



The solar experiment



Is it possible to heat a house with sunshine alone?
In Ireland? **Lars Pettersson** finds out on a passive house in Co Galway

Harvesting the sun's energy to turn it into heat has become a relatively common proposition in Ireland. Solar thermal collectors are often placed on your roof to give you hot water and, in the case of a passive house, the system will be able to partially heat up your home in the winter (In the warmer months, from March to December, there shouldn't be any heat requirement in a passive house). However the technology behind solar heating is not advanced enough to allow us to heat our homes and get hot water from them all year around - even in a passive house.

One option is to create a sort of thermal battery or storage device (called a "seasonal store") to store up the heat accumulated during the hotter months and release it in the colder ones, when the system isn't functioning to full capacity.

This idea is being tested in Co Galway in a PassivHaus, which clearly has a very low energy demand and as such can use a storage device to meet all of its hot water/heating requirements year-round. This type of system is quite expensive, due to the fact that a low energy demand house means longer payback times.

Solar collectors fall short of meeting yearly demand

A passive house is not a zero energy house - it is a home that is so highly insulated it won't need a conventional heating system to heat it or supply hot water. The amount of energy you'll need will in fact be less than 15kWh/m²/year, otherwise it has not reached the PassivHaus standard. Another way of expressing the passive house requirement is to use the peak heat demand. In a passive house



we can use a maximum of 10 Watts per square meter of floor area. On the coldest day of the year, this is equivalent to saying that the maximum amount of heat required in a 200m² house should be no more than what it takes to power a toaster (2,000W)!

Oftentimes, part of this energy requirement is met by solar thermal collectors, but unfortunately, due to a combination of our weather and their performance, a solar thermal system is probably only going to be able to heat and supply hot water to your home in the warmer months, from March to November.

The problem here is that the sun is much lower in the sky in the winter than it is in the summer, and it's cloudier too. It's radiating less energy, which means that the collectors, and the heat output, are consequently affected.

Despite what you might think and feel about Irish weather, it's relatively mild, and this has the advantage of not requiring much energy to heat homes in the winter months. This combination of factors triggered the idea to devise a system that would be able to heat a home all year long by solar means alone. So how to deal with those pesky winter months? Build a storage device of course! This "seasonal store" gathers and preserves solar energy to release it when the collectors aren't able to heat the house.

Expensive but it works!

The house that was monitored for this project was built in Galway in 2005 and it requires no more than 8.5kWh/m²/year for its heat requirement, much better than the PassivHaus standard. Building the tank cost €30,000 as outlined by the requirements below:

- House size: 230m²
- Number of occupants: family of four
- Thermal energy requirements of the house: 3,915kWh/year (1,725kWh for space heating + 2,190kWh for domestic hot water)



- Materials costs to build tank: €10,000
- Labour costs to build tank: €20,000 (this could be halved if installing a second system)
- Tank's heat storage requirements: 8,000kWh/year (twice the energy requirements of the house due to 50% heat loss)
- Tank's embodied energy: 9,079kWh (505kWh for the concrete tank + insulation around the tank of 6,533kWh for the 400mm Polystyrene and 2,041kWh for the 200mm soy-urethane)
- Payback time of the tank: 55 years (at day rate for electricity of €0.14/kWh, €548/year is saved)

How it works

With an unusually large array of solar collectors, some overheating and boiling can occur in the summer months if the storage tank is not large enough to take the amount of energy produced by the sun. A smaller collector area won't rectify the problem, as it may not be able to generate temperatures high enough to be useful in the winter. Instead, it is more appropriate to build a larger tank.

In our case, the solar collectors on the roof first heat the water in the small standard 300-litre tank, the kind you would get in a typical installation. As ►

The tank was built underneath the greenhouse but it would have been preferable to place it closer to the home to avoid heat losses

Equipment checklist

Standard solar thermal collectors:

Vacuum tube collectors of 1.8m², estimated to produce 714kWh/m². Estimated area required for the collectors: 8,000kWh ÷ 714kWh/m²/year = 11.2m². We installed six collectors with a total of 120 tubes and this gave us a total aperture area of 10.8m². Two accumulation tanks are connected to the solar panels on the roof - the standard one in the utility room (which you would have with a regular installation) and the seasonal heat store (a larger tank storing heat for use in the winter).

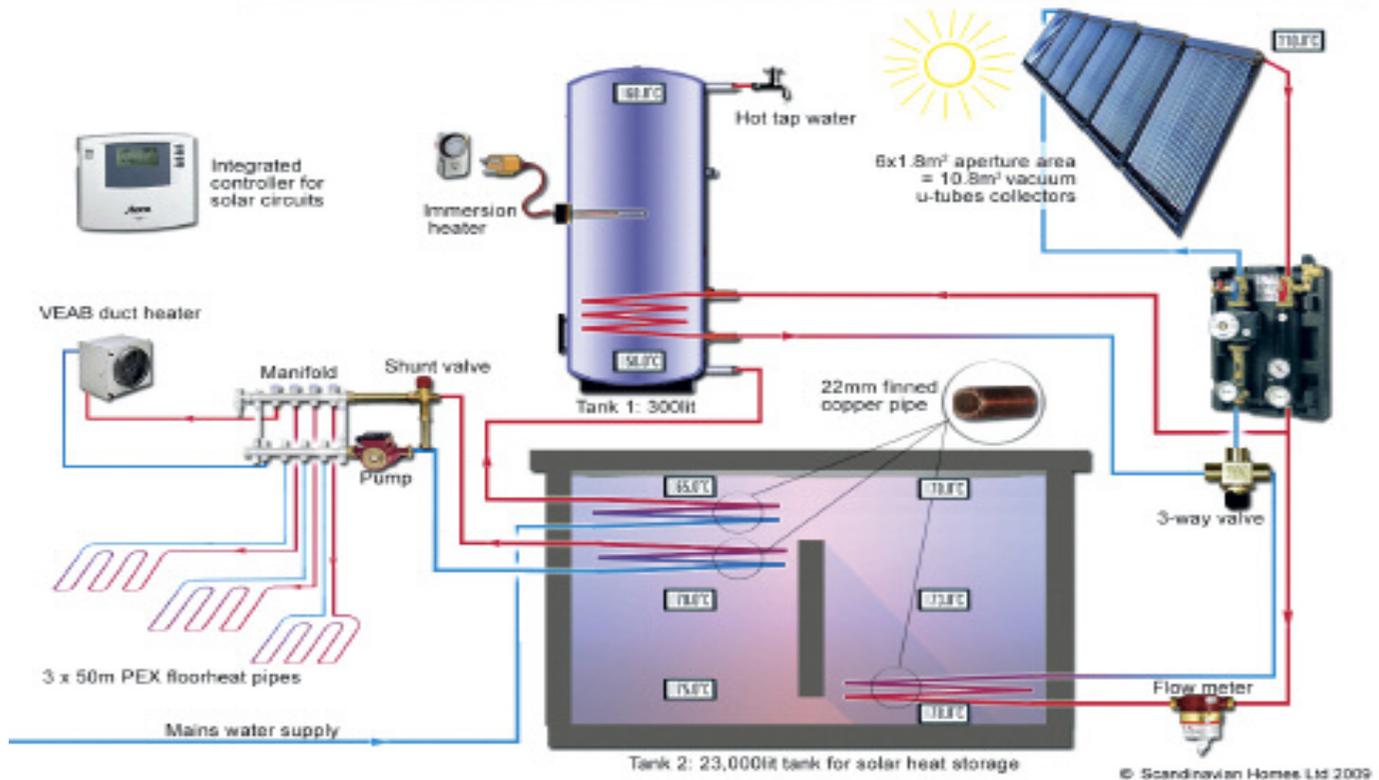
Standard heat tank:

A typical 300-litre tank is located in the utility room; it supplies the house with domestic hot water.

Seasonal store (large heat tank):

A very large 23,000-litre (23m³) underground pre-cast concrete tank is located underground next to the house. It is externally insulated with a total of 600mm of expanded polystyrene. The U-value of the insulation of the walls, the bottom and the top of the tank is extremely low; in the order of 0.059W/m²K. The large underground tank is connected to the house via an insulated culvert which contains a total of five pre-insulated 20mm flexible stainless steel pipes.

0-energy passive house with seasonal store of solar heat



Scandinavian Homes

The €30,000 large storage tank was able to cover the home's heat demand all year round

with a regular solar thermal system, the tank supplies the home with hot water. When the tank gets hot enough, the flow is simply redirected towards the large underground tank (the "seasonal store") to be charged.

The critical time of the year is considered to be December and particularly January when the sun is low over the horizon and the heat generated by it and stored in the large tank has been depleted. In March, the solar radiation is considered enough for daily usage, and later in the spring the large thermal storage tank starts to increase its temperature again.

The house is equipped with a total of 180m underfloor heating pipes. One 60m length in the utility room, one 60m length under the floor of the upstairs shower-room and one 60m length divided between the bathroom and en-suite on the ground floor. This simple and very cheap installation is typical for a passive house - the resources are spent on insulation, not on complicated heating and distribution systems!

Passive or Passiv?

A passive house is a generic term which refers to utilising passive systems, including things like passive stack ventilation, exclusive use of sunlight, etc. In 1995 two engineers built a best-practice example of what they thought a passive house should look like in a German climate; the principles they used were developed into the PassivHaus standard, which led to the creation of the PassivHaus Institut. In Ireland the terms tend to be interchangeable because PassivHaus certification is widely recognised as the most convenient means to prove that a house is truly "passive"; the basic premise is that the home be built airtight and with so much insulation that it require very little heat to keep the house comfortable and warm.

Room for improvement

The first winter, that of 2009-2010, was moderately successful considering the space heating requirement of the house was met up until Christmas Day. At this time the temperature of the seasonal store tank had dropped below 25°C, a temperature that is no longer useful for space heating. The reason for this had to do with the maximum temperature (of just 46°C) having been achieved on the 20th of October 2009 which led to the tank being depleted earlier than expected. This year's maximum was 67°C in spite of the unusually cloudy summer of 2010, so we hope to heat the house with 100% solar energy well into January.

Heat losses represent the biggest problem, including transmission losses. Between the tank and the house, and within the tank itself, we must accept that more than 50% of the heat collected is lost. Despite the exceptionally high levels of insulation employed in the installation, total losses are expected to be 3,697kWh, doubling the forecasted heating requirements.

A more economical installation would therefore involve reducing the size of the storage tank to between 1,000 and 2,000 litres and locate it right next to the garage, thereby heating it. By placing the tank next to the garage the ducts would also have been shorter, resulting in reduced heat losses and installation costs. We placed our large heat tank beneath the greenhouse, which in hindsight wasn't a great idea because in the winter it doesn't seem to be able to retain the heat gained during the day due to its lack of contact with the soil beneath!

So what have we learned so far from this seasonal store project? ▶



Can provide
up to 70%
of the energy
needed for
hot water



VELUX solar collectors can be used on their own or combined with Roof Windows for an integrated look.

Go green in the bathroom

Enjoy a clean renewable source of energy with a VELUX Solar Hot Water System

These days we're all aware of the benefits of solar energy – not only is it a greener, cleaner way of providing hot water and heating for our homes, but it can also reduce heating bills substantially.

The question is not so much whether to install solar heating, but which system to fit.

Here at VELUX we have been manufacturing and selling solar products in Europe for over 15 years, applying the same levels of quality and innovation as we have done for generations to our range of Roof Windows. Our Solar Hot Water System comes as a single complete package, making it easier to install. Just as importantly our solar collectors are beautifully streamlined, for a Solar Hot Water System that's as easy on the eye as it is on the environment.

For more information on our Solar Hot Water Systems visit www.velux.co.uk/solar or www.velux.ie/solar

for a brighter future |

VELUX®



Monitored results show that the solar thermal collectors are able to pick up the sun's energy even when it's cold and partly cloudy

- Yes, a large array of solar collectors connected to a very large storage tank can be very successful in Ireland, albeit at a cost, as the tank was able to by and large cover the heat demand in the winter months
- High insulation is required, as is a low temperature heating system (standard in a PassivHaus)
- It's best to place the tank as close to the home, so as to minimise heat losses (if the tank is too far, you could lose as much as 50% of the heat in the pipes) and to channel those heat losses to a room nearby, such as a garage
- A small photovoltaic panel on the roof could be added so that the heating would work off-grid.

For this to work, the circulation pump can be replaced with a low voltage (12V) version

- The sun comes through the clouds and shines a lot more than you might think!
- The vacuum tubes are remarkably quick to pick up the heat, even in very cold weather

For a regular house in Ireland, a solar system revved up by a seasonal store could carry the hot-water production and the space heating requirements for the warmer six months of the year. Unfortunately regular houses still need a conventional heating system for the winter months as such homes typically require between five and 20 times more energy than a passive house to be comfortable and warm.

For a passive or super passive house in Ireland, a seasonal store is not economically attractive. The reason for this is that the running costs are so low to begin with that the payback time is inevitably high. Other "top up" systems, such as a heat pump or a even a simpler heating device, may be more cost-effective. That said, it certainly is attractive to be independent and to have no fuel bills... ever! ■

You can visit this PassivHaus in Galway every Wednesday between 3pm and 6pm. For more information, including research results, log on to www.scanhome.ie. Shane Colclough (colclough-s@email.ulster.ac.uk) of the University of Ulster is monitoring and evaluating the performance of the seasonal store installation; a full report will be published in 2011.

Lars Pettersson, Scandinavian Homes Ltd.
(passive house designers and builders),
Moycullen, Co Galway, Ireland,
tel. 091 555 808, mobile 087 2414 808,
www.scanhome.ie

The companies listed below provide products & services relating to this article.

Actis

(Multifoil insulation for roofs, attics, walls & floors) Wiltshire Tel: 01249 462888
www.actis-isolation.com

Advanced Timbercraft Ltd

(Timberframe house construction) Newtownabbey, Co Antrim Tel: 9083 8951
www.advancedtimbercraft.com

Alternative Heating & Cooling Ltd

(Waterfurnace heat pumps & underfloor heating) Skibbereen, Co Cork Tel: 028 23701 www.ahac.ie

Craftstone 2000 Ltd

(architectural cast stone, precast & glassfibre reinforced concrete products, composite insulated panel) Banbridge, Co Down Tel: 9269 9777 www.craftstone.co.uk

DCI Energy Control Ltd / Safeguard Security

(Wall & loft insulation, central heating and renewable energy measures) Carrickfergus, Co Antrim Tel: 9336 8005
www.dcienergy.co.uk

Elementary Energy

(Solar Energy, Biomass Boilers, Wind Turbines, Heat Recovery Ventilation) Corofin, Co Galway Tel: 093 32 843 www.elementaryenergy.ie

Flo Gas Ireland Ltd

(Heating: Calculations, systems & appliances) Drogheda, Co Louth Tel: 041 983 1041
www.flogas.ie

Haldane Fisher Ltd

(Complete builders' providers) Newry, Co. Down Tel: 3026 3201
www.haldane-fisher.com

Homecare Systems Ltd

(Villavent ventilation & central vacuum (SACH) systems) Donaghmore, Co Tyrone Tel: 8776 9111 www.homecaresystems.biz

Inspire Architectural Design

(Architectural Technologists) Enniskillen, Co Fermanagh Tel: 6632 9083 www.inspireni.co.uk

JW McCall Supplies

(Tiles, bathrooms, hardwood flooring, timber & building supplies) Downpatrick, Co Down Tel: 4481 1685 www.jwmccall.com

Kingspan Home Ltd

(Timber Frame) Monaghan, Co Monaghan Tel: 047 81270 www.century.ie

Kingspan Insulation Ltd

(CFC/HCFC-free rigid phenolic & urethane insulation) Castleblaney, Co Monaghan Tel: 042 979 5000
www.insulation.kingspan.com

Nuaire Ltd (Renewable ventilation solutions)

Lisburn, Co Antrim Tel: 9267 0363
www.nuaire.co.uk

Roofblock (Masonry roof overhang)

Newtownards, Co Down Tel: 9181 8285
www.roofblock.co.uk

SIG Ireland

(Insulation, Roofing, Interiors & Specialist Construction Products) Nangor Road, Dublin 12 Tel: 01 499 2400 www.sig.ie

Superglass (Mineral Wool Insulation)

Stirling, Scotland Tel: 01786 402 003
www.superglass.co.uk

The Green Oak Framing Co

(Green oak trusses for whole house or extension) Omagh, Co Tyrone Tel: 8164 8926
www.greenoakframing.com

Further Reading:

Solar Domestic Water Heating, The Earthscan Expert Handbook for Planning, Design and Installation, by Chris Laughton (2010). Get a 20% discount at www.earthscan.co.uk using the voucher code SELFBUILD.

Other Resources:

University of Ulster (monitoring) www.cst.ulster.ac.uk
Sun-King (vacuum tube collectors) www.sunkingsolar.com
PassivHaus Institut (PassivHaus standard) www.passiv.de

ROI calling NI: prefix with 048
NI calling ROI: prefix with 00353(0)

info