SUSTAINABLE ENERGY IRELAND

Renewable Energy Information Office

Renewable Heat Pumps in the Healthcare Institutions

An eco-friendly and healthy heating and cooling system

Heat, more than 80% of our energy consumption

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.

Public hospitals in Ireland have an annual energy bill of 30 million pounds and consume the equivalent of 100,000 tonnes of oil every year for their energy needs. This represents about 7.5% of the total final energy consumption of the tertiary sector in Ireland. The vast majority of that energy is provided by burning fossil fuels like coal, petrol, peat, gas, etc. for heat and electricity. This results in the emission of nearly half a million tons of carbon dioxide, the main contributor of greenhouse gases emissions.

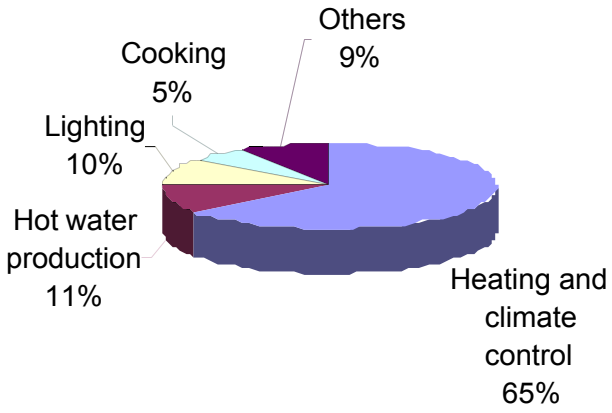
As hospital building owners, managers and users, we have a large responsibility in tackling the problem of energy and its impact on our environment. And we can be a significant part of the solution by shifting to sustainable sources of energy and using energy more efficiently.

As figure 1 overleaf shows, heating and climate control represent an average 65% of hospitals' energy consumption. It is therefore an area to tackle as a priority to reduce energy bills and related environmental impacts. Renewable heat pumps offer a cost-effective and sustainable solution for hospital managers to achieve this. They provide space heating, hot water and cooling using typically 60% less energy than conventional systems by harnessing free and clean energy from the environment.

What is a heat pump?

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

Fig. 1 **Share of energy uses in hospitals**



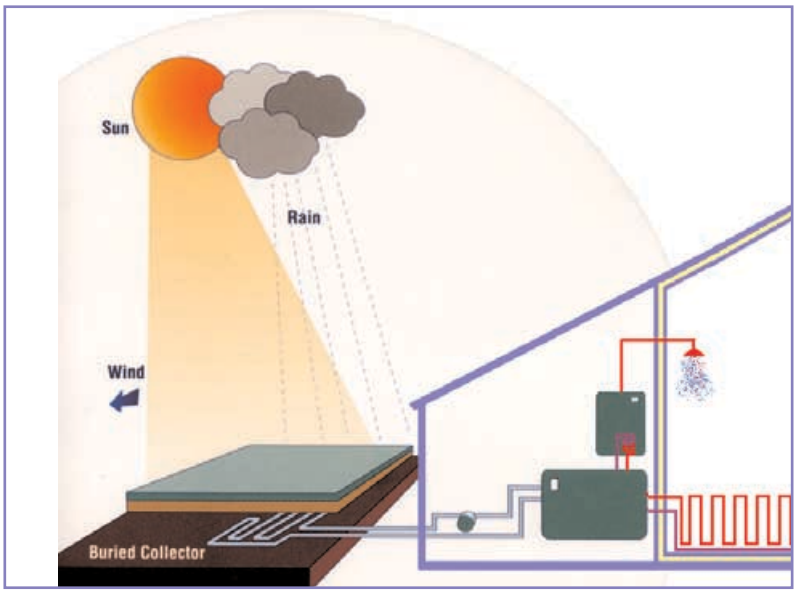
A heat pump is really a three-in-one HVAC system. It combines space heating, hot water and
air-conditioning in a economical and eco-friendly machine. They are particularly suited for hospitals as they have a high demand for space heating and sanitary hot water production, extensive work-in times and a simultaneous need for cooling.

This well-established technology offers benefits to hospital managers that range from increased comfort for occupants, reduced energy consumption and CO2 emissions to significant financial savings in operating and maintenance.

Using free sources of energy

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

In buildings equipped with a mechanical ventilation system, heat from the out-going ventilation air can also be converted to re-usable heat by means of a heat pump.



In Norway, the Stokmarknes hospital saves about €31,743 annually by pumping heat from the sea

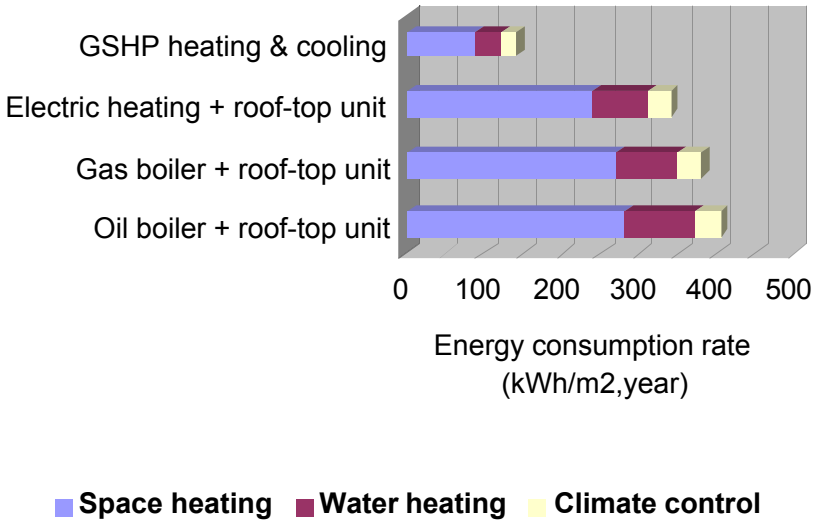
In 1987, the Stokmarknes hospital, located in Norway, installed a heat pump using sea water as the heat source. The hospital has a relatively high heating need varying from 100 kW to 800 kW throughout the year. The heat pump has a maximum capacity of 400 kW and can meet half of the design heat demand, while an oil boiler is used to meet peak demands.

The heat pump covers 88% of the whole annual heating need of the hospital (2,500 MWh), relying on an inexhaustible supply of low temperature heat from the sea. Since the heat pump uses only 840 MWh per year and the additional heat demand is covered by the equivalent of 425 MWh of oil, this means that the energy saving is as much as 1,235 MWh per year (nearly 50% of total heat demand).

The annual energy saving equals a cost saving of nearly €31,743. With a total investment cost of €213316 (1987 prices), the payback period was seven years compared to an alternative electric system, nine years compared to an alternative oil system (calculated with an electricity price of IR£ 0.02/kWh). Energy savings have also reduced annual emissions of CO2 by 800 tonnes and SO2 by 5.5 tonnes.

A total system with an unbeaten efficiency

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 graph below compares the energy consumed for heating, hot water and climate control (ventilation and cooling) in a 'good-practice' hospitals , using a boiler and a roof-top unit or a ground source heat pump system. It clearly shows that savings of up to 65% can be generated by installing a ground source heat pump system instead of a conventional system.



In large buildings, several individual heat pumps can be placed in different zones and each can be sized to meet the needs of the space it conditions. Some zones of the building may need heating at the same time as other zones need cooling. When properly integrated, a heat pump system can recover excess heat in one zone (sunny side, computer rooms, etc.) and transfer it via a water pipe loop to areas of the building requiring heating. It is therefore possible to achieve a balance between heating and cooling needs during a good part of the year (40 to 60%).

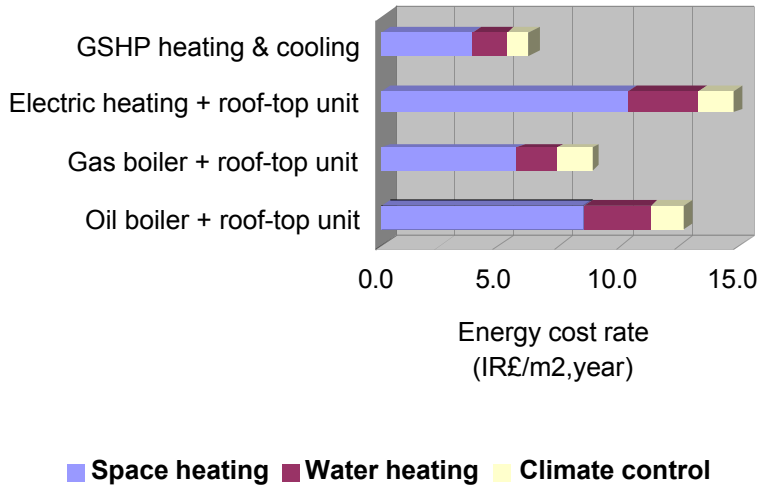
When the demand for heat exceeds the energy reclaimed, a central heat pump can supply the distribution loop with heat from a renewable source, generally the ground.
In reverse, the same heat pump can extract excess heat from the loop and dispose of it in the ground to replenish it with heat for future demand.

When required, the cycle of a heat pump can be easily reversed to provide active cooling. Here again, a heat pump can do that very efficiently. In the United States, the Energy Star labelling system requires that the ratio of total cooling capacity to electrical energy input is superior to 14 for a ground source heat pump. So-called 'free cooling' can be carried out by by-passing the heat pump and circulating chilled water into the heat distribution system (floor heating or fan assisted convectors). 'Free cooling' uses very little electricity (circulating pumps) and is very cheap to operate.

One of the most cost-effective heating technologies

The initial cost of a heat pump is often competitive with boilers and cooling towers, and the operation costs are usually much lower. When properly designed and integrated in the building, heat pump systems can yield a simple pay-back period of five years or less when compared with conventional systems.

The graph below compares the energy costs in 'good-practice' and 'typical' hospitals to provide heating, hot water and climate control (using oil or gas, and electricity) with the electricity cost of a ground source heat pump to provide the same services. Again a ground source heat pump can bring up to 60% savings on your energy bill.



As they have fewer mechanical components, heat pumps are also more reliable, easier to service and less prone to failure. In the USA, it is not uncommon to find heat pumps that were installed 30 or 40 years ago still operating effectively today.

Air-source and water-source heat pump systems have maintenance costs comparable to most conventional HVAC systems, but ground-source systems appear to have significantly lower maintenance costs.

Best for the environment

Hospitals are ranked as the second most intensive energy users after food services among commercial and institutional buildings in Ireland. As such they are large contributors to greenhouse gas emissions which not only have an impact on our climate but also on our immediate environment and health.

When opting for a ground source heat pump instead of a conventional HVAC system (central boiler with or without a cooling tower), the substantial energy savings generated will result in a reduction of CO2 emissions.

But hospital managers can do even better! It is now possible in Ireland to switch to a green electricity supplier at no extra cost. By running your heat pump with green electricity, you will be able to cover your heating and cooling needs entirely with renewable energy. That means reducing the CO2 emissions from your building usage to the minimum, bringing a green and sustainable image to your organisation.

Greater flexibility in design

Greater flexibility in the interior layout of the building is also possible with heat pumps. The absence of anaesthetic external equipment such as cooling towers allow for greater flexibility and diversity in the architectural design of the building or the preservation of heritage buildings. This also avoids the need for roof penetration, which can cause leaks, as well as maintenance decks or architectural blinds.

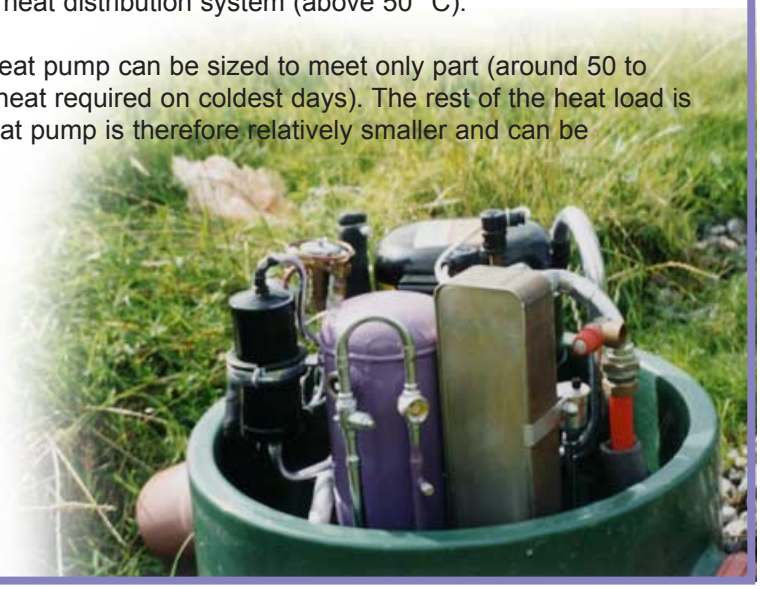
In general, water/ground source heat pump units require less space than conventional boilers, saving space for other more useful purposes.

Opting for a ground-source or water-source heat pump with a water-loop heat distribution system can provide other architectural benefits. The size of the ductwork can be reduced because the air handling system only provides make-up air and does not carry heat. This permits the use of pre-engineered, low-pressure ducts, allows a shallower ceiling space and lower floor-to-floor height. This gives more architectural flexibility and can reduce building costs.

Can I add a heat pump to my existing system ?

Yes, you can. In Sweden, 50% of the replacement of existing heating system is done with renewable heat pumps. In most cases, the heat pump is connected to the existing central heating system and supply most of the heat required (70 to 90%). During very cold periods of the year, the existing boiler takes on and provides the higher temperatures required in the heat distribution system (above 50 °C).

Such a combination is quite economical as the heat pump can be sized to meet only part (around 50 to 70%) of the maximum heat load of the building (heat required on coldest days). The rest of the heat load is met by the boiler. The initial investment of the heat pump is therefore relatively smaller and can be recouped more rapidly.



Healthier and more comfortable

Heat pumps offer improved comfort due to on-demand year-round heating and cooling selectively, allowing for many separate comfort zones. They are also very quiet and can be installed anywhere inside the building. Exterior noise levels are also much lower, allowing for more flexibility in the design of outdoor spaces.

The performance of renewable heat pumps is the best when operated with low temperature heating systems, ideally floor or wall heating, or with enlarged radiators or fan coils. A floor or wall low temperature heating system gives the best response to the physiological needs of the human body. The temperature profile from floor to head is very homogeneous. On top of being very comfortable, this reduces greatly the thermo-circulation of air in the room and avoids dust from being swirled. Floor/wall heating has proved to be beneficial for reducing asthma problems and significantly improving indoor air quality.

Millions of commercial buildings owners enjoy the benefits of heat pumps worldwide

Heat pumps are a mature technology that has proved its financial and environmental benefits worldwide. The International Energy Agency estimated that the total number of heat pumps installed in commercial buildings in the world was close to 90 million in 1996 (see table below). In the States, 26% of health care buildings are equipped with a heat pump for heating and 17% for cooling.

Country	Total Heat pump stock (IEA,1996)
Austria	4,300
Canada	158,100
Germany	5,300
UK	415,000
Japan	6,780,000
China	828,000
USA	715,750

And there is no reason why it should not happen in Ireland. We have the perfect climatic conditions and renewable resources for operating heat pumps. By using free and local sources of energy, you can reduce your dependency on imported heating fuels, whose prices are among the highest in Europe and will continue to increase.

Who can advise me and supply me with a heat pump?

You will find a list of suppliers and installers of renewable heat pumps in Ireland at the back of this brochure. Contact them to discuss your situation and enquire about a preliminary design and offer for your building.

If you want to go further, we recommend you commission a detailed design and feasibility study for the installation of a heat pump system, specially in the case of large projects. This study can be carried out by an experience engineer or architect. Most of the heat pump suppliers provide design service.

The Renewable Energy Information Office will provide you with independent information and advice on heat pumps. Do not hesitate to contact us if you want help in analysing different proposals for a heat pump system.

The roadmap for success

Here are a few tips to ensure maximum benefits from a heat pump project:

For the system designer:
1. Incorporate it right at the beginning of the building construction or refurbishment project;
2. Carefully determine the building requirements for heating, ventilation and air-conditioning (HVAC);
3. Take into consideration the variety of needs and constraints of the different areas of the building as well as its different users;
4. Size the heat pump and associated HVAC system to match the building requirements accurately. Accurate sizing of the heat pump and design of the HVAC system will ensure lower capital and operating costs, best comfort and total security.
5. Take full advantage of the versatility of heat pump systems to ensure a high level of comfort for the building occupants, while minimising energy consumption by balancing cooling and heating needs simultaneously.

For the project developer:
6. Integrate the heat pump project into a "sustainable" energy strategy for the building whereby its energy requirements are minimised by high insulation, natural ventilation, passive solar design, …
7. Require an official and independent certificate, or quality label, for the heat pump from the supplier ensuring minimal performance and compliance with quality standards.
8. Require proof of qualification and experience of the installer of the heat pump to ensure proper installation.
9. Require adequate warranty of equipment and make provision for its maintenance. Make sure that the heat pump operators are properly trained.

The Renewable Energy Information Office

The Renewable Energy Information Office is a service of Sustainable Energy Ireland. Its objective is to support the development of renewable energy in Ireland by providing independent and expert advice as well as information on related financial, environmental and technical issues.

Five ways to contact us:
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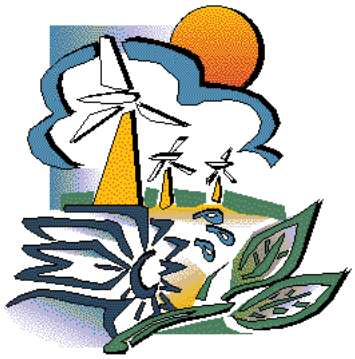
TELEPHONE: our hotline – 023 42193
FAX: 023 41304
EMAIL: renewables@reio.ie
VISIT OUR WEBSITE: www.sei.ie/reio.htm



Sustainable Energy Ireland is a joint initiative of the Department of Public Enterprise and Enterprise Ireland. It is supported by the EU through the community Support Framework.

I want to know more about renewable heat pumps

Further reading

The Renewable Energy Information Office has a range of publications covering all renewable energy technologies, among which:

Free Factsheets available Directly from Us or Our Web Site:

* Wind Energy
* Bioenergy
  - Biomass
  - Landfill Gas
* Hydropower
* Green Electricity
* Renewable Energy for Buildings & Industry:
  - Passive Solar Design
  - Heat Pumps for Your Home
  - Heat Pumps for Commercial Buildings
  - Heat Pumps for the Health Sector
  - Solar Water Heaters
  - How to Heat with Wood

All these brochures can be downloaded from our website: http://www.sei.ie/reio.htm

The Heat Pump Centre of the International Energy Agency has a very good range of publications on heat pumps, among which:

- Heat Pumps, an opportunity for reducing the greenhouse effect (1992)
- Heat Pumps, a better way of meet heat demand (1996)
- Heat Pumps, better by nature (1993)
- Environmental benefits of heat pumping technologies, analysis report (1999)
- Domestic Hot Water Heat Pumps for Residential and Commercial Buildings (1993)
- Commercial/institutional heat pump systems in cold climates (2000)

The IEA Heat Pump Centre Newsletter is published four times a year and is a very useful source of up-to-date information. Visit the IEA Heat Pump Centre website at: http://www.heatpumpcentre.org

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has a very good range of practical references for the design and operation of heat pumps:

- Ground source heat pumps – Design of geothermal systems for commercial and institutional buildings (1997)
- Commercial/institutional ground-source heat pump engineering manual (1995)
- Operating experiences with commercial ground-source heat pump (1998)

These publications can be ordered from their website http://www.ashrae.org, by email: orders@ashrae.org or by fax: 00 404/321-5478

Other publications:

Ground source heat pumps, a technology review:
R H D Rawlings. The Building Services Research and Information Association, Technical Note TN 18/99

RETScreenTM International:
RETScreen provides free-of-charge software for renewable energy project analysis, including renewable heat pumps. The software can be downloaded from the Natural Resource Canada's website at http://retscreen.gc.ca

Interesting websites

Renewable Energy Information Office, Irish Energy Centre:
http://www.sei.ie/reio.htm

The Heat Pump Centre of the International Energy Agency:
http://www.heatpumpcentre.org

CADDET, Energy Efficiency Information of the International Energy Agency:
http://www.caddet-ee.org (including database with case studies)

The European Heat Pump Network:
http://www.ehpa.org

Centre for Alternative Technology:
http://www.cat.org.uk

UK Heat Pump Network:
http://www.heatpumpnet.org.uk

The Geothermal Heat Pump Consortium (USA):
http://www.geoexchange.org

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
http://www.ashrae.org

List of suppliers and installers of renewable heat pumps in Ireland

CONSERVER Ltd
Manufacturer of ground-source heat pumps. Network of installers nationwide.
Kim Roberts
Ashmount, Monkstown
Co. Cork
Tel: 021/4841802 Fax: 021/4841206
Email: kental@indigo.ie Website: www.conserver-energy.com

DEKA UNDERFLOOR HEATING SYSTEMS
Supply of underfloor heating systems, including heat pumps.
CBG House
Reen, Kenmare
Co. Kerry
Tel. 1 890 400030
Email: dandk@iol.ie

DUNSTAR Ltd
Design and installation of Irish ground source heat pump systems.
Paul Sikora
Kent Street 1, Clonakilty
Co. Cork
Tel: 023/35165 Fax: 023/35174
Email: dunstar@tinet.ie Website: http://www.solterra.ie

ECO HEAT Ltd
Supply and installation of Austrian ground-source heat pumps.
Fritz G. Rinagl
Aras na hAbhann, Milltown
P.O. Borris
Co. Kilkenny
Tel: 0503/737271 Fax: 0503/737272
Email: ecoheat@eircom.net

GEOTHERMAL IRELAND
P.O. Box 19
Fermoy
Co. Cork
Tel: 058/ 60949
Email: info@geothermal-ireland.com
Website: www.geothermal-ireland.com

MODERN HEATING SYSTEMS Ltd
Supply and installation of German heat pumps.
Dietmar Rickert
Newtownsmore, Killashee
Co. Longford
Tel & Fax: 043/45193 Mobile: 087/6486876
Email: drickert@eircom.net

SWEDISH TRADE CENTRE,
Importer of Swedish heat pumps
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