

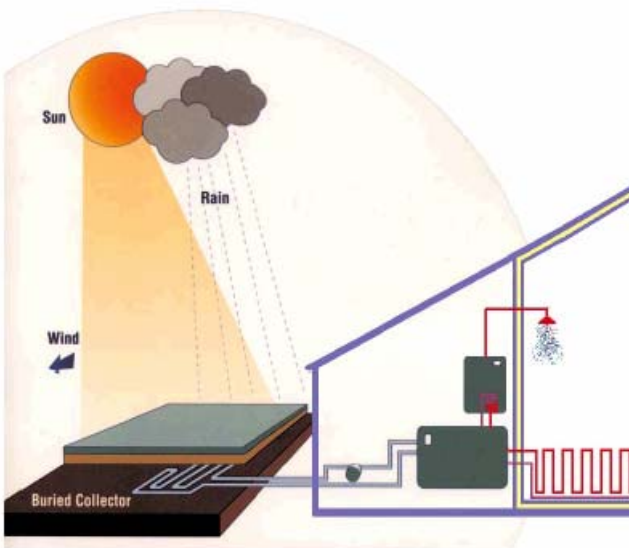
Heat Pumps



The burning of fossil fuels to meet our energy demand is resulting in the emission of vast amounts of greenhouse gases. This has attained such a level in the last decades that it poses a serious threat on our climate.

Global warming has become a reality and, if not tackled urgently, will have dramatic effects on our lives, the lives of our children and on our planet. Irish households consume the equivalent of 2.4 million tonnes of oil every year for their energy needs outside transport. This represents 25% of the total final energy consumption in Ireland. Burning fossil fuels like coal, oil, peat, gas, etc provides the vast majority of that energy. This results in the emission of 11 millions tonnes of carbon dioxide, the main contributor to greenhouse gases emissions.

Each of us has a large responsibility with the problem of climate change. But we can be a significant part of the solution by shifting to sustainable sources of energy and using energy more efficiently. Today heat pumps can help us to reduce our energy consumption for space heating and hot water production (which is over 80% of the energy you use at home) by more than 60%, with a payback period of around five years.



A heat pump is a system that can harness energy from free renewable sources for heating your house and producing your hot water. Through compression, heat pumps can 'pump up' heat at

low temperature and release it at a higher temperature so that it may be used again.

A heat pump is an environmental energy technology that extracts heat from low temperature sources (air, water, ground), upgrades it to a higher temperature and releases it where it is required for space and water heating.

A heat pump does not look very different and can perform the same functions as a conventional gas or oil boiler i.e. space heating and sanitary hot water production. But it does it much more efficiently, using most of heating energy from free renewable sources. Heat pumps are a mature technology on which you can rely on just as any other well-established heating system. Heat pump units often last 20 years or more.

Low temperature heat sources are available everywhere around us in very large quantities from renewable energy sources: outdoor air, surface water (rivers, streams, and ponds) or the ground. These sources are continuously replenished with free energy from the sun, rain and wind.

Waste heat can also be used. If your house is equipped with a mechanical ventilation system, heat from the exhaust air can also be converted to re-usable heat by means of a heat pump.

Energy is needed to drive the heat pump, generally electricity. But for every unit of electricity used, it will generate 3 to 5 units of useful heat. The ratio between the useful heat produced and the electricity used is generally referred as the Coefficient of Performance (COP) to express the overall efficiency of a heat pump.

The efficiency of a heat pump will depend mainly on the temperature of its energy source and the temperature at which the heat generated is needed. Basically, the higher the temperature of the heat source is and the lower the temperature of the useful heat is, the more efficient will be the heat pump.

A heat pump using the soil as a heat source (constant temperature of 8 to 12°C), and floor or wall heating (water temperature of 35 to 55°C) is one of the best combinations, with efficiency in excess of 400%. Compare that with the efficiency of a good oil or gas boiler (70-85%) and you will understand why heat pumps are so attractive.

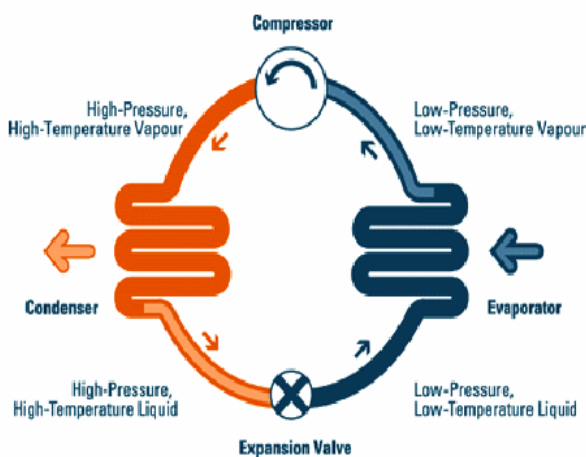
Heat pumps can also be operated in a reverse mode for cooling purposes.

The heat pumping cycle can be divided in three steps:

Step 1. A fluid with a boiling point lower than the heat source temperature serves as a medium for heat transport. It is called the working fluid or refrigerant. As the working fluid extracts the heat from the source through a heat exchanger, its temperature rises and it evaporates.

Step 2. Then a compressor compresses the evaporated fluid. Consequently, the pressure and the temperature of the vapour increase. When pumping up a bicycle tyre, you can also observe this phenomenon. The lower side of the pump – where the pressure is highest – is getting very hot.

Step 3. Finally, heat is being transferred from the evaporated fluid to the heat distribution fluid (water or air) in the condenser. As it releases its heat, the working fluid temperature decreases to such a degree that it condenses. After passing through the expansion valve, the fluid regains its initial liquid, low-temperature and low-pressure state. It then flows back to the evaporator where the process starts all over again.



Energy is needed to activate the heat pump cycle and to compress the vapour for the production of useful heat. The efficiency of this process is expressed by the ratio between the useful heat delivered by the condenser and the driving energy used by the compressor. This ratio is called the Coefficient of Performance (COP).

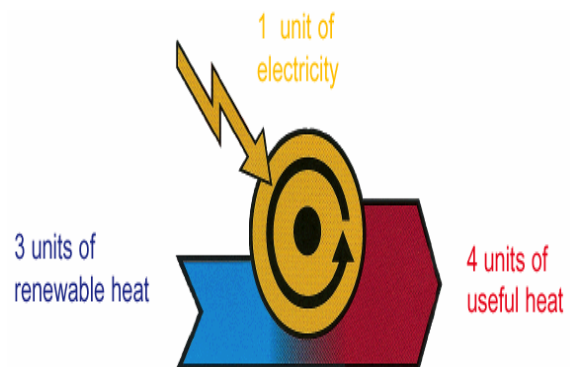
The performance of a heat pump system is affected by several factors, which include:

- * The climate (annual heating and cooling demand and peak loads);
- * The temperature of the heat source and the heating distribution system;

- * The auxiliary energy consumption;
- * The heat pump control.

The performance of electrical heat pumps should be balanced by the fact that the efficiency of electricity generation in Ireland is less than 40%. That means that for every unit of electricity used, more than 2.5 units of primary energy (mix of oil, gas, peat, etc.) have been burned. Therefore, a heat pump with a COP of 4 driven by electricity generated by a thermal power plant has a primary energy efficiency of 160%.

That is already better than the 100% achieved by a modern gas-condensing boiler operating at low temperature for example. But you can increase the primary energy efficiency of your heat pump, and therefore its environmental benefit, by 3 times by driving it with green electricity. It is now possible to switch easily to a green electricity supplier at no extra cost (see the REIO fact sheet on green electricity).



The choice of the heat source is of vital importance for the heat pump, as it will directly influence its application, efficiency (COP & SPF) and initial and operating costs. Renewable heat sources that can be used by heat pumps are air, water and ground.

The main factors that will affect this choice are:

- * Its availability: quantity, location relative to need and coincidence with need;
- * Its cost: installation, operation and maintenance;
- * Its temperature: level (the higher the better) and variation.

Ambient air, the most common heat source for heat pumps, is free and widely available. However air-source heat pumps achieve on average 10-30% lower seasonal SPF than ground-source or water-source heat pumps. This is mainly due to the rapid fall in capacity and performance with decreasing outdoor temperatures.

The capital costs for a complete heat pump system are made up of the equipment cost of the

heat pump unit, the heat source collector, the heat distribution system, and installation. The ground coil and its installation are typical of a ground-source heat pump system and represent 30-50% of the total capital cost.

The following table gives an indicative breakdown of the capital costs of a ground-source or water-source heat pump system in a residential building in Ireland:

Heat Source Collector	
Horizontal ground source 1	€1900-€2500
Vertical Ground source 1,2	€/m of borehole 25-75
Water Collector	€1900-€2500
Heat Pump unit	
Capacity 10 kW	€4500-€5000
Capacity 15 kW	€5000-€5700
Installation	€1000-€2000
Control Unit	
Channel & hot water control	€380-€640
Hot water heating kit (excl. cylinder)	€640
Underfloor heating Incl. material, installation, finish	€/m ² 30-40
Hydronic convectors	
3kW terminal, incl. installation	€/unit 320
6kW terminal, incl. installation	€/unit 355

1 incl. trenching or digging

2 Based on US figures, including drilling. According to heat pump suppliers, vertical ground collectors are not economical for small-scale applications in Ireland.

While heat pumps in residential buildings are usually more expensive initially to install than other heating systems, their greater energy efficiency allows you to recoup the extra cost in a few years. After that, you will make large savings in energy and maintenance costs compared with conventional heating systems.

The following table presents a comparison of the costs related to different heating systems delivering 20,000 kWh for space heating and domestic hot water production in a typical 180 m² house in Ireland.

Heating Systems	Initial Investment ** € VAT Incl.	Purchased Energy		Operating costs * (€/year, VAT Incl.)
		kWh/year	Litres of oil Equivalent/year	
Electric storage	6,350	22,222	2106	1295
Gas oil boiler	7,650	30,769	2917	1665
Natural gas boiler	7,650	28,571	2708	980
Ground source heat pump	12,700	6,667	632	555

(*) Energy prices and efficiency by the Irish Energy Centre, November 2000

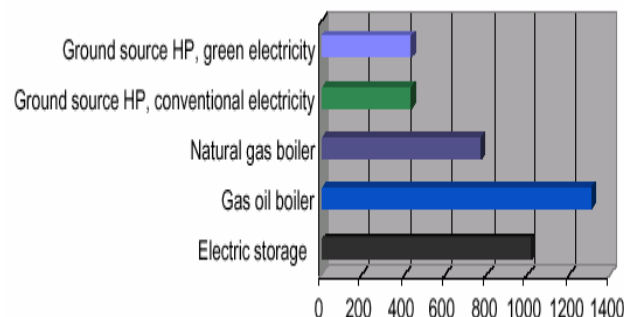
(**) Cost for 'turn key' delivery including heating, hot water production and heat distribution system according to European Heat Pump News issued by the European Heat Pump Organisation.

In brief, your heating bill can be reduced by as much as 70% if you opt for a heat pump.

That means hundreds of Euro saved every year. Heat pumps also require little or no maintenance (1/3 of conventional systems) and are less prone to failure.

Heat pumps are generally more expensive to install than conventional heating systems. But your energy savings will rapidly recover the extra cost for the initial investment (€3800-6350), typically between 3 and 8 years.

Annual operating costs of different heating



systems to deliver 20,000 kWh of useful heat

When replacing your oil boiler with a ground source heat pump, you will reduce your CO₂ emissions by at least 40%. That's already a significant contribution towards the fight against climate change. As electricity in Ireland is mainly generated by fossil fuels with a high carbon content (coal, peat, oil, etc.), using 1 kWh of electricity is responsible for a relatively high level of CO₂ emissions (0.82 kgCO₂/kWh). With the replacement of old power stations using coal or peat with more efficient and cleaner electricity plants, the potential of electric heat pumps to reduce CO₂ emissions will increase further.

But the really good news is that Green Electricity produced from renewable energy sources (wind, hydro, biomass) is now commercially available in Ireland at a competitive rate. The generation of Green Electricity is free of CO₂ emissions and has a primary energy efficiency of 100%. So by driving your heat pump with Green Electricity, you will heat your house and hot water totally with renewable energy sources and without emitting any CO₂. That's a major achievement for the environment.

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