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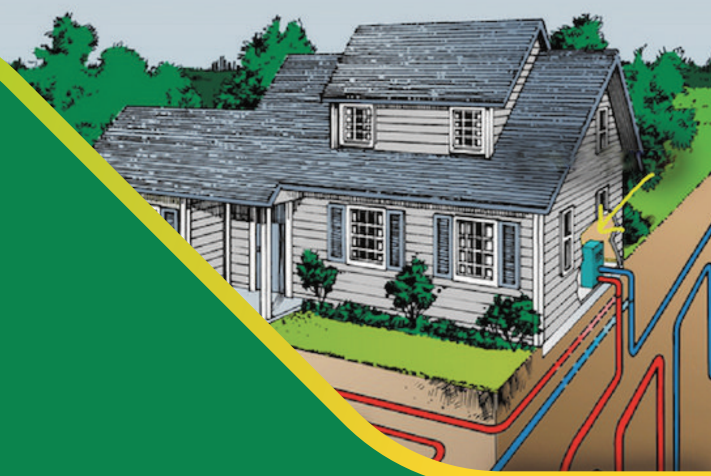
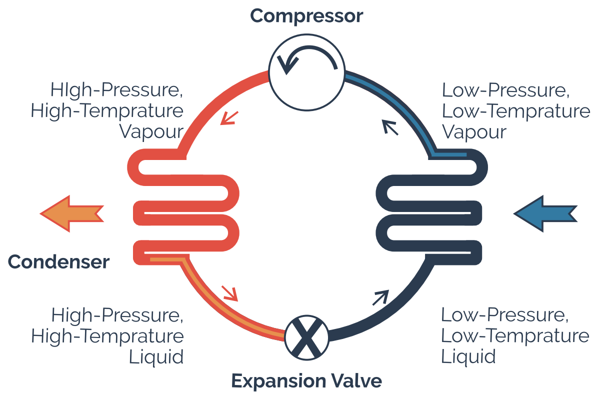
eds MEGHRAJ BASE

HEAT Pumps



Heat pumps are electrical devices which convert energy from external heat sources (air, water, etc.) to useful heat which can then be used for space heating and/or hot water supply in residential and commercial buildings. They are regarded as one of the most energy efficient and environmentally friendly technologies that enhance the utilisation level and effective integration of intermittent renewable energy sources.



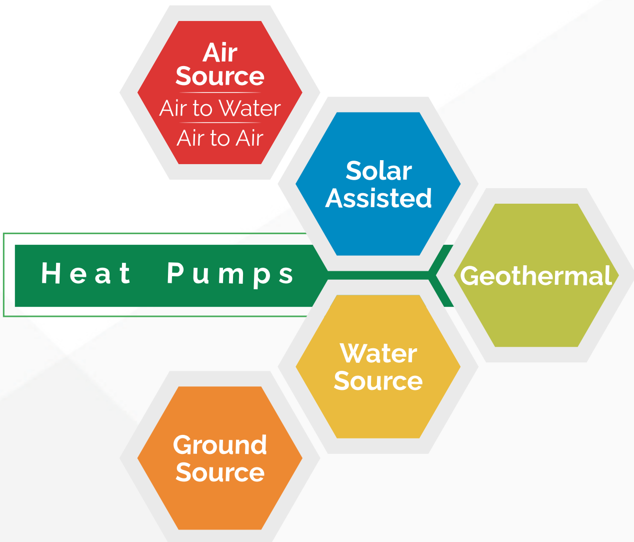
The heat pumping cycle can be divided in three steps:

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.

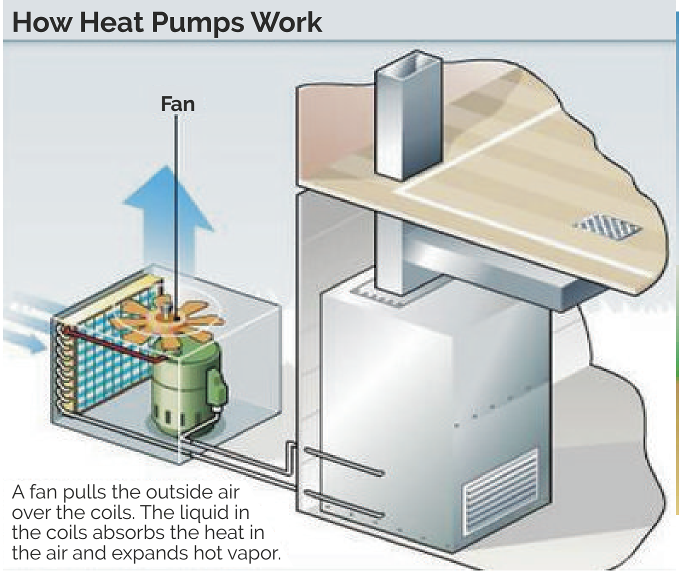
2. Then a compressor compresses the evaporated fluid. Consequently, the pressure and the temperature of the vapour increase. When pumping up a bicycle tyre, you can also observe this phenomenon. The lower side of the pump – where the pressure is highest – is getting very hot.

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.

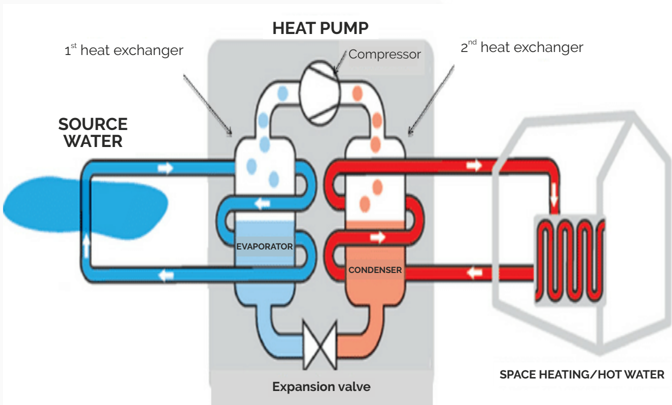
Types of Heat Pumps



An air source heat pump (ASHP) takes low grade heat from the air, and boosts it to high grade that can be used for domestic heating or any other purpose. The pump uses less electricity than the heat it produces. The performance of an ASHP is similar to a refrigerator, but works in a reverse mode. ASHPs find applications in domestic space heating and hot water supply.

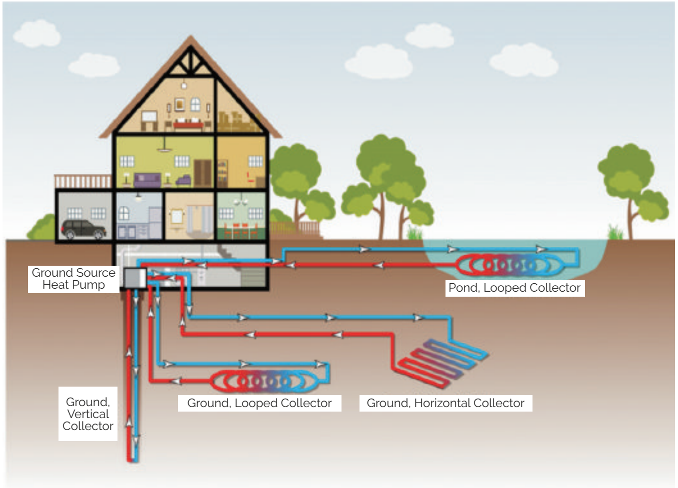


Water source heat pumps (WSHPs) use water bodies such as lakes, ponds, rivers, etc. as a source of heat. They extract low grade heat from water and convert to useful heat. Compared to air-source heat pumps, WSHPs generate less carbon emissions and result in substantial cost savings. As opposed to ASHPs, ambient temperature conditions do not significantly influence the performances of WSHPs. WSHPs are often characterized by high efficiency, but their applications are limited due to the requirement of large waterbodies or storage tanks near dwellings.



Source: *ResearchGate*

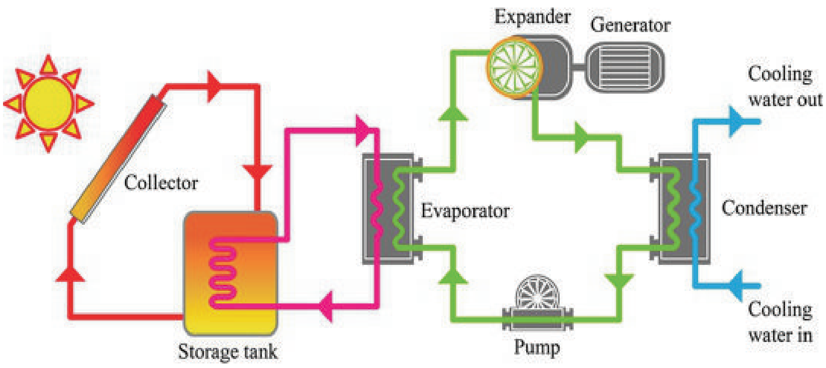
Both ground source heat pumps (GSHPs) and geothermal HPs use heat energy naturally stored in the ground as a source. Sometimes, the terms ground source and geothermal are used interchangeably. However, there are some key differences between both technologies. GSHPs use heat from relatively shallow ground (often between 1.2m and 200m depth), and are usually used for domestic and small commercial applications. Whereas, geothermal HPs use energy from the earth's core from about 500–2500m deep, and are used for large industrial applications.



Source: *Consolidated Electric Cooperative*

GSHP's can be categorized as having closed or open loops and those loops can be installed in three ways: horizontally, vertically, or in a pond/lake, sewage system or other water bodies. In comparison to the traditional air conditioning systems, up to 50% energy savings can be achieved through this innovative technology. In addition, the technology is also 100% water efficient since it rejects heat using conduction, convection and advection and not through evaporation as in traditional A.C system cooling towers which lose approximately 6-8 litres of water per hour to the atmosphere for every ton of air conditioning.

Solar assisted heat pumps are efficient and reliable systems which can meet low temperature heat demand such as domestic space heating and hot water requirements. The intermittency of solar may affect the performance of such heat pumps. This problem can be solved by incorporating dual sources of heat. One example in this case is a solar assisted GSHP, which serves to be cost effective as well as environmentally friendly.



Source: *ScienceDirect*

Heat pumps can also be operated using other sources of heat such as industrial waste heat. Modelling and screening of HP options for exploiting low grade waste heat in process sites suggests that adsorption heat transformer is the best option though its performance may be case specific. Examples of energy savings from power generation include with exergetic efficiencies of up to 70% and 16% savings achieved in coal-fired power plants. Likewise, considerable reductions in primary energy consumption and emissions, associated deployment of heat pumps for heat recovery in sewage treatment plants, can be obtained.

Technology	Installation cost	Average COP	Environmental Impacts	Pros	Cons
Air Source Heat Pump	+	3	Highest environmental impact in cold regions Leakage of refrigerant can cause pollution • Causes noise pollution	• Less or no pollution concerns • Simple operation • Low Maintenance Cost • High COP • Low primary energy consumption	• Frost formation on outer units • COP varies with ambient temperature • Requires more space
Water Source Heat Pump	++	4.3	Can cause water pollution, stratum settlement and trigger geological disasters	Highly efficient • Not affected by ambient conditions • Can utilise waste heat from rivers and lakes	Requires water bodies or storage tanks in vicinity • Needs regulatory permission for installation
Ground Source Heat Pu	+++	3.5	Unchecked heat transfer fluids are hazardous • Surface water can enter borehole • Can perturb groundwater temperature	Highly efficient and shows great energy saving potential • Very reliable source of heat • Can operate in regions with extreme winters	Needs careful assessment of local geology and requirements • COP may decrease over heating season due to saturation of soil temperature

Technology	Installation cost	Average COP	Environmental Impacts	Pros	Cons
Geothermal Heat Pump	++++	4	Reduces emissions with low payback period	• High COP • Utilises vast source of heat • Most suitable for large industrial applications & district heating	May need supplemental heat system for better performance
Solar Assisted Heat Pump	++ to +++++	Higher than individual HP COP	Significant environmental benefits • Can reduce emissions by 50%	Financially and energetically viable solution • Solar helps HPs in achieving higher COP • Lowers grid electricity consumption	• Needs additional control mechanism for optimal operation • Highly location and application specific

Heat pumps are proven technologies that can contribute to the overall efforts of reducing GHG emissions and mitigating climate change. They are seen as some of the most promising solutions for decarbonizing the heating and cooling sectors. Considerable environmental benefits are feasible when HPs replace electric resistive space heating. In some examples, greenhouse gas emissions can be reduced by 50% compared to gas based heating systems.

Indian Manufacturers

- Inficold India Pvt. Ltd
- Thermax Ltd. Pune
- Prototech Energy Pvt Ltd
- Ariston Thermo India Pvt Ltd
- Daikin India
- Blue Star
- Samsung

Source: QUICK'S HVAC, INC.

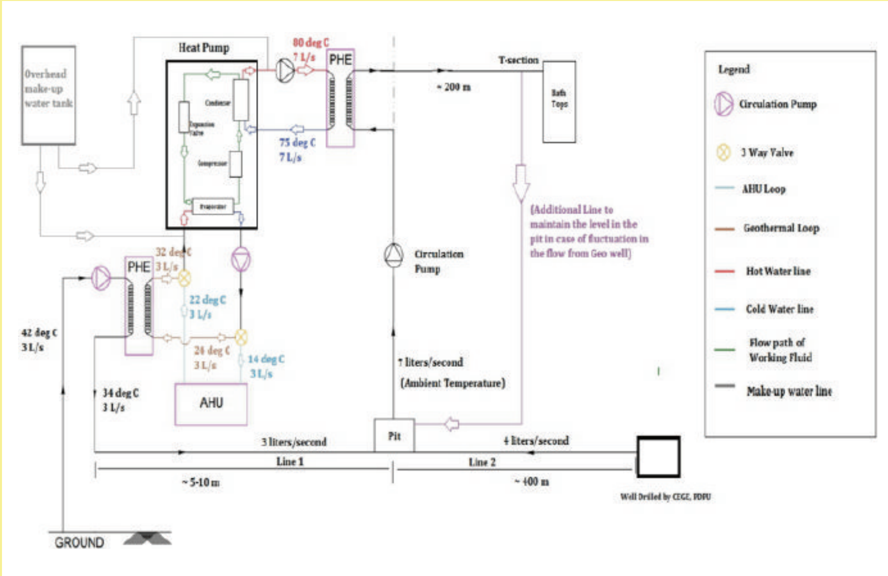
Dholera, Gujarat, India

Geothermal Space Heating and Cooling

Geothermal Space Heating and Cooling system at Dholera is based on Ground Source Heat Pump (GSHP) instrument, a first of its kind in India. Centre of Excellence for Geothermal Energy (CEGE), Pandit Deendayal Petroleum University (PDPU) have developed this system in association with Green India Building System and Services (GIBSS).

Two geothermal bore wells were drilled at Dholera of 1000 feet depth. The temperature of the water is 47 to 50 degree Celsius, with a flow rate of seven to eight litters per second. The water is produced from the well without any external energy.

Capacity of system: 32 TR



Sr. No.	Input Type	Units	Geothermal Hot Water	Cooling side temperature
1	Thermal performance of heat pump	Litres/s	3	
2	Cooling water inlet temp	˚C	40	23 ± 10%
3	Cooling water outlet temp	˚C	32	15 ± 10%
4	Geothermal energy used	kW	98	
5	Hot water outlet temp	˚C	80	80 ± 5%
6	Heat capacity	kW	168	168
7	Heat pump COP		2.4	2.1
8	Compressor input power	kW	70	80
9	Cooling provided	kW		88 ± 10%
		TR		25 ± 10%

The system achieves a approximated 40% savings on HVAC costs

India schemes & policies

A. Scale up of Access to Clean Energy for Rural Productive uses.

B. 'Off-Grid and Decentralized Concentrated Solar Thermal (CST) Technologies for Community Cooking, Process Heat and Space Heating & Cooling Applications in Industrial, Institutional and Commercial Establishments' scheme