

SOLAR THERMAL



Since the beginning of time, the sun has been the source of energy and life on earth. It is a huge nuclear reactor, at 6,000 °C, which provides our planet with heat and light. Today, solar energy can provide cost-effective solutions to fight climate change and reduce our dependency on expensive and polluting fuels.

A solar water heater is an efficient and reliable technology that converts sunlight into heat to produce your hot water. In Ireland, a solar water heater can reduce your energy bill for producing your hot water between 40-70%.

In Ireland a horizontal surface of 1 m² receives an average of between 1,000 and 1,200 kWh of solar energy per year (the equivalent of 120 litres of oil).

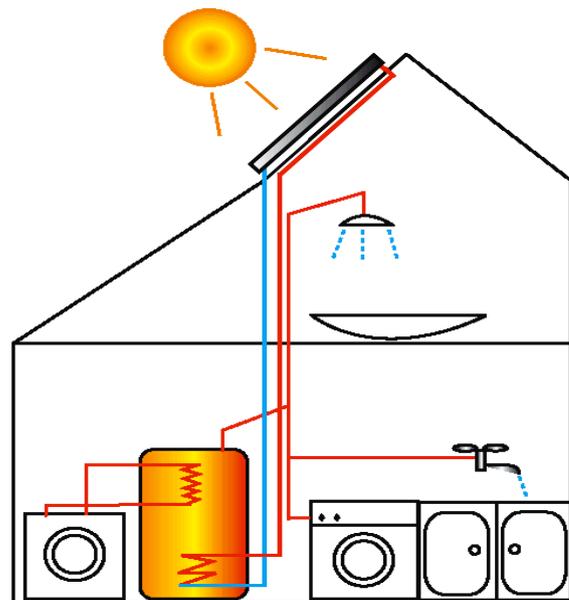
Both direct sunlight (40%) and indirect sunlight (60%) provide this energy. So, even when the sky is overcast and you can't see the sun, its radiation (sunlight) is available at ground level and can be converted into useful heat by your solar water heater.

Did you know that an average Irish family spends annually €1000 on energy in its household? Reducing your energy bill by 30% can be achieved at little extra-cost by applying passive solar design principles when building or retrofitting your house.

An average Irish family will pay more than €32,000 over the next 30 years only to heat its house, at current energy prices. And energy will not get cheaper as gas and oil reserves are being depleted rapidly and the pressure on prices will increase. Emissions of greenhouse gases from energy consumption and their impact on climate change will also seriously affect our life and the life of future generations. All of that is because our so-called modern society has become excessively dependent on fossil fuels.

Every year, Ireland receives from the sun the equivalent of 600 times its total annual energy consumption. On a bright day, any surface standing in the sun will receive about 1,000 watts of solar radiation (a power equivalent to that of 10 strong light bulbs). No wonder how hot your car gets when left in the sun.

SOLAR THERMAL: Solar thermal technology is for water heating. Active space (or air) heating for large buildings can also be achieved by solar ventilation systems. This type of system typically uses a transpired collector, consisting of a thin, black metal panel mounted on a south-facing wall to absorb the sun's heat. Active space heating linked to under floor heating projects here in Ireland.



A solar water heater is composed of:

- * A solar collector, which absorbs solar radiation (sunlight) and changes it into heat;
- * A pump, which transfers the heat from the collector to hot water in a storage tank;
- * The storage tank accumulates hot water produced by solar energy so that it can be used when it is needed;
- * A number of accessories, which ensure the regulation and the safety of the system;
- * A back-up heater (gas or oil boiler, immersion heater, heat pump) which will bring the hot water to the temperature required when there is not enough sunlight to do so (mostly in winter).

In Ireland, solar collectors alone cannot provide all the hot water for a household's needs throughout the year. They are normally installed in conjunction with a conventional heating system,

the back-up heater. A solar water heater is therefore a complete system, which will provide you with plenty of hot water at all time.

Two main types of solar collectors, both available on the Irish market, can be recommended:

- Flat plate collectors, with a selective absorber, are well suited for hot water production and low temperature heating.
- Evacuated tube collectors which are more efficient at higher temperature and when solar radiation is less intense.

The following table gives you an idea of the size and cost of a standard solar water heater according to the number of people in your household:

Number of people in the Household	Area of solar collectors (*)	Volume of the solar Hot water tank [litres]	Indicative initial investment (**)
2-3	2-4 m ²	100-200	€ 2,540 - 3,175
4-5	4-6 m ²	200-300	€ 3,175 - 3,809
6-7	6-8 m ²	300-400	€ 3,809 - 5,079

(*) Area for flat plate collectors. The equivalent area for evacuated tube collectors will be smaller as they have a higher efficiency.

(**) Price for a complete solar package (collectors, storage tank, controller, pump, hydraulic components, etc.), excluding VAT and installation. Installation should require two or three days for a skilled installer.

If you are producing hot water throughout the year, the optimal inclination for your solar collectors is 40°-50°. but they can be tilted from 30°-60° without a significant loss of performance. Your collectors are most productive when facing south. However they can be oriented between southeast and southwest without significant loss of efficiency.

Solar collectors should not be placed in the shade or shadow produced by neighbouring buildings, trees, etc., especially between southeast and southwest.

You should have some space to install a solar storage tank (200-300 litres) in your hot press or boiler room.

You should have a sufficient area to install the solar collector on your roof (4-6 m²).

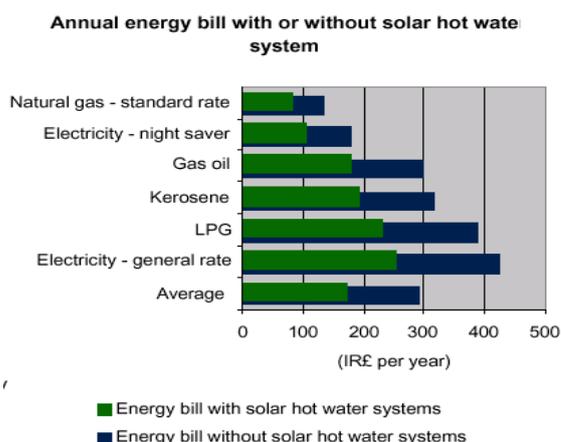
The optimum area of collector, which might be installed in a dwelling, depends on the water usage. It is generally held that 3-5 m² of flat plate collectors might be right for a family of up to 4 persons; for 5-6 people 4-6 m² might be the optimum. The corresponding evacuated tube

collector absorber area may be reduced to two thirds of the equivalent flat plate collector.

Hot water usage differs widely from one household to another so that the above are guidelines only. Unless we have a hot water meter we can only estimate our hot water requirements.

Without precise knowledge of hot water usage and climatic conditions it is difficult to specify the level of contribution a solar system will make to hot water production. However, it is generally accepted that a well-designed system will provide the majority (typically 80%) of a family's hot water requirements during the summer months and make a useful contribution during the rest of the year. This means that up to 60% of the bill for heating water can be saved in a typical year.

Your annual energy savings will depend on the kind of energy you are replacing and the evolution of its price.



The graph opposite presents the annual savings generated by a solar water heater supplying 60% of the energy required by a family of four to six people for its hot water.

Once correctly installed, your solar water heater requires very little maintenance. In normal conditions, rainfall ensures that the dust and tree leaves are removed regularly. If not, a quick cleaning with a water hose is sufficient. Your installer will also give you tips on how to check once in a while that your system works correctly. A solar water system is manufactured and installed to last. Modern systems have an average lifetime of 25 years or more. Make sure that sufficient warranties are given for the material and secure a good deal on after-sale services. Also ask the supplier about quality certificates or homebound for the system.

PASSIVE SOLAR: Passive Solar design of buildings is the utilisation of the energy available from the sun (typically light, and possibly wind) to reduce the cost of heating and lighting. Buildings designed for passive solar heating usually have

large, south-facing windows. Materials that absorb and store the sun's heat can be built into the sunlit floors and walls. The floors and walls will then heat up during the day and slowly release heat at night, when the heat is needed most. This passive solar design feature is called direct gain. Other features include subspaces, trombone walls and day lighting.

The ongoing financial savings which energy-efficient design can achieve can be of real importance in daily life. Winter heating costs can consume a significant portion of family income, and the extra floor area afforded by a simply constructed sunspace is welcome in many crowded households for spatial as well as economic reasons. The other reason for architects to promote green design is that of architectural quality. Buildings with more natural and less artificial input are better. Daily buildings are, in general, more pleasant than artificially lit ones; natural ventilation, if clean air is available from a quite external environment, is more acceptable than mechanical; the fewer heat emitters, the better; and so on, Passive solar design can improve building energy performance in three areas: building heating, cooling and lighting – The relative importance of this energy saving contributions varies depending on the building's location and function.

South-facing surfaces receive more solar radiation in winter and less in summer when compared with surfaces with east or west orientations. This is approximately in phase with the heating requirements. Throughout the year, solar gains through west and southwest glazing are very similar to those through glazing facing east and southeast. In summer, windows facing west can give rise to overheating if they are not protected from the sun's rays, which are at a low angle of incidence.

The most efficient way of protecting a building from unwanted direct sunlight is to shade its windows and other apertures. The degree and type of shade necessary depends on the position of the sun and the geometry of the building. Shutters, blinds, louvers, awnings and curtains are all examples of adjustable shading devices. Some can also be used in winter to increase thermal insulation. Ideally, shading devices should be placed on the exterior.

Even when steps have been taken to shade a building, to reduce heat gains and to minimise the flow of external warm air into the building, internal temperatures in hot climates during summer can often be higher than those outside. Efficient appliances and lighting can minimise internal gains. And appropriate ventilation design can reduce their effects on comfort in summer. Where

external air is cooler than the upper comfort limit, fresh air driven through the building by naturally occurring differences in air pressure can help to remedy this problem. Also, when two air masses have different temperatures, their densities and pressures are also different and this gives rise to movement of air from the denser (cooler) zone to the less dense (warmer) one. For example, by providing openings at the top and bottom of the building, warm air will rise naturally and escape from the top outlet while cooler fresh air will enter through the openings at the base.

When solar radiation strikes any material part of it, it is absorbed, transformed into heat and stored in the mass of the material. The material heats up progressively by conduction as the heat diffuses through it. Materials with high heat storage capacity such as concrete, brick and water heat up and cool down relatively slowly. Thermal insulating materials such as glass fibre and foam, usually because of their open or cellular structure, form poor heat stores and diffuse heat very badly. The concept of collecting heat through use of walls for thermal mass is mainly applicable to warmer regions where there is a need for heating only at night but where thermal insulation is not necessary. In Northern Europe, more heat will be lost from inside through an un-insulated south-facing wall than can be collected from the sun. External walls must be insulated, preventing the diffusion of solar heat into the wall.



The principal objective of Passive Solar Design (PSD) is to provide a building with a comfortable and healthy indoor environment at low energy and environmental cost. It relies on the careful application of the following principles during the design and the construction of the building:

- Making provision for solar gains and avoiding heat losses so as to minimise the use of heating;
- Providing access to daylight to reduce the need for artificial lighting;
- Using natural ventilation to avoid dependence on mechanical systems, especially air-conditioning;

- Providing efficient and responsive heating and lighting systems.

About 65% of the energy consumption in our house is for space heating and another 15% are for hot water production and 20% losses through conventional boiler inefficiencies.

For most buildings heating bills can be reduced by 20% at negligible capital cost by applying passive solar design. Significantly larger savings can be achieved if a comprehensive low-energy design strategy is adopted. Passive solar heating relies on Collection, Conservation, Storage and Distribution.

Direct Gain is the best passive solar collection technique for Ireland's climate. It is based on the greenhouse effect whereby solar radiation is collected through glazing, absorbed by walls, floors and other solid elements, and then re-emitted in the form of heat.

Orientation of the house within 30° of due south is a basic but fundamental principle of passive solar design to maximise solar gains. The south facade should also be free from overshadowing by trees or other buildings, especially when the sun is at a low angle during winter.



Other typical elements of a house designed for solar collection are:

- A glazing area of about 20% of the floor area, of which 50% should be south-facing;
- Relatively large windows on the south-facing façade;
- Smaller north-facing windows to avoid heat losses while providing good daylight;
- Preferably vertical glazing as opposed to sloped glazing;
- Preferably tall windows as they allow daylight penetrate further into a room;
- Glazing materials, which allow good light transmission and good insulating properties (high performance windows).

Once collected, useful solar gains must be retained within the building. A good heat conservation strategy will reduce the overall

heating requirement, shorten the heating season and increase the proportion of the heating demand, which can be met by passive solar gains.

The following principles generally apply for heat conservation:

- Minimise surface to volume ratio by keeping the building compact;
- Reduce the surface area facing north and/or exposed to prevailing winds;
- Limit heat losses by insulating the building envelope and controlling ventilation and infiltration;
- Locate spaces with lower heat requirements (garage, corridors, bathrooms, kitchen, etc.) on
- The cold side of the building.

As mentioned above, a solar heating system always needs a complementary source of energy in order to ensure that the heat required is supplied at all time. Instead of using an oil boiler or a gas boiler as a back-up, you can choose to combine your solar system with a wood boiler or a heat pump in order to maximise the environmental and financial benefits of your investment.

Wood and solar energy are natural partners for a 100% renewable heating system. Using wood as an energy source contributes to reducing carbon dioxide emissions and the sustainable management of our forests. Modern and efficient wood heating systems are available for all needs and budgets. A solar water heater or a combination system can be integrated with a wood heater without difficulty and complement it very well. It will reduce wood consumption and limit the heating season significantly.

A heat pump and a solar heater also form a perfect combination for heating your house and your water without burning fossil fuels and polluting the air. A heat pump can harness heat at a low temperature from the environment (ground, water, air) and release it at a useful temperature for heating purposes. For every unit of electricity used to activate the heat pump, four units of heat are generated. They are reliable, clean and economical. When the solar collectors do not produce sufficient heat, the heat pump will start and supply the rest of the heat required. A solar-heat pump combination will reduce your fossil energy consumption to the very minimum.

**Mayo Energy Agency,
Arran Place,
Ballina,
Co. Mayo,
Republic of Ireland
Tel: (096) 76113 / Fax: (096) 76199
Email: mayoenergy@eircom.net
Web: mayoenergy.ie**