Homeowners: Solar Panels

From RVR

Solar Panels

Solar Panels work by collecting radiant energy from the sun and using it to heat your water.

However, there are two different designs of solar panel.

Vacuum Tube

Vacuum tube panels are also known as Evacuated Tube panels.


Vacuum Tube Panels on a roof

These are the most efficient type of collector available. They are very good at collecting the heat and retaining it.

The panel consists of a header and a series of tubes. These tubes consist of two layers of high quality solar glass with a vacuum manufactured between the two layers.

When radiant heat from the sun hits the panels, it can pass through the vacuum , the same way the sun's rays pass through space. However, once it hits the absorber in the middle of the tube and warms it up, it is then trapped inside the tube. It can't escape as there is a vacuum between the absorber and the outside air. As a result, there is no possibility of the heat conducting or convecting out of the tube.

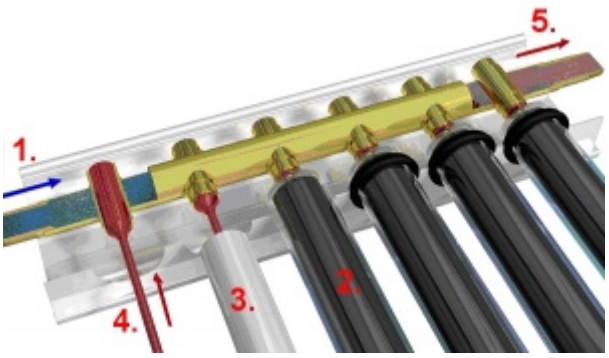
Vacuum panels and Flat Panels (see below) provide similar performance during summer months. This is because there is an abundance of energy available from the sun. However, since vacuum tube panels lose lose less heat, they work better in colder autumn and winter seasons and in cloudy weather. As a result they are ideal for Irish and British latitudes.

There are two types of vacuum collector technology available:

Heat Pipe

In Heat Pipe Vacuum Collectors, the solar fluid does not absorb the energy directly. Instead there is a refrigerant in the tubes that indirectly heats the solar fluid.

The graphic below gives a good description of how a Heat Pipe type collector works.



1. The solar fluid is circulated up around the panel from left to right.
2. The Sun's rays are collected by a Vacuum Tube. This traps the energy inside like a thermos flask.
3. An aluminum fin is welded around the actual copper pipe in the tube. This works like a radiator in reverse, collecting the heat instead of dissipating it.
4. Inside the copper pipe there is a refrigerant which heats and cools very rapidly. When it heats, it rises to the top of the pipe by convection. There it reaches a copper bulb which transfers the heat out into the solar fluid. When this happens it cools and drops until it is heated again.
5. The solar fluid, having been heated by 20+ tubes, leaves the panel and is circulated down to the tank. The process begins again at step #1.

Heat Pipe type vacuum collectors are very easy to transport and handle as the tubes can be disconnected from the manifold of the collector.


RVR Solar HP20

Benefits of Heat Pipe Technology

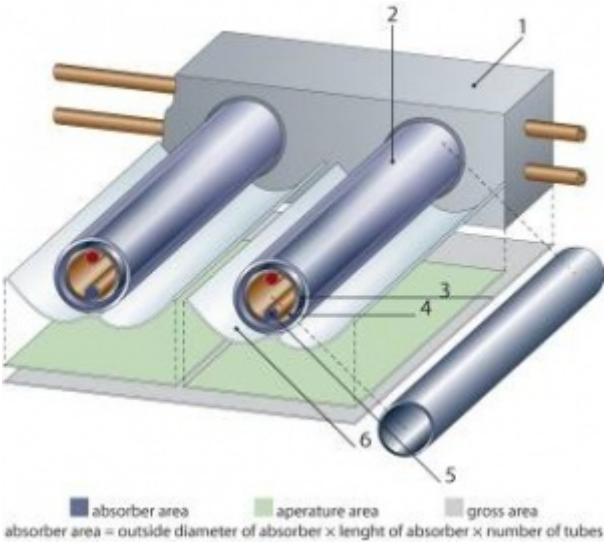
- Panel can be taken apart and reassembled.
- Can be installed on a roof by one person, installing the frame first, then the manifold and then each tube individually.
- The frame can be installed on-roof initially (for instance while building a new house) and the tubes can be added when the people move in. This helps prevent damage to the solar heating system.
- Heat Pipe type vacuum collectors are often cheaper than fluid type as they are easier to transport.

RVR Supply a range of heat pipe vacuum tube collectors. Further information is on the RVR Solar HP20 model (http://www.rvr.ie/default.aspx?subj=catalog/ProductDescription&catIdPath=0_70_75_71&productId=SOL401) and HP30 model (http://www.rvr.ie/default.aspx?subj=catalog/ProductDescription&catIdPath=0_70_75_71&productId=SOL402) product pages.

Fluid Type

In a fluid type vacuum collector, the solar fluid passes through a U-Tube in each of the solar tubes, absorbing the olar energy directly.

The graphic below gives a good description of how a Fluid type / U-Tube type collector works.



1. The solar fluid is circulated up around the panel from left to right.
2. The Sun's rays are collected by a Vacuum Tube. This traps the energy inside like a thermos flask.
3. The heat cannot escape due as there is a Vacuum between it and the outside (no conduction). Hence the name, Vacuum Tube.
4. An aluminum fin is welded around the actual copper pipe in the tube. This works like a radiator in reverse, collecting the heat instead of dissipating it.
5. The solar fluid circulates directly through a copper U shaped tube. The solar heat is transferred to the fluid.
6. A parabolic "CPC" reflector ensures maximum efficiency as it gathers the suns rays, no matter which direction they come from.

Fluid type vacuum panels are often a great time saver for the installer. The panel cannot be disassembled so it is delivered fully finished and ready to simply bolt to the roof. Unfortunately this means they cost more to transport and as a result are usually dearer.


Calpak 12VTN

Some Fluid Type collectors come with a CPC "Compound Parabolic Reflector" behind the tubes. Some do not. On a panel without a CPC reflector, some of the sun's rays pass between the tube and are not collected. On a panel with the CPC reflector, sunlight that passes between two tubes is always reflected back into one of the tubes. The Calpak panels RVR supply contain these and so the panels provide very good performance as well as quite small dimensions.

Benefits of Fluid Type Technology

- Requires less roof space than other solar collectors
- No on-site assembly of collector required

RVR Supply the 12VTN vacuum collector from Calpak. Further information is on the 12VTN (http://www.rvr.ie/default.aspx?subj=catalog/ProductDescription&catIdPath=0_70_75_71&productId=SOL001) product page.

Flat Panel

Flat panels are also known as Flat Plate Collectors.

These are not quite as efficient as Vacuum Tube Collectors, but they are a little bit cheaper and do have the benefit that the can be installed "In-roof", or level with the roof. This way they just look like a big skylight and often look more attractive.


Flat Panels on a roof

In this type of panel, there is a large block of insulation at the back, with a series of S- shaped copper tubes running on top. On top of this, laser welded to the copper piping, is a large "Selective" absorber sheet. This means that the sheet has been painted with a special dark blue/black colour paint that is the optimum colour for absorbing sunlight. There is a special tempered glass sheet on top that protects the panels from the elements while still allowing the sun's tays to pass through.

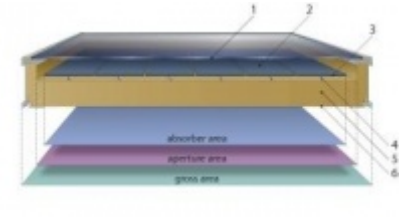
Unfortunately this entire collector does not have a vacuum inside, so when heat is absorbed by the sun some of it is lost back out to the atmosphere. This is usually countered by simply having a larger area of collectors. As a result, flat panels are sometimes bigger than vacuum tube panels.

How a flat panel works

In a Flat Panel, the solar fluid passes directly through the copper piping of the panel, absorbing the solar energy directly.


Tisun Flat Panel Collector

The graphic below gives a good description of how a Flat Panel type collector works.



1. The solar glass is a special material designed for solar panels.
2. There is an air space between the glass and absorber.
3. The absorber is made from copper or aluminium and coated with a special material top ensure maximum absorption of solar heat.
4. Copper tubes are laser welded to the absorber to ensure that the heat is transferred to the solar fluid.
5. A layer of polyeurethane or rockwool insulation is used to minimise heat loss from the back of the solar panel.

Benefits of using a flat panel

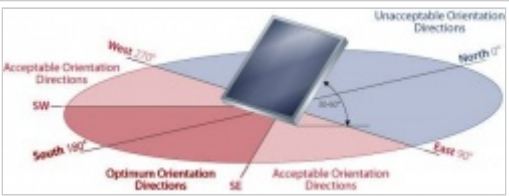
- Often costs less than Vacuum tube collectors
- Can be flashed into a roof, giving an appealing finish

RVR Supply the FM-S Flat panel from TiSun. Further information is on the FM-S (http://www.rvr.ie/default.aspx?subj=catalog/ProductDescription&catIdPath=0_70_75_71&productId=SOL551) product page.

Orientation, angle and shade

A major factor which affects efficiency is the orientation of the collectors.

Since the sun is due south, the panels should be oriented towards the south. Collectors which are facing SW or SE will lose approximately 6% of their efficiency.



Acceptable orientation of a solar collector

Panels should also be mounted at approximately 50%deg;. Higher or lower angles are also ok but can affect efficiency in extreme cases.

Finally, panels should be free of shade. Any part of a collector that is in shade will not be able to collect any energy.

Gross Area vs Aperture area

Two terms which are ofter used are Gross area and Aperture area. Gross area means the total surface area of the panel. This includes everything from the header and tubes to any bottom brackets and frame surface. Aperture area is more important as it refers to the surface area which collects energy.

For example, the Calpak 12VTN panel has a gross area of 2.15m2 but it has an aperture area of 1.95m2. This is because it has a CPC reflector.

On the other hand, the RVR Solar HP20 panel has a gross area of 2.64m2 but has an aperture area of 1.86m2. Because it does not have a cpc reflector, the area between the tubes is not counted as part of the aperture area. As a result, it has to have a bigger surface area (gross area) to compensate and achieve the same aperture area.

Efficiency of a panel

It is very difficult to compare two solar panels side by side, even if they look very similar. Many hidden factors affect the efficiency of the panel, e.g. the materials used, the quality of the glass, the size of the tubes, orientation and angle. In fact, panels of a similar size on the SEI registered supplier list can vary in efficiency by as much as 45% even though they physically look very similar.

Only a BER assessor or engineer can accurately compare the outputs of two Solar Panels. This can only be done using the official DEAP software, which takes account of all the factors that affect the performance of a system.

However some manufacturers publish efficiency data for their panels. This consists of several figures which are provided by standard independent tests.

The important figures are as follows:

- **η0: Optical efficiency:** This indicates the percentage of the solar rays penetrating the glass of the collector and being collected.
- **A1 and A2:** The coefficients a1 and a2 describe the heat loss of the collector. They indicate the amount of heat that the collector loses to the atmosphere per m2 of aperture
- **Aperture Area:** The area of the panel which collects energy

It is still difficult to determine the output of a collector just by looking at the figures alone:

- A collector can have a high η0 which means it collects a lot of energy. But it can also have a high a1/a2 which means it doesn't retain the energy well.
- A collector can have a low η0 which means it does not collect much energy. But it can also have a low a1/a2 which means it retains most of the energy it collects.
- A collector can sometimes compensate for poor efficiency figures by having a larger aperture area. Alternatively a collector with a small aperture area can sometimes have excellent efficiency figures and

give a better output.

As a result it is important to choose a supplier who:

- Has a reputable brand and is well known
- Has good technical knowledge
- Has a good understanding of efficiency and the theory of how to compare panels
- Publishes their efficiency data

You should avoid suppliers who:

- Try and compare panels based on "number of tubes" or anything other than efficiency data
- Have poor technical knowledge
- Do not publish their efficiency data

This will ensure you end up with a quality solar system with good efficiency.

Further Reading

You can read about the components that make up the heart of the system here: Homeowners:Solar Station, Solar Fluid and Expansion Vessel