Energy-Saving Heat Pumps and Underfloor Heating

Design, Installation and Space Considerations

ComfortHeat
Hydronic & Electric Floor Heating Systems

"Energy input is necessary for heating an interior space, so if this can be controlled and reduced, there are opportunities to make significant energy savings."

INTRODUCTION

With the built environment contributing approximately 40% of annual global emissions,[1] it is important for architects, designers and specifiers to take advantage of all available energy-saving opportunities when designing and constructing buildings. None of these solutions on their own can guarantee optimal performance, but when combined with other readily-available products, an energy-efficient building is within reach for everyone.

Any use of energy-efficient systems and products must be considered in the early design phase of any project. Many of the best-performing products require a certain amount of space and other elements of the building coordinated to work efficiently. Maximum benefit can only be realised by having these specifications early in a building's design.

The advantages of underfloor heating are widely acknowledged. Property owners frequently invest in these systems to provide unmatched comfort in both residential and commercial spaces. As part of this process, one must select between hydronic underfloor heating and electric underfloor heating. It is common to combine hydronic solutions to heat pumps.

Heat pumps are thought to be the future of domestic heating because they are a cleaner, more sustainable heat source than most alternatives. In comparison to a conventional oil or gas boiler, heat pumps often operate at lower temperatures, which makes them much more effective with radiant floor heating systems. They can also lower a home or building's carbon footprint.

When it comes to the installation of heat pumps, a lack of service space is currently the most pressing problem plaguing builders, installers and suppliers. Heat pumps and other energy-saving technologies cannot be installed where a building has insufficient service space allocation.

In this whitepaper, we explore the design and installation considerations involved with energy-saving heat pumps and underfloor heating, and the importance of specifying such systems early in the design phase.

HEAT PUMPS AND UNDERFLOOR HEATING

Convection and high heat are used by traditional heating systems to distribute heat throughout a building. To move the heat quickly and efficiently, some systems utilise mechanical fans, but these fans also produce draughts, dust, and internal noise.

Energy input is necessary for heating an interior space, so if this can be controlled and reduced, there are opportunities to make significant energy savings. If you specifically consider floor heating options, you can have electric cable systems, or water pipes where heated water is supplied by a gas or electric boiler. Heat pumps are a particularly efficient alternative that should be considered for more applications.

With electric cables, there is a fixed electricity load designed by the cable manufacturer. On average, this equates to 160W of heating per square metre. The heating load decreases between electric floor heating and the hydronic floor heating to 100W per square metre when hydronic underfloor heating water pipes are installed. Simply switching to hydronic heating from electric underfloor heating results in a 37% reduction in energy consumption.

If you look at gas or electric boilers, they give 1KW of heating for 1KW of energy. So either of these heat sources will not improve on the 37% reduction. However, using a heat pump with a hydronic heating system will give 4KW of heat load for 1KW of energy usage, so this system will need 25W per square metre of heating. This is an 84% reduction in energy usage from the electric floor heating cables and a 75% reduction on a hydronic heating system using gas or electric boiler.

HOW HEAT PUMPS WORK

In order to produce energy that can be used to heat a space, heat pumps extract renewable heat from the ground (for geothermal heat pumps) or the air (for air-to-water heat pumps). An air-to-water source heat pump transfers heat from the outside air to water, which heats indoor spaces via radiators or underfloor heating. Heat from the air is absorbed into the unit by a cool liquid refrigerant. The refrigerant is compressed to produce heat which is moved to water through a heat exchanger. The water then transports the heat to the floor.

A geothermal heat pump operates similarly to a conventional heat pump except it uses water-to-water heat transfer. Water absorbs heat from the ground or from bodies of water. The heat is absorbed into refrigerant, which is compressed, and, through a heat exchanger, moves the heat into water circulating around the floor heating system.

Compared to other heating systems, heat pumps are more efficient because the amount of heat they generate is more than the amount of energy they consume.[2] In addition to energy savings, heat pumps also generally require less maintenance than traditional heating systems.

The majority of the current demand for space and water heating could, according to the International Energy Agency, be satisfied with less CO2 emissions if heat pumps were used instead of condensing gas boilers.[3] According to a 2016 article, compared to a gas heater's 50% to 95% efficiency, a leading residential heat pump (at the time) could deliver heat at a 600% efficiency.[4] This type of performance means that heat pumps can cut your energy costs by up to 90%.[5]

DESIGN AND INSTALLATION CONSIDERATIONS

What to think about when specifying a heat pump

Local climate

An air-to-water heat pump uses ambient air temperature as its fuel source. The performance of the heat pump changes along with the temperature of the outside air. An air-to-water heat pump has a range of operating temperatures that it can handle, but there are limits because it gets harder to draw heat from the air when it gets too cold. There are cold climate heat pumps specially designed for freezing temperatures.

For your project, determine the minimum ambient air temperature for the area before choosing the best heat pump option. Due to the constant underground temperature of the earth, geothermal heat pumps can be used in any climate, whether it is hot or cold outside.[6] They can be installed internally as no air is circulated whereas an air-to-water heat pump must be installed outside.

Indoor heating requirements

The type and size (capacity) of a heat pump needs to match the intended use. A heat pump that is too small will struggle to keep a space comfortable, while an oversized unit will cost more and likely not be used to its full potential.

A heat pump can be used as a space conditioning system or to heat water, or both. A hot water tank is required, which has its own service space requirements. The size and selection of the hot water tank is important. If used in conjunction with hydronic floor heating, it will need to be designed to work with high heat loads.

Outdoor unit location

A typical location for an air-to-water heat pump is next to an exterior wall, where pipes can run through the wall directly and into the building. The building design must account for space to provide the infrastructure with clear air space and a 1800mm clearance from the building to the nearest obstruction. This ensures a hydronic heating system using a heat pump can function optimally and deliver the expected energy savings.

Unobstructed airflow around the heat pump is crucial. An air-to-water heat pump relies on large volumes of air being forced through refrigerant pipes to absorb any heat in the air. There is a chance the heat pump will reprocess air if airflow is restricted at the front of the unit, which can reduce the efficiency of the heat pump.

Careful planning early in the design phase can minimise the visual impact of the outdoor unit. Other factors to consider include access to the heat pump for servicing and maintenance, whether the unit will obstruct a walkway, and noise considerations when the heat pump is in operation.

Consider solar energy

In Australia, solar panels are becoming more and more popular as a way for homeowners to generate their own electricity. A solar PV panel system and a heat pump system can be combined to create a sustainable hydronic system. Heat pumps are powered by electricity. When you combine heat pumps for heating with solar panels as an energy source, you can heat a building at a much lower cost.

The solar panels generate renewable electricity, which partially or completely offsets the running costs of the heat pump. Heating may be required 24 hours a day, so a thermal energy storage solution will also need to be specified to ensure that the energy generated during the day is usable during the darker hours.

Tanks can be used to store hot water, which is then used to supply your building with hydronic heating and domestic hot water; yet another reason to provide adequate service space alongside the building. Hydronic air-to-water heat pumps use water to move the heat from the heat pump to the floor or panel radiator. While the water is heated, it is always in a closed loop and is not added to. Domestic hot water can also be heated with a heat exchanger loop in a specially-designed tank so that the potable water in the tank can be heated from the heat pump. Most domestic hot water tanks designed to operate with a hydronic heat pump also have an electric element. The system is similar to the off-peak electric hot water systems of the past, but instead uses energy-efficient heat pumps and solar, which limits the need for grid electricity input.

Combining the efficiency of a heat pump with a renewable energy source results in a lower carbon footprint, with potential for residential and commercial applications. There are reported examples of homes featuring a solar panel and air heat pump combination, with one homeowner noting that their domestic carbon footprint had fallen from 5.4 tonnes of carbon dioxide per annum to just under 2 tonnes.[7]

Choosing the right manufacturer

Choosing the right manufacturer is critical to this process as they can advise on the appropriate system for the application and site conditions, and how to ensure optimal heating performance. The quality and extent of a company's warranties, installation instructions and customer support as well as the range of products on offer should be considered. For a complex system such as underfloor heating, a specialist supplier with end-to-end services is recommended.

“Compared to other heating systems, heat pumps are more efficient because the amount of heat they generate is more than the amount of energy they consume.”

COMFORT HEAT

Comfort Heat stocks the full range of world leading hydronic and electric underfloor heating products to suit all your heating needs, for all floor coverings, both electric and hydronic. Large industrial projects to small bathroom renovations or even a simple DIY kit, Comfort Heat has the solution for your heating requirements.

With expertise in both electric and hydronic floor heating systems, Comfort Heat can provide the most effective and efficient heating solution for your project. From the superior twin conducting cable of the electric floor heating systems to the quality components used in hydronic systems, Comfort Heat has the commitment to design superior installations which meet the needs of their customers.

REFERENCES

1 Architecture 2030. “Why The Built Environment?” Architecture 2030. https://architecture2030.org/why-the-building-sector (accessed17 March 2023).

2 Energy Saving Trust. “In-depth guide to heat pumps.” EST. https://energysavingtrust.org.uk/advice/in-depth-guide-to-heat-pumps (accessed17 March 2023).

3 International Energy Agency. “Heat Pumps.” IEA. https://www.iea.org/reports/heat-pumps (accessed17 March 2023).

4 Energy Efficiency Council. “Back to basics: Heat pumps.” EEC. https://www.eec.org.au/for-energy-users/technologies-2/heat-pumps (accessed17 March 2023).

5 Pears, Alan. “Heat pumps can cut your energy costs by up to 90%. It’s not magic, just a smart use of the laws of physics.” The Conversation. https://theconversation.com/heat-pumps-can-cut-your-energy-costs-by-up-to-90-its-not-magic-just-a-smart-use-of-the-laws-of-physics-185711 (accessed17 March 2023).

6 Office of Energy Efficiency and Renewable Energy. “5 Things You Should Know about Geothermal Heat Pumps.” Energy.gov. https://www.energy.gov/eere/articles/5-things-you-should-know-about-geothermal-heat-pumps (accessed 17 March 2023).

7 McIntosh, Alastair. “Solar Voltaic Panels & Air Heat Pump Combination.” Alastair McIntosh. http://www.alastairmcintosh.com/general/energy/solar-heating.htm (accessed17 March 2023).

All information provided correct as of April 2023

ComfortHeat
Hydronic & Electric Floor Heating Systems