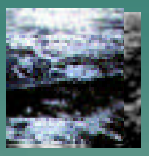
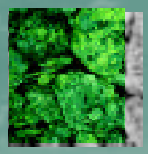
heat pump programme

IEA
OECD



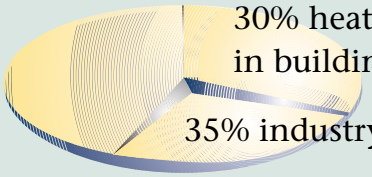


Heat pumps can cut global CO_2 emissions by more than 6%

RENEWABLE ENERGY FOR A CLEANER FUTURE

Potential benefits - worldwide

Global CO_2 emissions



Potential: 50% saved by heat pumps in buildings and 5% in industry

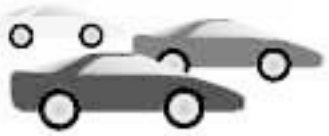
Saved by heat pumps
1.2 billion tonnes CO_2 per year
=
6% of total global CO_2 emissions

In homes, commercial buildings and industry

Yearly equivalent environmental benefits

Emissions from 800 GW fossil fuel fired capacity eliminated

450 million trees planted



200 million cars off the road

500 thousand million litres reduction in petrol consumption

Heat pump technologies are widely used for upgrading free heat from sustainable sources, such as air, water, the ground and waste heat, to useful temperatures. They are used for residential and commercial space heating, cooling and water heating, refrigeration and in industrial processes. In producing heat, they are called **heat pumps** and they compete with fossil fuel-fired boilers and direct electric heating. This brochure addresses the large potential contribution of heat pumps in reducing CO_2 emissions.

Environmental bene

Heat pumps stand out because they are able to convert low-grade heat into useful heat.

Even in winter, the outside air, water and ground still contain heat which can be extracted and upgraded by a heat pump. This natural heat can be used to heat buildings or for hot water production. The heat sources are continually replenished by the sun, therefore the extracted heat is renewable energy. Heat pumps can also extract waste heat, e.g. from ventilation air, and make it suitable for reuse. The energy needed to drive a heat pump is only about *one third or less* of the useful heat produced.

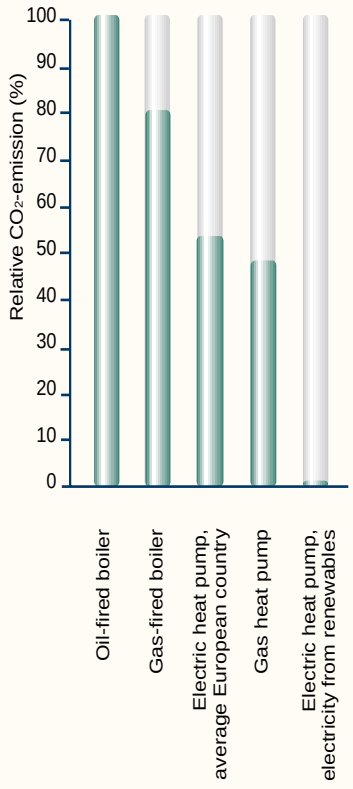
Almost all heat pumps are driven by an electric motor. A growing minority of heat pumps are gas-fired. The performance of heat pumps is usually described as the Coefficient Of Performance (COP), which is the ratio of useful heat produced to the drive energy of the heat pump. The Seasonal Performance Factor (SPF) is the average COP taken over a heating season.

The largest number of heat pumps currently being used are small reversible units which can provide both heating and cooling, in individual rooms, houses, shops, offices, schools and institutional buildings. Annually, over 10 million units are produced worldwide, and over 65 million units are in operation in Japan, the USA, China and Europe. These heat pumps are cost-effective in many regions of the world, as they cost little extra compared to a cooling-only air conditioner.

In cold to moderate climates, heating-only heat pumps are used to heat tap water and homes. In commercial buildings and industrial processes, heat pumps are often applied where simultaneous heating and cooling is required, or heating in winter and cooling in summer. Worldwide over 10 million systems are installed in commercial and institutional buildings.

To emphasize the potential which heat pumps offer, the International Energy Agency (IEA) Heat Pump Centre has assessed the global environmental benefits of heat pumps.

The environmental impact of an electric heat pump applied in a building is compared with a conventional boiler. The single most important CO_2 emission source is the local combustion of oil or gas in a boiler and the generation of electricity for driving the electric heat pump. The emission rates of a boiler and an electric heat pump depend on the energy efficiency of the equipment, and on the fuel mix and efficiency of electricity generation. The relative CO_2 emission of conventional heating systems and two types of heat pump are compared in the Figure. Assumed is an average European CO_2 emission for electricity generation of 0.55 kg CO_2/kWh_{el}. An electric heat pump operating on electricity from renewable energy sources does not emit any CO_2 at all. Both the electric and gas heat pump emit considerably less CO_2 than boilers.



Relative CO_2 emission of heating devices.

In conclusion, heat pumps offer a distinct advantage over conventional heating equipment in terms of CO_2 emissions. How much they can save is explained next.

fits of heat pumps

Saved by current (1997) heat pump stock 0.5%

How installed heat pumps save CO_2 emissions*:

140 million tonnes emitted by residential heat pump stock
204 million tonnes equivalent emissions by base line oil-fired boilers (efficiency 80%)
64 million tonnes saved by residential heat pumps (30% saving)
50 million tonnes additionally saved by commercial and industrial heat pumps

Saved by installed heat pumps: 0.5% of total global emissions

* annual heat demand 10,000 kWh per residence; 65 million residential heat pumps; annual total global CO_2 emissions 22 billion tonnes (1997).

Global CO_2 emissions saving potential 6%

The potential of heat pumps for reducing global CO_2 emissions is much higher than the current 0.5%, as shown below:

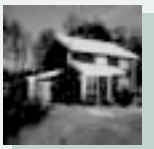
6.6 billion tonnes CO_2 from heating buildings (30% of total)
1.0 billion tonnes saved by residential and commercial heat pumps (50%), assuming 30% share in heating
0.2 billion tonnes saved by industrial heat pumps

Global emissions saving potential of heat pumps: 6%

A potential CO_2 emissions saving of 6 % is one of the largest that a single technology can offer, and the technology is available in the marketplace.

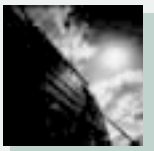
Application areas

Residence:
In Central and Northern Europe, with a moderate to cold climate, residential heating-only heat pumps provide an energy-efficient way of heating at low emission levels. Many of these heat pumps extract (solar) heat from the ground.



In Switzerland for example, replacing an oil-fired boiler by an electric heat pump reduces CO_2 emissions by **98%**. This high number is the result of a nearly CO_2-free electricity production.

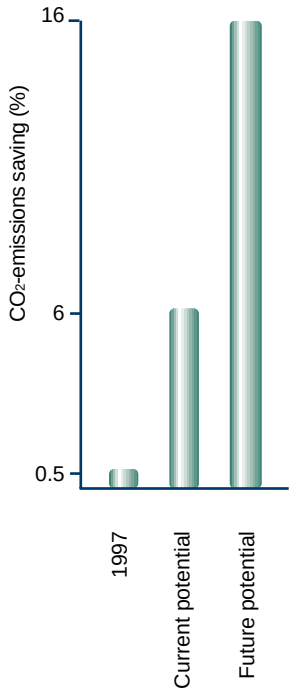
Commercial building:
In many countries, space heating and cooling are two vital elements to create a comfortable working atmosphere. In the Netherlands, the 26,000 m^2 Anova office building is heated and cooled by a ground-coupled heat pump which supplies and extracts heat from an underground thermal storage, an aquifer. This installation saves 7% on electricity and 84% on natural gas compared to a base line installation and the CO_2 emissions drop by **52%**.



Industry:
In many industrial processes, heat pumps are applied to recover process waste heat. They are used in dehumidification, distillation and evaporation processes, but also for water heating and combined heating and cooling, large opportunities exist in the food and chemical industries. One of the largest heat pump installations in the world is integrated in a propylene/ propane distillation process of Shell in Pernis, the Netherlands. This heat pump saves 37 million m^3 gas annually and cuts CO_2 emissions by **90 thousand tonnes**.

Perspective of more than 16% emissions saving

The CO_2 emissions reduction potential of 6% will increase in the near future, because both heat pumps and power plants are becoming more efficient as a result of technology developments. While the efficiency of a fossil-fuelled boiler based on the higher heating value can never be higher than 100%, the theoretical attainable heat output of a space heating heat pump is about 14 times the energy input by electricity – in other words, the COP is 14. Today's COPs range from 2.5 to 4 with a few installations reaching 7, but further improvements are envisaged, increasing the emissions saving by heat pumps. An actual COP of 8 is anticipated within the next decade. Consequently heat pumps will become more attractive and take a larger share of the heating market.



Saving of total global CO_2 emissions by heat pumps.

In conclusion, there is a large potential for extending the present environmental advantage of heat pumps over conventional heating systems. This potential is an invitation waiting for realisation, through R&D, the support of governments and utilities, and through market transformations.

Future CO_2 emissions saving potential 16%

The potential contribution of heat pumps to CO_2 emissions reduction increases due to technology and market developments*:

6.6 billion tonnes CO_2 from heating buildings
3.7 billion tonnes saved by heat pumps (80%) assuming 70% share in heating

Future global emissions saving potential of heat pumps: 16%

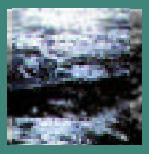
* Power plant efficiency 55%; a share of 15% renewable energy; COP=6.

Heat pumps are better by nature and a credit for action for a better environment.

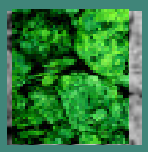
The IEA Heat Pump Programme

Established under the umbrella of the International Energy Agency in 1978, the Heat Pump Programme is a non-profit organisation funded by its member countries. The aim of the Heat Pump Programme is to accelerate the use of heat pumping technologies as practical and reliable devices that can save energy resources while serving to protect the environment. Currently, the Heat Pump Programme has 15 member countries.

The IEA Heat Pump Centre links people and organisations worldwide in support of heat pump technology.



Related organisations: IIF/IIR and UNEP



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