south are PVC-construction with high thermal insulation values for frame and glazing sections.

North Elevation

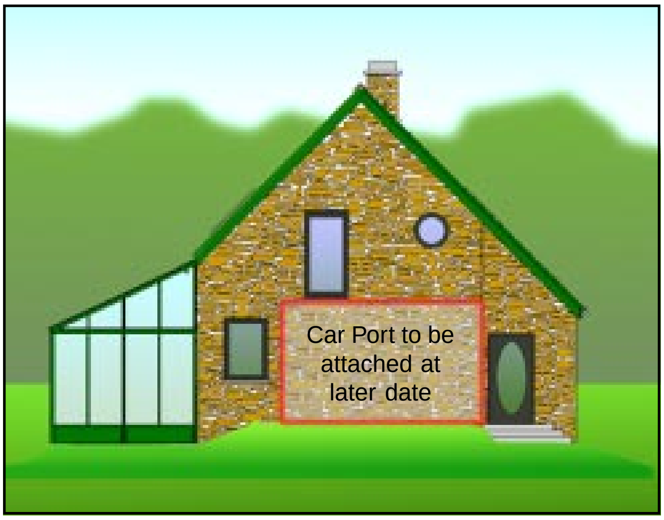


Use of Natural Light on the South Side

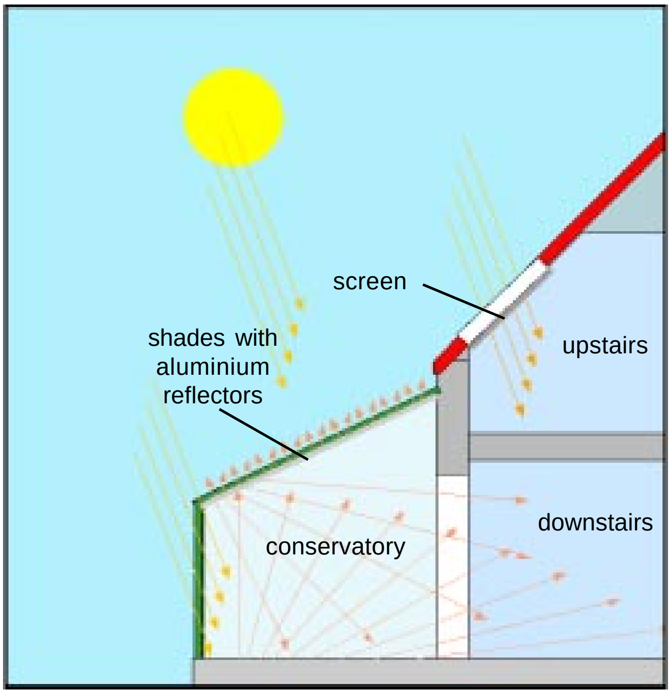
On the south side natural light enters the building through four large Velux windows on the upper floor. In case of excess during the summer months these can be covered with translucent shades. In the wintertime the shades will be exchanged for roll-up insulation which can be lowered at night to retain heat.

On the ground floor light enters through the conservatory. Insulation blinds with reflective aluminium coating on upper and lower side can be unrolled to create shading at the required level. These shades also facilitate the convection ventilation in the conservatory. Alternatively they can be unrolled to cover the entire conservatory ceiling to provide insulation at night time.

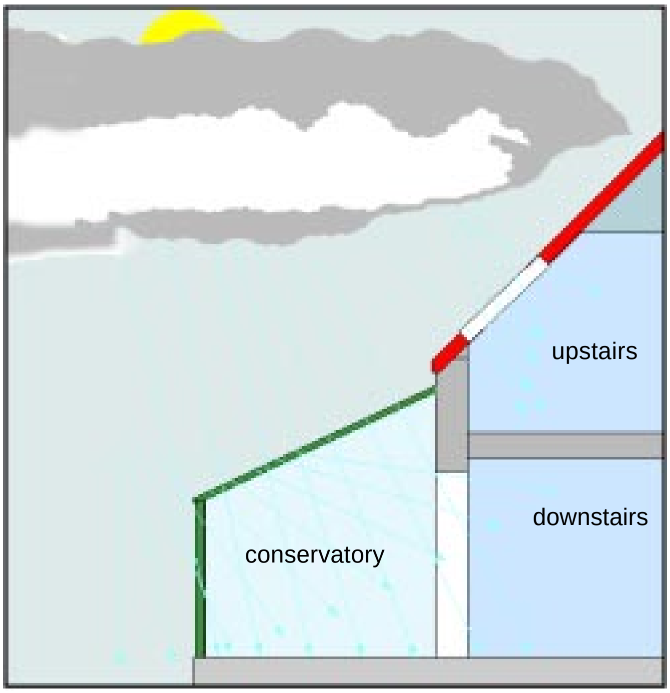
The low angle at which light reaches the building in the winter months allows it to penetrate far into the rooms through these large windows.



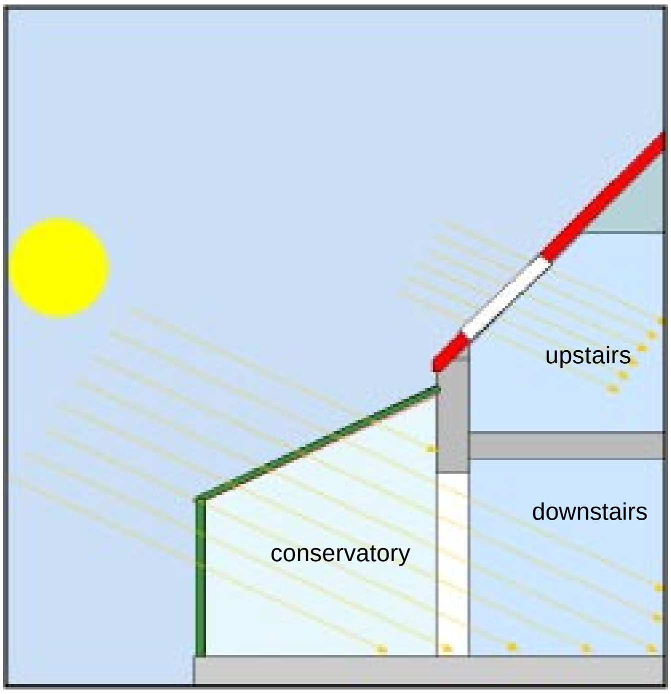
East Elevation



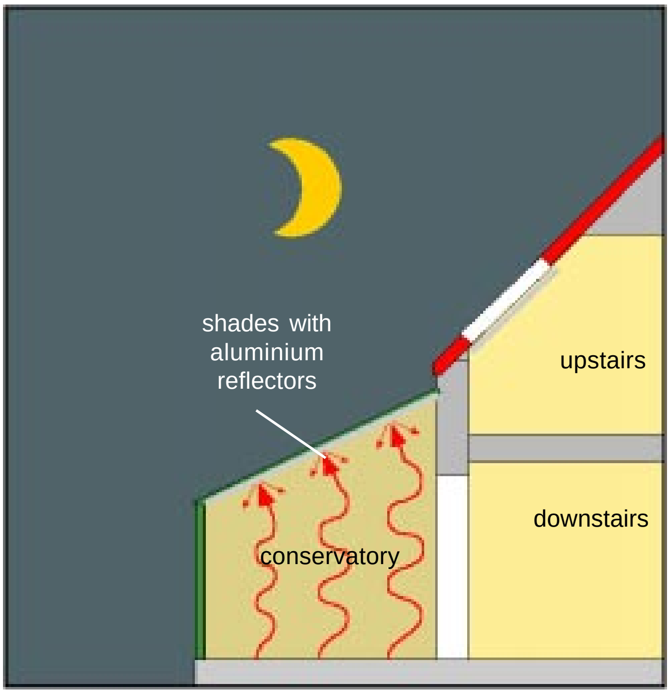
bright summer day



dull summer day



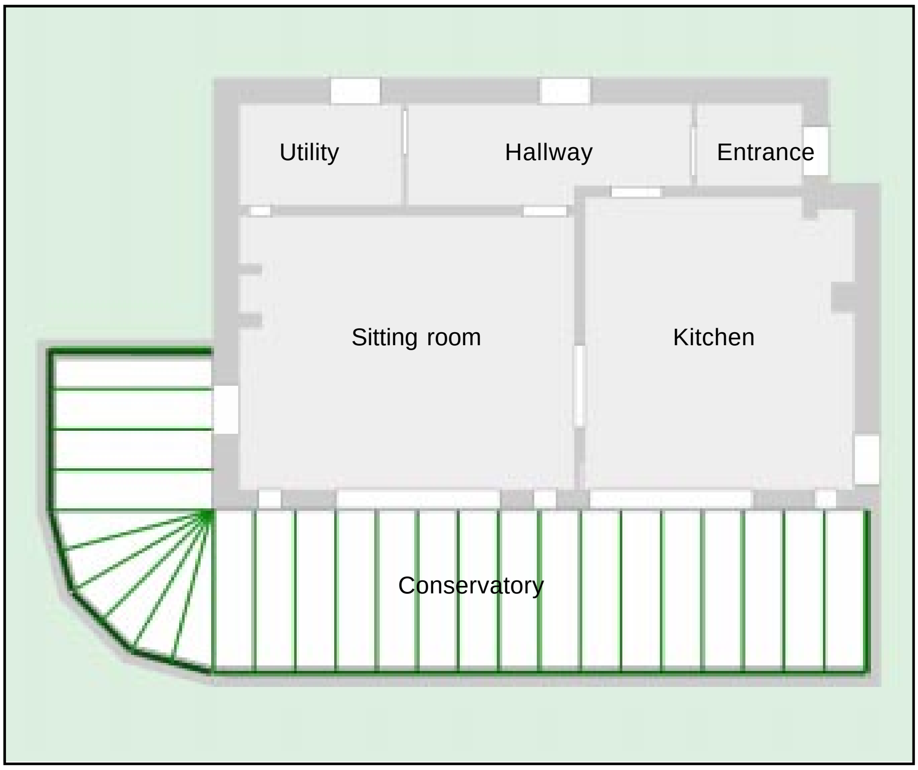
winter day



winter night

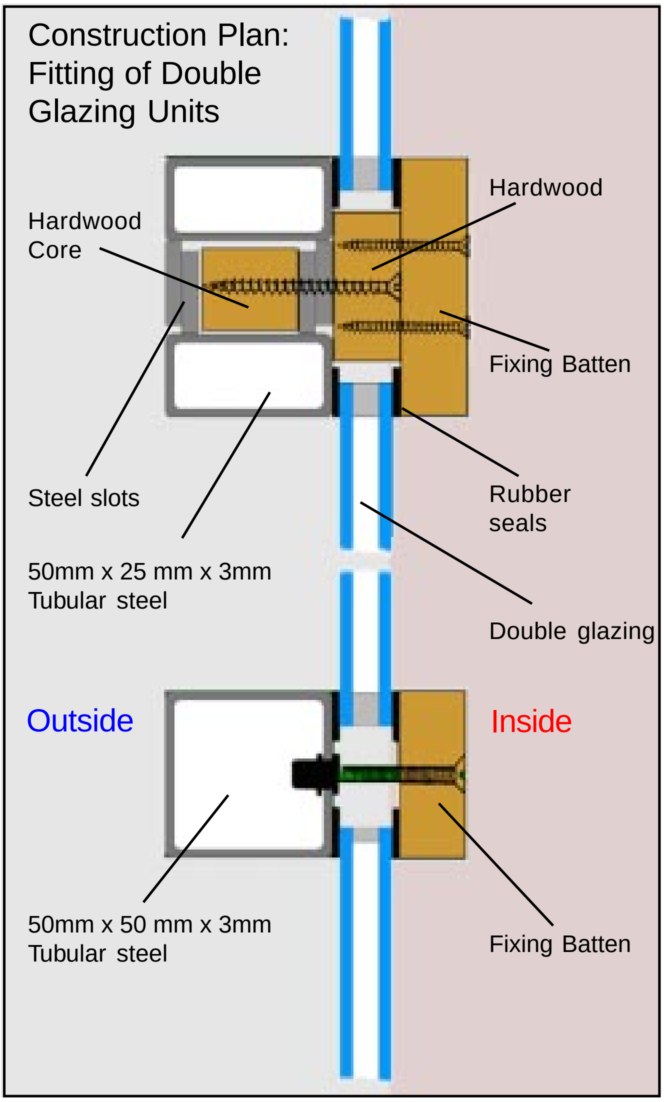
The Conservatory

The conservatory is situated on the south side of the house and covers the entire south wall and a part of the west wall. The main section is 16.3 meters long and 3.3 meters wide. The total floor area is approximately 60 square meters.
Toughened glass double glazing units were used on all vertical outside surfaces, while the roof area is covered with 4mm toughened glass.
The conservatory also houses the primary (4.3 cubic meters) and secondary (9.4 cubic meters) storage tanks for solar heated water.



We used steel frame construction. The square and rectangular tubular sections were welded into frames. These were zinc galvanised and finished with a powder plastic coating for long-life protection. Finally, they were assembled in situ and fixed with stainless screws and bolts that will allow disassembly at a later stage.

In order to minimise heat conduction, the double glazing units were fixed with timber battens on the inside of the structure in such way, that throughout the construction the steel frame is not exposed to internal and external condition at the same time.

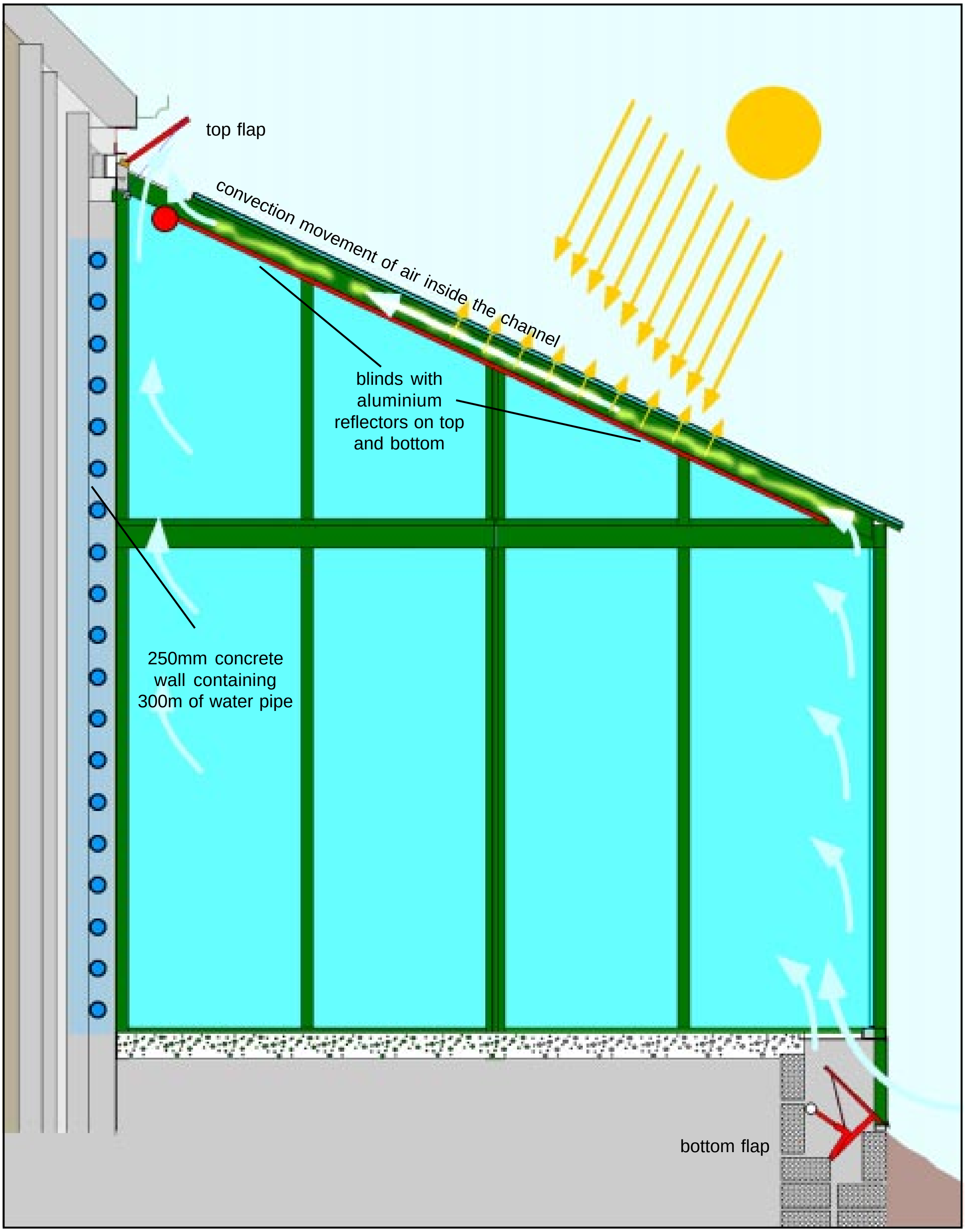


Cooling and Ventilation Systems

The cooling of the conservatory during warm weather is facilitated through a convection system in combination with opening flaps on the very bottom and very top of the construction.

A roll-up blind, made out layers of aluminium and air-cushioned thermo-plastic material can be lowered underneath the roof glassing creating a channel. Sun rays heat the air in the channel and the resulting expansion leads to an upward movement of the air column inside. Warm air is released through the top flap and cold air is drawn in from the bottom of the conservatory to replace it. At the same time the blinds prevent excessive sun light to penetrate the glass construction.

The cavity wall separating inner the rooms has a thickness of 250mm on the south. 300 meters of floor heating pipe is cast into this mass. Water from underground can be circulated through this pipe for cooling in the summer and in winter to prevent frost from entering the construction.



The conservatory inside during construction. The picture is taken from West to East. Near the ridge on the left side one can see the top openings with the flaps being fixed temporarily. On the right, barely visible, is the cold air duct.

In order to achieve maximum performance the flaps and blinds will be operated by the computer system. A manual override allows occupants to take control if they wish.

The cold air duct with the flaps temporarily fixed. Also showing the fixing battens for the double glassing.

Water pipes ready to be cast into the conservatory wall.

Cold air flaps from the outside.

While the downstairs rooms are to a large extent interconnected with the conservatory, the cooling of the upstairs rooms on hot summer days is facilitated through mechanical openers mounted to the roof lights and controlled by microprocessors.

Occupants can override the system any time by either simply opening and closing the lights themselves or by using manual controls on the computer system. The system also checks for strong winds and rain and will automatically close roof lights in adverse conditions, thus avoiding damage to the building and its contents.

Roof light with remote controlled opener

Heating

The relatively humid, but mild weather in South West Ireland gives a special meaning to heating systems in this part of the world. While heating in the winter months in Central Europe serves to rise of temperature inside buildings to a habitual level, heating in the coastal regions of this Island serves also, and very importantly, the purpose of removing excess moisture.

Open fires, as they were custom until about 20 years ago in this country - although rather inefficient in overall performance - served this purpose by radiating heat from the fire to the room and, at the same time, circulating massive amounts of air through the inner building out the chimney

The replacement of these open fireplaces with oil or gas-fired central heating utilities constituted a vast improvement in terms of efficiency, easiness in controlling and occupant's comfort. However, considering the immense efforts in producing and transporting these fuels, the dangers involved and the damage to the world's natural resources make it a dubious way of heating. It also seems questionable if it is really necessary to create a flame of some 800°C in order to heat water to 70°C which in turn heats a room to 20°C. Energy losses along the way are one of the many drawbacks.

The experimental Solar House Project is set up to determine how well a building can perform with optimised systems. Under ideal circumstances it would be possible to create pleasant living conditions without the input of any external energy but Sun Energy.

Several criteria suggest that it might be possible to come close to this ideal. Firstly, the mild climate itself demands little input to raise temperatures inside a dwelling to a pleasant level. With modern insulation and good control systems half the battle is won. Secondly, those days with very low temperatures during the winter months are normally combined with clear sunny spells. If one harnesses the energy radiated on these days, store it and release it when and where needed, the need for further input may be rather small.

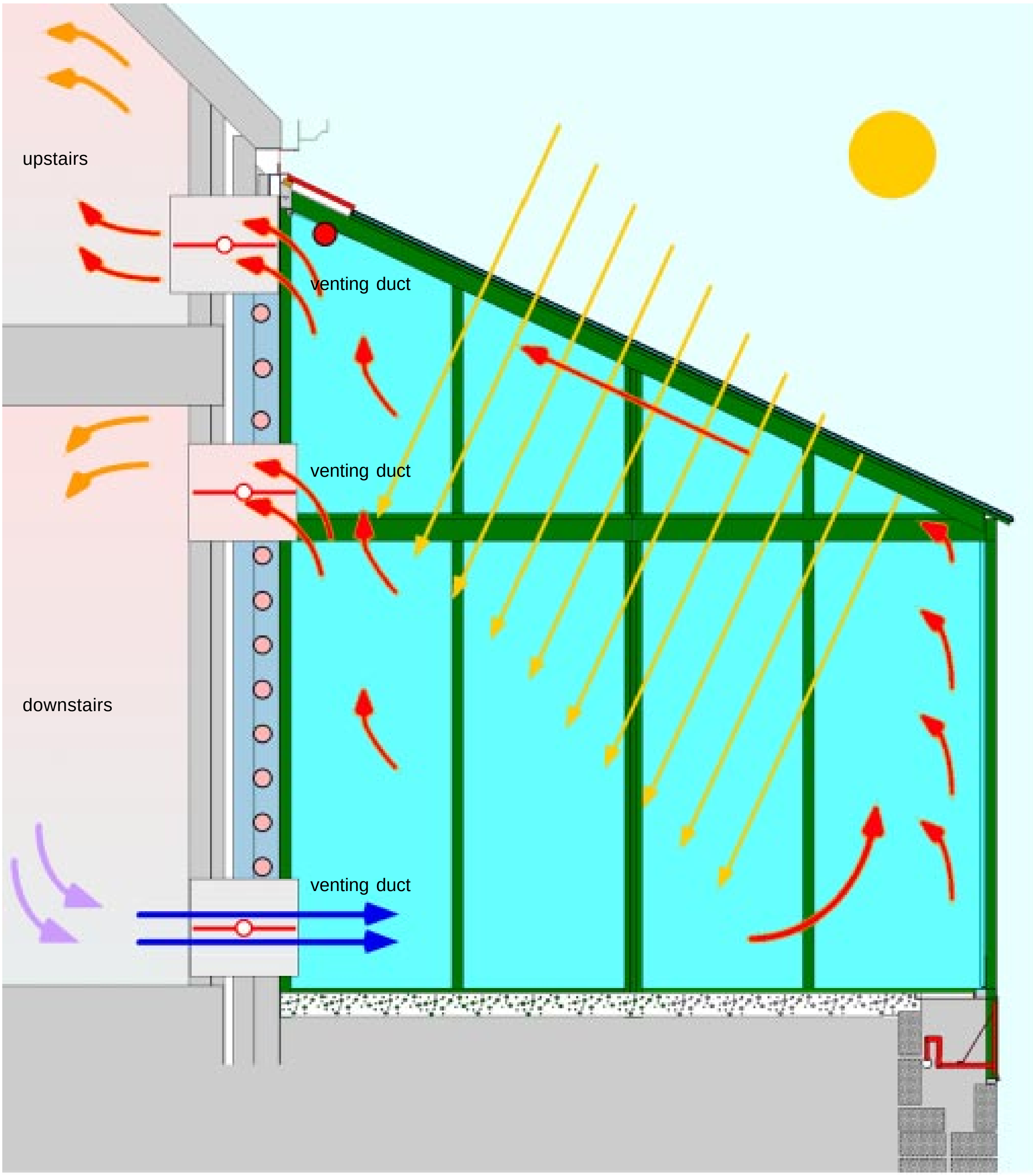
If one wants to succeed, it is of paramount importance that a dwelling is laid out to serve this goal from the start of planning. Orientation is the first and most basic aspect of a dwelling, followed by room layout, placing and sizing of windows and doors and selecting building and insulation materials. Each site will have its requirements and often compromises will have to be made. We were fortunate to have a site that allowed a great deal of freedom in making choices.

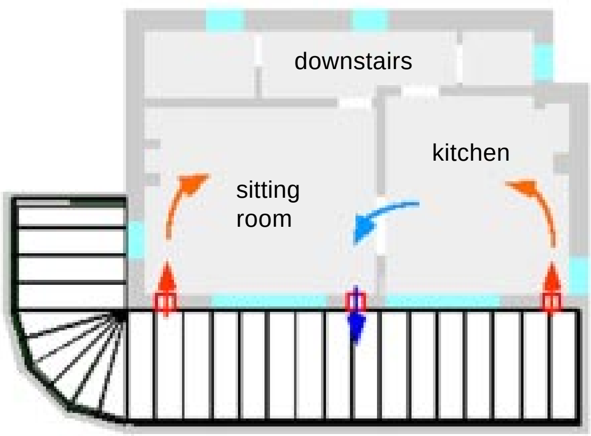
In order to achieve maximum performance we have combined three independent systems of heating sources. The most favourite, because of its simplicity, is the passive system in form of a large conservatory stretched over the entire south side of the building. The second system is a 30 square meter Solar Collector in the south side of the roof. This is an active system that requires pumps and controls to circulate water through the collectors, various other devices and storage tanks. In case these two systems should fail to supply the required energy there is a heat pump. The combination of these three with in intelligent control system and an under-floor-heating set-up should give maximum performance. How does it work? In order to explain the system as a whole - and it is important to see it as a unit - one must understand the mechanisms of each.

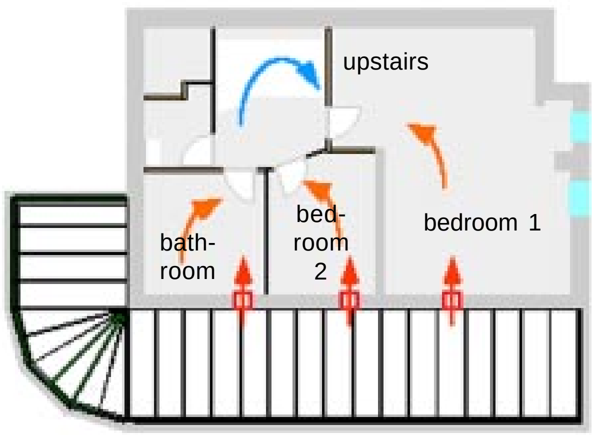
The Passive System

Essential for the passive heating system is large glass facade or conservatory on the south side of a building. It's glass skin acts as a barrier between the in and outside. Its unique properties allow certain electromagnetic rays (light, heat etc.) to pass through and filters out others. By choosing the right type of glass and shading utilities one can gain a good bit of control over what passes in and what passes out. We used double glazing on the vertical sections. This will allow light and heat rays to come in and it will retain warm air relatively well. On the roof section we used single sheet glass which has a better performance when it comes to allowing energy in, but does not retain warm air very well. This drawback is being compensated with a roll-up insulation blind that can be extended underneath the glass layer to form a second barrier. Together with the glass on top this will out-perform double glazing in terms of insulation.

On a sunny, but cold day, the blinds are rolled up and sun light enters the conservatory. Here it heats the air which begins to move upward. Ducts that connect the inside of the building with the conservatory are being opened by the computer system and the warm air can travel through them to the inner rooms being moved by the convection motion. This process can be assisted by a fan if necessary. Cold air from the inside of the building is brought back to the conservatory at ground floor level, thus creating a circulation of ever warmer air. The process is stopped naturally when the sun rays are no longer present, for example at night time. In order to retain as much as possible of the warm air, the insulation blinds would then be lowered underneath the roof glazing and the ducts to the inner rooms are being closed.


upstairs
venting duct
venting duct
downstairs
venting duct


downstairs
kitchen
sitting
room


upstairs
bed-
room
2
bath-
room
bedroom 1

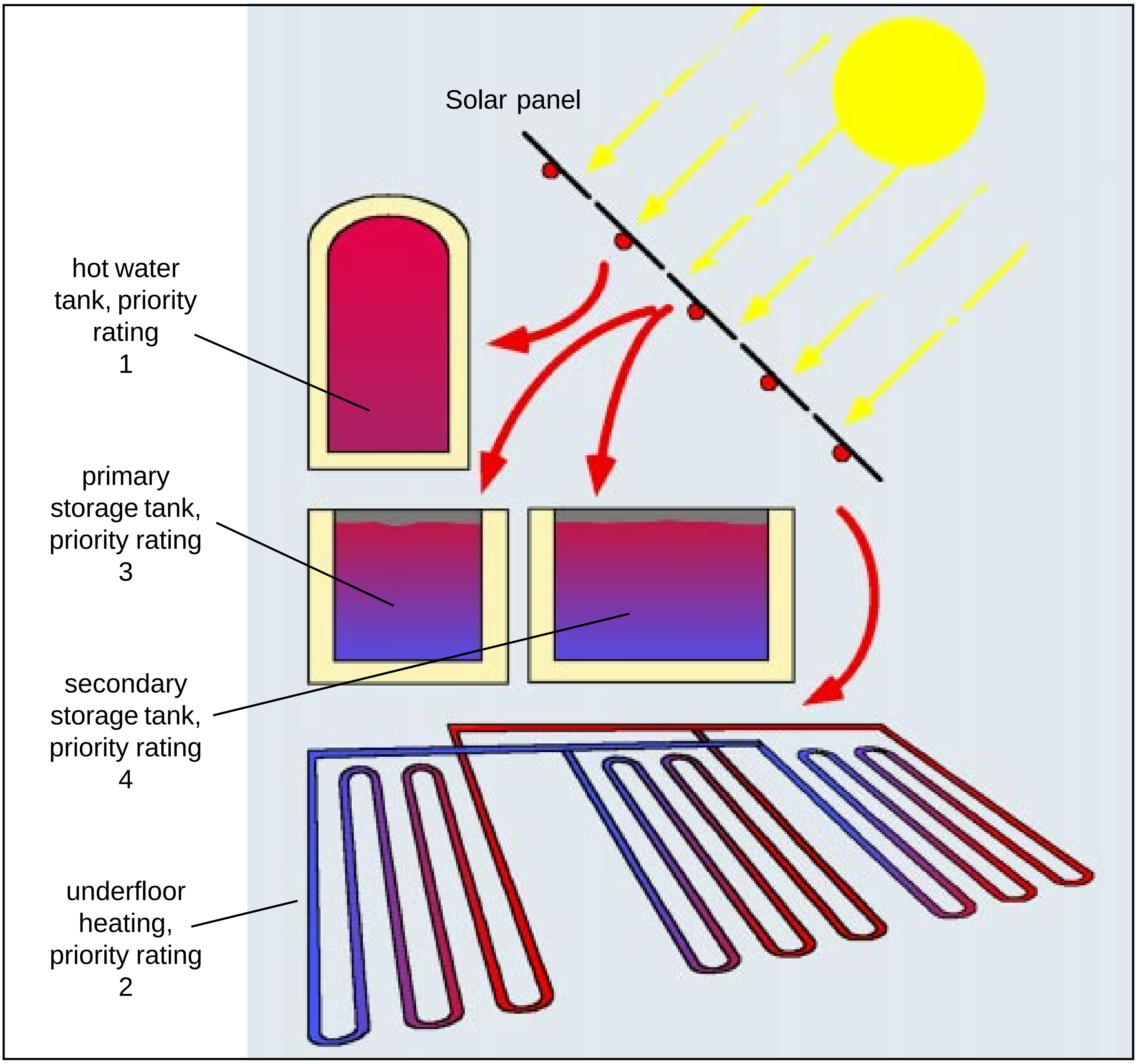
One of the ventilation shafts during assembly in the main bedroom upstairs.

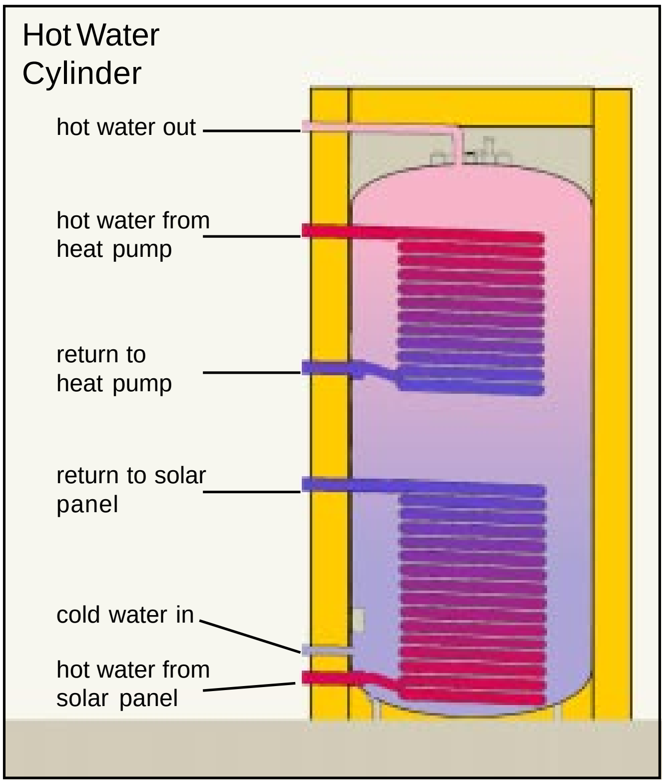
Through the open duct one can see the conservatory.

With closed hatch, before fitting the grills.

The Active Systems

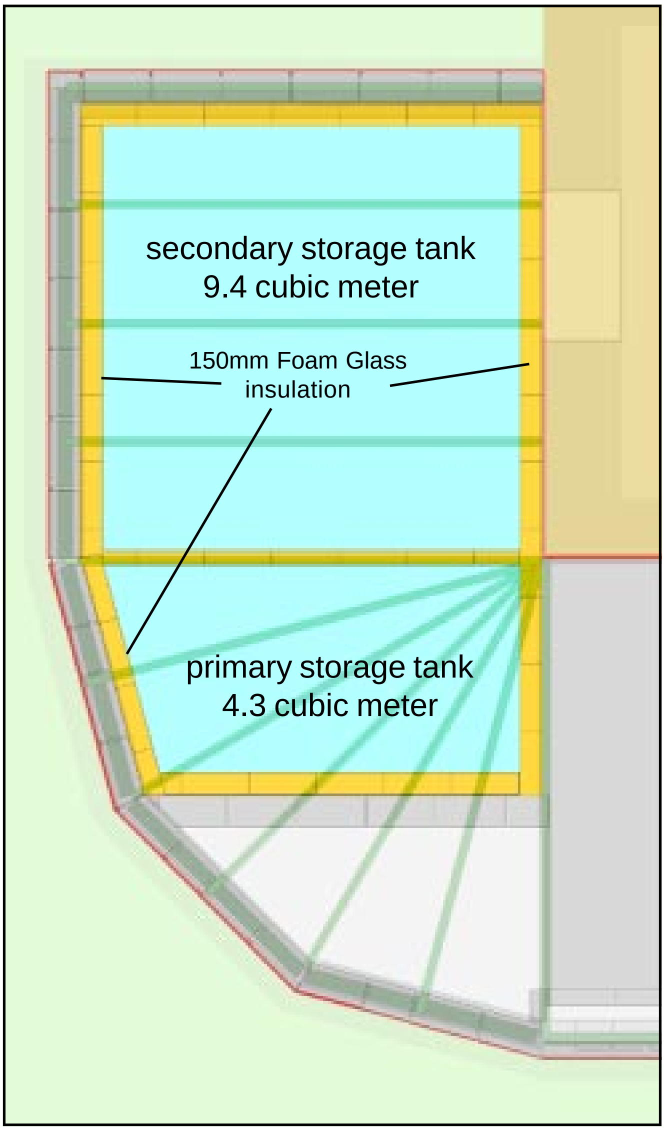
The schematic drawing below shows the principle functions of the active Solar Heating System. Sun rays hitting the collector panel heat the water inside. Thermostats placed at strategic points throughout the assemblage register temperature and will active pumps and valves to circulate hot water to those devices that require heating. In order of priority this can be the hot-water tank, the under-floor central heating, the primary storage tank or the secondary storage tank(s).





We installed a special solar hot water cylinder with a capacity of 400 Liters.


30 square meters of solar collector facing south at a tilt of 45°



The final layout of the storage tanks and insulation under the floor of the conservatory.

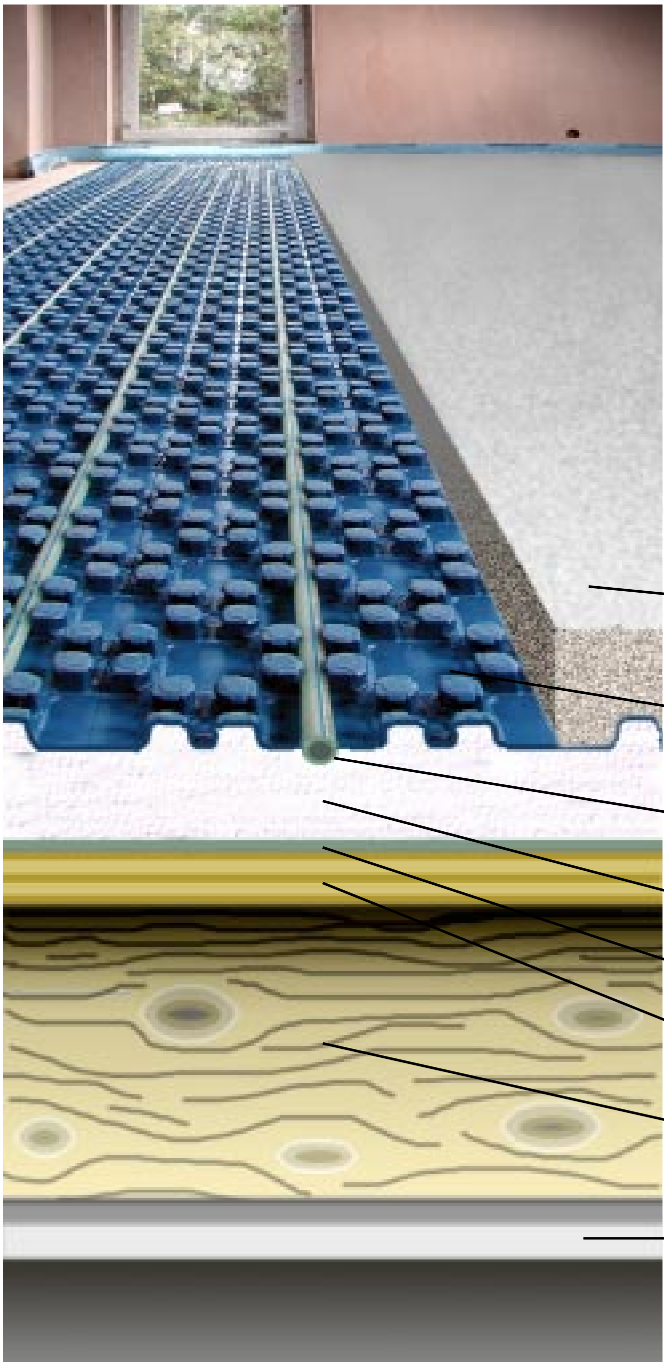

The tanks during construction at sub-floor level of the conservatory's south west side as seen from the roof.

The reason for having at least two storage tanks, a primary and a secondary, is quite simple and may contribute in a significant way to the efficiency of solar energy heating. Cold winter days in Ireland tend to be also clear days. On such day during the bright hours there might be enough passive heating from the conservatory alone. Meanwhile the solar collectors on the roof are heating water, which if stored in one large tank will only raise the temperature a little. Fed into a small tank it will have a more dramatic effect. This could mean that, when the evening time comes, the water in the tank might be warm enough to supply the under-floor heating with little or no further energy input. Tests will have to show what ratios of collector panel and storage tank are most efficient. It is planned to install a learning computer program that will govern the distribution of energy. It will continuously change its own parameters in order to try to optimise - thus learning by trail and error.

Under-floor Heating

Efficient solar heating requires an efficient under-floor or in-wall heating systems throughout the house. Modern techniques make it fairly easy to install the necessary insulation and pipes. The pictures below and right show the arrangement of the various elements involved in installing an upstairs under-floor central heating assembly into the floor space.

Pipe layout in the main bedroom’s south-east corner.

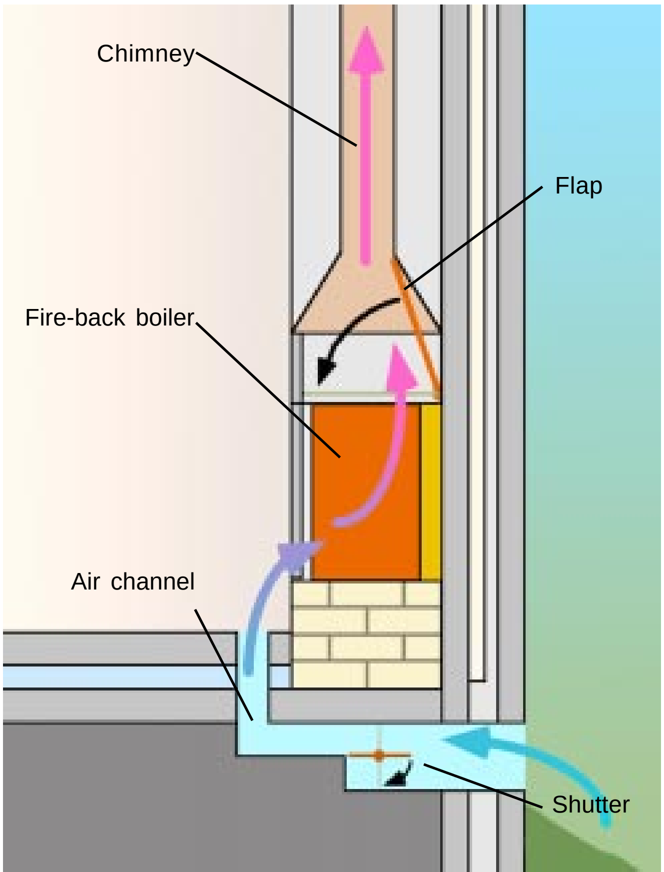


The Fireplace

A very special item that we did not want to miss, even in an energy efficient house, is the fireplace. Being surrounded by woods is a good argument for having a wood-burning device. We have thought long and hard if we can justify putting an open fireplace into an energy efficient house. From the point of energy efficiency it simply is not. Wood-burning stoves are far better equipped to burn timber. But there is the other side. The people in this country have known for a long time the soothing tranquillity of an open fire. The psychological effects can be beneficial and may increase the well being and the feeling of being at home.

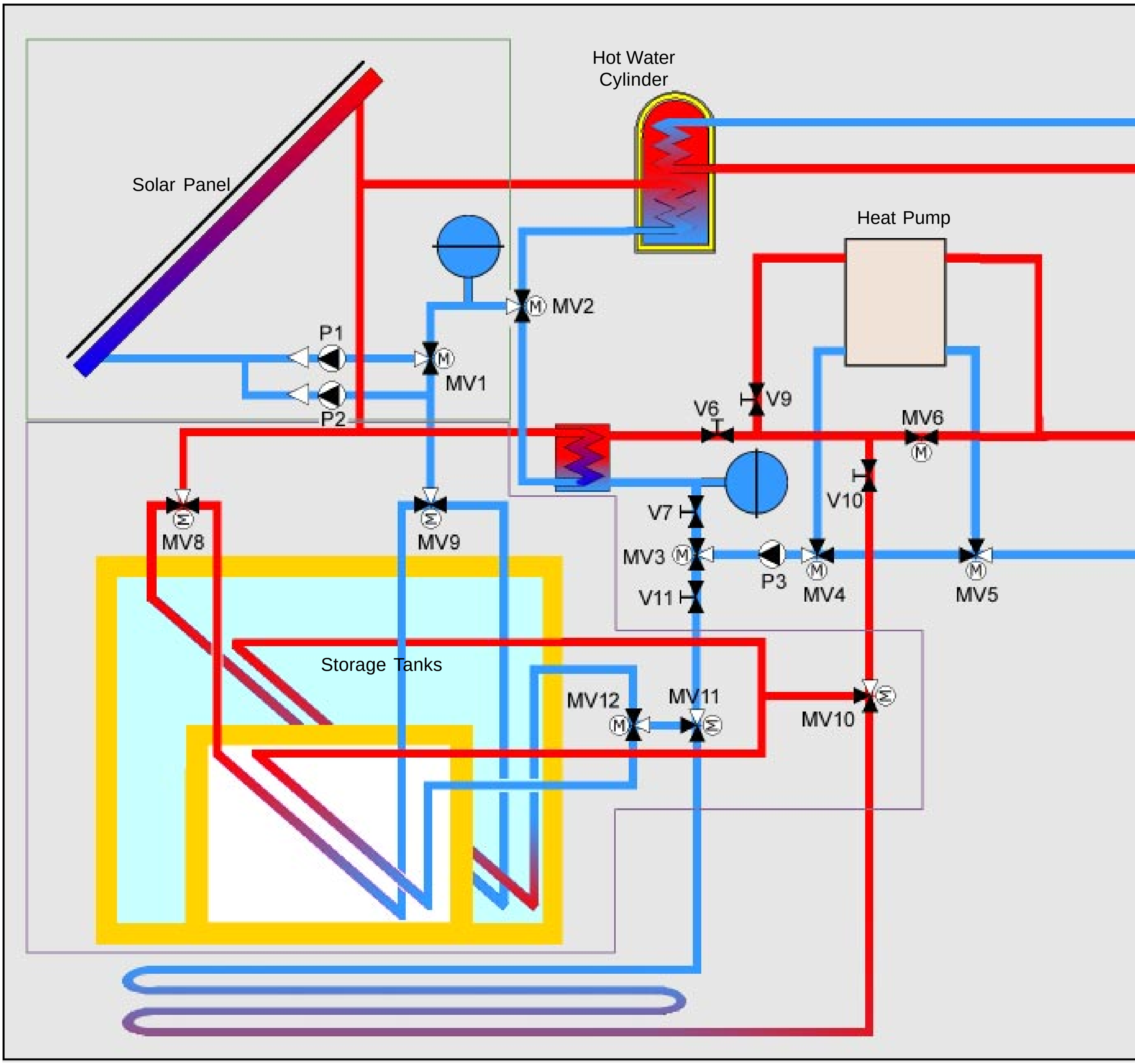
So, rather than abandoning an open fireplace we have tried to build one that is more efficient. We are installing three devices to combat the major drawbacks of such fireplaces. The first one was quite common about twenty years ago but is not so easy to find these days, a fire-back boiler. We bought a ready-made one and altered it. It had been designed for coal-burning fires and had a grid and low-reaching collectors. We removed the grid hangers and raised the whole boiler about 10 cm by setting it on firebricks, thus making is suitable for wood burning. The fire is now build on a firebrick base and even logs with a diameter of 15 cm or more will fit under the collectors.
The warm water from the back boiler is fed into the general hot-water system via a heat exchanger and can be distributed in the same way as the hot water from the solar panels.

The fire-back boiler during installation. The opening of the air channel can be seen in the front.



The second item we installed is not as common. This is an air channel that was cast underneath the floor from the outside of the building to right in front of the hearth. It allows fresh air to be drawn in to feed the fire, thus eliminating the draw of warm air from the room.

The third device consists of two items, a flap between hearth and the chimney, a shutter in the air channel. While the flap is closed a barricade prevents occupants from lighting fires, if the flap is opened the shutter in the channel is automatically opened as well, allowing fresh air in. This set-up prevents unwanted air circulation and drafts when the fireplace is not in use.



Plumbing

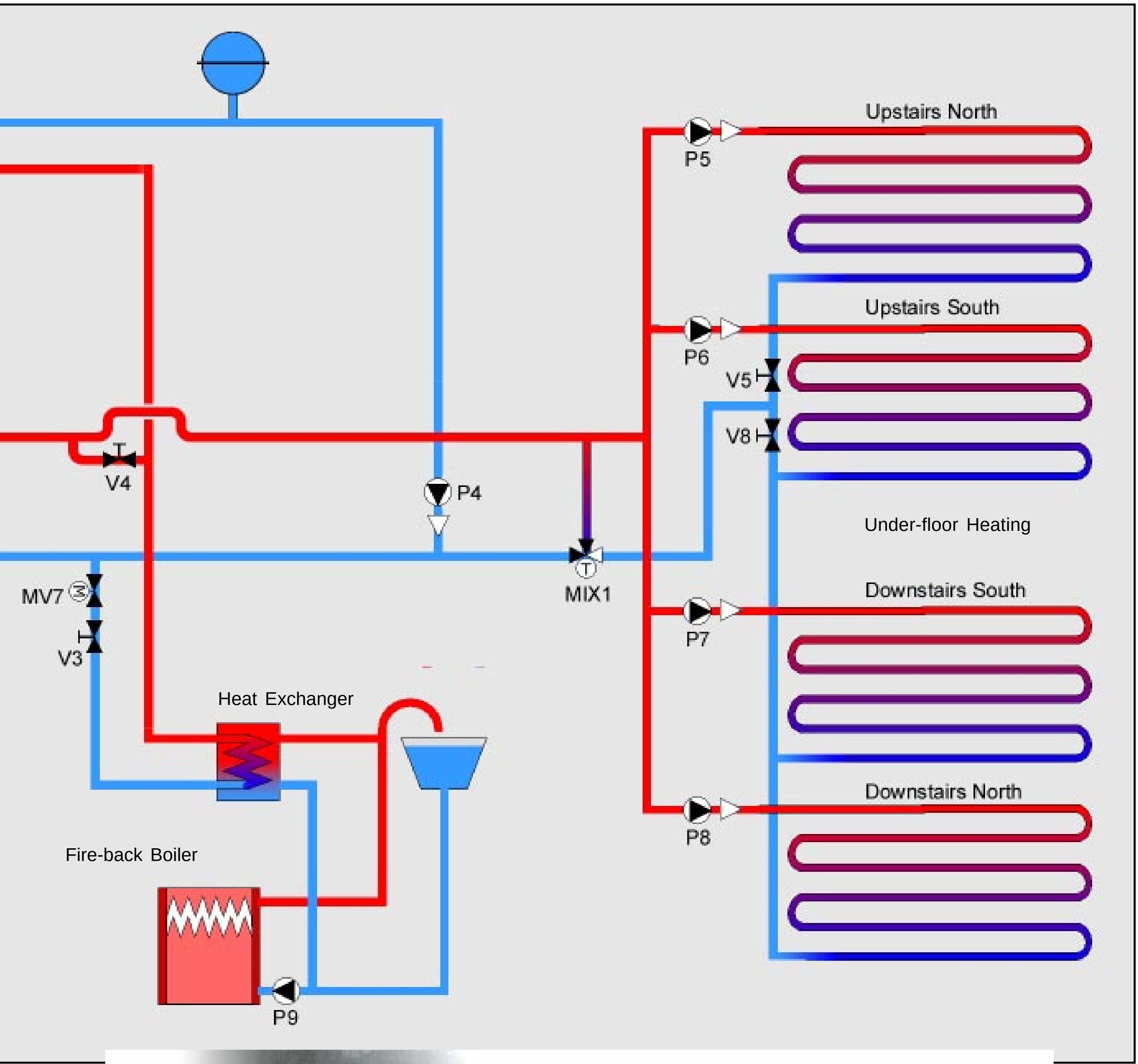
The above diagram shows the principle of the integration of the various sources and distribution of warm/hot water. On the left we have the solar panel which supplies hot water through valves to the hot-water cylinder, the storage tanks or a heat exchanger.

The heat exchanger between the solar panel and the rest of the system is necessary because, on the panel side, the plumbing is required to withstand the high temperatures and pressures that may build up. Temperatures as high as 200°C have been measured and a safety valve is set to open the release at a pressure of 6 Bar. This part requires copper/brass plumbing throughout.

On the secondary side of the heat exchanger we can use plastic pipes and fittings, making the remaining installation much easier and saver.

On the centre right of the drawing we have the other two heating devices. The heat pump and the fire-back boiler. Again it was necessary to separate the back boiler from the rest for safety reasons, by using a second heat exchanger. This device will be placed in the higher parts of the building to assist gravity feed and reduce the need for pumping water from the boiler.

Should the water supply from all other sources fail to return the required energy, the heat pump will switch in by bridging the supply from the storage tanks to the under-floor heating and hot-water tank.



The
Heat Pump

The Control System

The number of various devices and their different functions shown on the previous pages make it quite obvious that a refined control system is required to make the entire set-up work at an optimum. Only today, with the electronic revolution having advanced as far as it has, it is possible to conceive of such system at a reasonable size and price.

However, if a person wants to install such comprehensive system at present, he or she will have to have the control hardware and software specially made. Today the manufacturer of such equipment as solar panels, heat pumps, under-floor heating, roof lights, security gear and ventilation apparatuses all have their own controls. In the past this has been adequate, but in order to become really energy efficient it will be necessary to integrate all devices in one system.

Of course, the fear is that, in case of a fault, the consequences would be dire. Nothing might work any more. The solution to this potential problem is demonstrated in nature, and is called neurological networking. If one part of the control system fails, other parts should be as little influenced as possible and ideally take over the work of the part that failed.

We are working to achieve this by using a number of small microprocessors that are linked to a network. Peripheral sensors send their information to the processors and active devices receive instructions from them. In such way, each processor looks after a small part of the whole control system, but is also communicating with all others via a central unit. Should the central unit fail, then the peripheral stations will still keep working, only with less efficiency.

In addition to information like humidity, temperature, air condition in- and outside the house, light intensity, rainfall, wind direction and speed, sensors will also detect movement and switch on and off lights were appropriate, monitor noise in a baby's bedroom, check for smoke, gas and intrusion and, in case of potential danger, trigger alarms.

The network will be connected to a modem, which in turn is connected to a telephone land-line and/or a mobile telephone, allowing remote monitoring and control via computer, telephone or mobile phone.

By looking at nature and copying it's intelligent devices (even though our current systems are rather humble in comparison) we may be able to build dwellings in future that are highly adaptable to the needs of their occupants as well as the environment in the way that living organisms continually adapt to the challenges of live.

One of the many types of sensors. This one measures wind speed

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