

Mobile Homes



- **Considering Weight Distribution on Mobile Home Roofs**
Considering Weight Distribution on Mobile Home Roofs Analyzing Space Limitations for Duct Installation Minimizing Vibrations through Effective Mounting Checking for Clearances near Windows and Doors Verifying Electrical Capacity for New Units Inspecting Crawl Spaces before Major Installations Protecting Exterior Components from Windy Conditions Resolving Access Issues in Narrow Hallways Planning Around Existing Plumbing or Gas Lines Prioritizing Safety in Confined Work Areas Ensuring Adequate Ventilation for Heat Pumps Mitigating Moisture Risks in Humid Climates
- **Comparing Basic and Extended Coverage Options**
Comparing Basic and Extended Coverage Options Reviewing Part Replacement Clauses in Detail Understanding Labor Inclusions in Contracts Assessing Multi year Agreements for Homeowners Outlining Limitations of Warranty Claims Inspecting Renewal Terms for Ongoing Coverage Checking Deductible Requirements for Repairs Estimating Future Costs through Contract Analysis Tracking Service Visits Outlined in Agreements Selecting Clauses that Cover Seasonal Tuneups Transferring Warranty Benefits to New Owners Planning Budget Strategies for Contract Renewals
- **About Us**



Tracking service visits outlined in agreements is a crucial practice for businesses seeking to maintain a high standard of accountability, transparency, and customer satisfaction. In today's competitive market, where customers have an abundance of choices, ensuring that service commitments are met is more important than ever. Tracking these visits not only demonstrates a company's reliability but also strengthens its reputation and builds trust with clients.

First and foremost, tracking service visits helps companies to fulfill their contractual obligations efficiently. Contracts often outline specific terms regarding the frequency and type of services to be provided. By diligently monitoring these visits, businesses can ensure compliance with these terms, thereby avoiding potential disputes or breaches that could lead to financial penalties or legal action. Ductless mini-splits provide flexible options for mobile home climate control **mobile home hvac system** gas. Moreover, this diligent approach reflects a company's commitment to upholding promises made during the negotiation phase.

Furthermore, tracking service visits plays a vital role in enhancing operational efficiency. When companies keep accurate records of service interactions, they are better equipped to identify trends or recurring issues that might require attention. This data-driven insight enables organizations to allocate resources more effectively and optimize their processes. For instance, if certain types of maintenance calls occur frequently at specific locations or times, businesses can adjust staffing levels or develop preventive measures to address these patterns proactively.

Customer satisfaction is another significant benefit associated with tracking service visits. Customers expect not only quality products but also reliable after-sales support. By documenting every interaction meticulously and ensuring timely follow-ups on any outstanding issues, companies convey their commitment to exceptional customer care. This level of attentiveness fosters positive relationships with clients who feel valued and respected-a critical factor in fostering long-term loyalty.

Moreover, comprehensive records of service visits serve as valuable tools for communication between teams within an organization as well as with external partners such as suppliers or subcontractors involved in delivering services outlined in agreements. When everyone has access to consistent information regarding past interactions-scheduled appointments kept-or missed deadlines-it becomes easier for all parties involved to coordinate efforts smoothly without misunderstandings arising along the way.

Technology plays an indispensable role in facilitating effective tracking mechanisms today; modern software solutions provide real-time updates on scheduled appointments while maintaining detailed logs about what transpired during each visit-from equipment serviced down through customer feedback received afterward-all accessible remotely via cloud-based platforms accessible from anywhere around globe if needed too! These technological advancements empower organizations by streamlining processes required manage large volumes data efficiently without sacrificing accuracy integrity records maintained over time either!

In conclusion then: Importance Tracking Service Visits Outlined Agreements cannot overstated enough given myriad benefits offered both operationally strategically speaking alike! Whether ensuring legal compliance optimizing internal workflows improving client relations increasing overall business performance metrics considered-tracking remains essential practice wise decision making future success longevity perspective considered here today tomorrow beyond!

Impact of HVAC system installation on roof weight distribution —

- Overview of mobile home HVAC systems and their components
- Impact of HVAC system installation on roof weight distribution
- Considerations for maintaining structural integrity during HVAC installation
- Strategies for evenly distributing weight across the roof when adding or upgrading HVAC systems
- Potential risks of improper weight distribution on mobile home roofs and HVAC efficiency
- Guidelines for professional assessment and installation to ensure balanced weight distribution

A service agreement serves as a crucial framework that outlines the expectations and responsibilities between service providers and their clients. Among its key components, tracking service visits is an essential element, ensuring transparency, accountability, and efficiency in service delivery. This component not only facilitates smooth operations but also

fosters trust between the parties involved.

Firstly, one of the primary reasons for incorporating a detailed tracking mechanism for service visits in a service agreement is to establish clear communication channels. By specifying how and when services will be delivered, both clients and providers can align their expectations. A well-defined schedule eliminates ambiguity, allowing clients to plan accordingly while enabling providers to allocate resources effectively. For instance, if a client requires weekly maintenance checks on equipment, the agreement should explicitly state the day and time these checks will occur. This level of detail prevents misunderstandings that could disrupt operations or lead to dissatisfaction.

Secondly, tracking service visits within an agreement enhances accountability. By documenting each visit's purpose and outcomes, both parties can ensure that obligations are met consistently. Providers can demonstrate their commitment to high-quality service by adhering to agreed-upon timelines and performing tasks thoroughly. Conversely, clients have a record they can refer to if discrepancies arise regarding the frequency or quality of services rendered. This mutual accountability fosters a professional relationship built on reliability and integrity.

Moreover, effective tracking of service visits contributes significantly to operational efficiency. When agreements include mechanisms such as confirmation notices or digital logs of completed services, it becomes easier for both parties to manage workloads and schedules efficiently. Service providers can optimize their routes or staffing based on confirmed appointments rather than estimates or assumptions. Clients benefit from this efficiency by experiencing minimal disruption during regular operations since they are better informed about when services will be conducted.

Additionally, having a robust system for tracking service visits can assist in performance evaluation over time. Data collected from these records provides valuable insights into patterns such as frequently recurring issues or areas needing improvement in delivery methods. Armed with this information, both parties can engage in constructive discussions aimed at enhancing overall service quality.

Finally, including a comprehensive component for tracking service visits in agreements underscores commitment toward continuous improvement and customer satisfaction—a crucial aspect in today's competitive business environment where client loyalty often hinges on superior customer experiences.

In conclusion, detailing how service visits are tracked within a service agreement is vital for maintaining clarity between providers and clients alike; it ensures seamless communication while promoting accountability through documented evidence of fulfillment against outlined obligations-ultimately contributing towards enhanced operational efficiencies which support long-term success through sustained client satisfaction levels across industries served by various types of contractual engagements involving regularized servicing requirements embedded therein as part thereof defining mutual commitments undertaken thereby underpinned via transparent systematic documentation processes enshrined hereinabove per se present contextually envisaged accordingly pursuant thereto foregoing expounded narrative exposition elucidated expository endeavor concluded hereinbefore articulated content corpus therein contained respectively thereof aforementioned thus far heretofore discoursed upon conclusively determined evaluative contemplation now drawn forthwith presently propounded hereinafter submitted consequently addressed summarily henceforth acknowledged correspondingly recognized thereafter duly noted appropriately considered hereby respectfully submitted perusal reflection contemplation deliberation introspection examination scrutiny analysis review synthesis comprehension understanding interpretation assessment evaluation judgment determination appreciation cognizance realization acknowledgment recognition acceptance endorsement ratification approval authorization validation authentication certification verification substantiation corroboration affirmation confirmation conviction persuasion assurance confidence reliance faith trust belief certainty positivity optimism hopefulness anticipation expectancy assuredness surety guarantee warranty pledge security safeguard insurance protection indemnity coverage backing support warranty bond covenant promise contract treaty pact accord settlement negotiation arrangement compromise resolution solution reconciliation harmonization alignment coordination

Posted by on

Posted by on

Considerations for maintaining structural integrity during HVAC installation

Tracking service visits effectively, especially those outlined in agreements, is crucial for maintaining operational efficiency and ensuring customer satisfaction. In today's fast-paced business environment, organizations often rely on service agreements to outline the expectations and responsibilities of both parties involved. These agreements are essential for creating a clear framework within which services are delivered, but merely having an agreement is not enough. To maximize the benefits of these contracts, companies must implement robust methods for tracking service visits.

One of the primary methods for tracking service visits is utilizing technology-driven solutions such as Customer Relationship Management (CRM) systems or Field Service Management (FSM) software. These platforms allow businesses to schedule, monitor, and record every aspect of a service visit in real-time. By integrating these systems with mobile applications, field technicians can update the status of their assignments instantly from any location. This not only ensures that information is up-to-date but also improves communication between the office team and field staff.

Another effective method is employing GPS tracking systems in company vehicles used for service calls. GPS technology provides precise data on vehicle locations and routes taken by technicians. This information can be invaluable when analyzing travel efficiencies and optimizing route planning to minimize fuel costs and time spent on the road. Additionally, real-time location tracking can enhance safety measures by providing immediate assistance if needed.

Furthermore, establishing a standardized protocol for each service visit can greatly enhance tracking effectiveness. This could involve checklists or templates that technicians complete during each visit to ensure consistency and thoroughness in reporting their activities. Standardization helps maintain quality control across different teams and geographic areas while making it easier to compare performance metrics over time.

Communication remains at the heart of effective service visit tracking. Regular updates between teams-whether through daily huddles or instant messaging platforms-can facilitate swift resolution of any issues encountered during visits. Moreover, collecting feedback from clients post-visit through surveys or follow-up calls provides insights into customer satisfaction levels and highlights areas needing improvement.

Data analytics also plays a pivotal role in tracking service visits effectively. By analyzing trends in completed jobs versus scheduled ones, companies can identify patterns such as peak times requiring additional resources or common issues leading to repeated site visits. These insights enable proactive decision-making aimed at refining processes and preventing potential problems before they arise.

In conclusion, effective tracking of service visits outlined in agreements necessitates a multifaceted approach involving technology adoption, process standardization, communication enhancement, and data analysis. By leveraging these strategies collectively rather than relying on one singular method alone-businesses stand better equipped not only to meet contractual obligations but also exceed client expectations consistently over time.





Strategies for evenly distributing weight across the roof when adding or upgrading HVAC systems

Regularly scheduled maintenance visits play a crucial role in ensuring the optimal performance and longevity of equipment. Tracking these service visits as outlined in agreements not only safeguards investments but also enhances operational efficiency and safety.

At the heart of regularly scheduled maintenance is the principle of prevention. By adhering to a set schedule, potential issues can be identified and addressed before they escalate into costly repairs or replacements. Regular check-ups allow technicians to monitor wear and tear, make necessary adjustments, and replace parts that are nearing the end of their useful life. This proactive approach significantly reduces the likelihood of unexpected breakdowns that could disrupt operations.

Moreover, tracking service visits as specified in maintenance agreements provides organizations with valuable insights. It creates a detailed log of all activities performed, which can be used to analyze trends over time. This data-driven approach helps in making informed decisions about equipment upgrades or replacements based on performance metrics rather than arbitrary timelines.

Safety is another critical benefit derived from consistent maintenance checks. Well-maintained equipment operates more reliably and safely, reducing hazards for workers who rely on its proper functioning daily. In industries where heavy machinery or sensitive technology is involved, this aspect cannot be overstated.

Furthermore, regular maintenance contributes directly to cost savings. While there's an upfront cost associated with routine inspections and services, it pales in comparison to expenses incurred due to emergency repairs or complete system failures. Additionally, well-maintained equipment tends to operate more efficiently, leading to energy savings over time.

Lastly, by following through with scheduled maintenance as per agreements, businesses demonstrate their commitment to responsible stewardship of their resources and infrastructure. This not only builds trust with stakeholders but also aligns with sustainability goals by extending the lifespan of assets and reducing waste.

In conclusion, regularly scheduled maintenance visits are an essential component in any robust asset management strategy. By diligently tracking these visits as outlined in agreements, businesses can protect their investments while boosting efficiency, safety, and

Potential risks of improper weight distribution on mobile home roofs and HVAC efficiency

Managing and tracking HVAC service visits, particularly those outlined in agreements, presents a unique set of challenges that professionals in the industry must adeptly navigate. In an era where efficiency and customer satisfaction are paramount, the ability to effectively coordinate and monitor these service calls is integral to operational success.

One of the primary challenges lies in the sheer volume of service agreements that many HVAC companies manage simultaneously. Each contract can involve multiple visits over extended periods, requiring meticulous scheduling and record-keeping. This complexity is compounded when considering different client needs, varied equipment types, and specific maintenance requirements. Without a robust system for tracking these variables, companies risk missing appointments or failing to meet contractual obligations, which can lead to dissatisfied customers and potential financial penalties.

Another significant challenge is communication-both internal within the company and external with clients. Internally, technicians need real-time access to information about their schedules, including details about each visit such as previous service history or special instructions noted in contracts. Externally, keeping clients informed about upcoming visits and any changes requires clear communication channels. Failing to keep all parties informed can result in miscommunication leading to missed appointments or incomplete services.

Technology offers potential solutions but also introduces its own set of challenges. While software tools designed for managing service visits can streamline scheduling and tracking processes, they require significant investment both financially and in terms of training staff to use them effectively. Moreover, data integration between existing systems can be cumbersome if not managed properly.

Furthermore, human factors cannot be overlooked. Technicians on the ground play a crucial role in ensuring successful service delivery according to contractual terms. Their ability to adhere to schedules while maintaining high-quality workmanship directly impacts client satisfaction. However, field work often comes with unpredictable elements such as traffic delays or unexpected repair complications that can throw off even the most carefully planned schedules.

To overcome these challenges, HVAC companies must adopt a holistic approach combining strategic planning with technological support and effective personnel management. Investing in user-friendly scheduling software that integrates seamlessly with existing systems can alleviate much of the administrative burden associated with tracking service visits. Additionally, fostering strong lines of communication-both within teams and with clients-is essential for smooth operations.

In conclusion, while managing and tracking HVAC service visits outlined in agreements may seem daunting due to logistical complexities inherent in such tasks; through careful planning coupled with efficient use of technology alongside skilled workforce coordination - it becomes entirely manageable leading ultimately towards enhanced customer satisfaction levels alongside improved business outcomes for firms operating within this dynamic industry sector today more than ever before!

Guidelines for professional assessment and installation to ensure balanced weight

distribution

In an era where efficiency and precision are paramount, businesses increasingly rely on advanced tools and technologies to manage the intricacies of service agreements. One critical aspect of these agreements is tracking service visits, a task that, if not handled meticulously, can lead to misunderstandings and potential breaches of contract. Fortunately, modern technology offers a variety of solutions that enhance the process of managing and tracking appointments.

One foundational tool in this domain is scheduling software. These platforms enable companies to organize service visits systematically, ensuring that all appointments are logged and tracked efficiently. By using scheduling software, businesses can automate reminders for both clients and service providers, reducing the likelihood of missed appointments. Furthermore, such software often integrates with calendar applications on smartphones and computers, providing seamless notification systems that keep all parties informed.

Another essential technology is Customer Relationship Management (CRM) systems. CRMs have evolved significantly over the years and now offer robust features specifically designed for managing service contracts. They allow businesses to store detailed information about each client's service history, preferences, and upcoming appointment schedules in a centralized database. This centralized approach ensures that all stakeholders have access to real-time data about pending services and past interactions. Moreover, CRMs can generate reports and analytics to help organizations understand trends in service delivery and client satisfaction.

Mobile applications also play a vital role in tracking service visits outlined in agreements. Both clients and service providers benefit from mobile apps that offer on-the-go access to schedules and updates. For field technicians or representatives who frequently travel between client locations, mobile apps provide the ability to confirm arrivals or departures instantly through GPS-enabled check-ins. This feature not only enhances transparency but also builds trust with clients by providing them with real-time updates about their scheduled services.

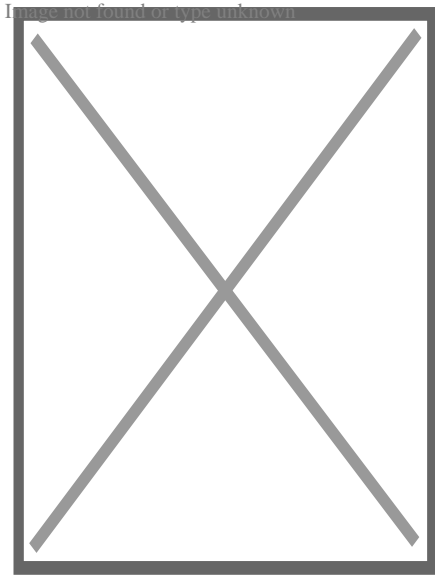
Furthermore, IoT (Internet of Things) devices are emerging as valuable assets in this space. For instance, smart sensors installed at client sites can monitor equipment status or environmental conditions remotely. When integrated with a business's appointment tracking system, these sensors can trigger automatic alerts for necessary maintenance visits based on predefined thresholds or anomalies detected in real time.

Finally, Artificial Intelligence (AI) is beginning to transform how businesses manage their service appointments. AI algorithms can predict optimal times for scheduling based on historical data or analyze patterns to foresee potential delays caused by traffic conditions or resource constraints. Such insights empower organizations to optimize their workforce allocation dynamically while minimizing disruptions.

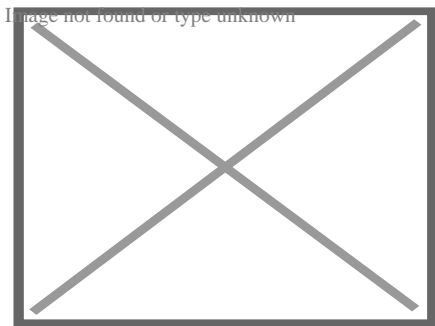
In conclusion, the landscape of tools and technologies available today provides robust capabilities for tracking appointments related to service visits as outlined in agreements. Through leveraging scheduling software, CRM systems, mobile applications, IoT devices, and AI-driven insights-businesses can streamline operations significantly while enhancing customer satisfaction levels concurrently. As these technologies continue evolving rapidly within our digital age; they promise even greater innovations ahead-further refining how we manage professional commitments effectively across diverse sectors globally!

About Heat pump

This article is about devices used to heat and potentially also cool a building (or water) using the refrigeration cycle. For more about the theory, see Heat pump and refrigeration cycle. For details of the most common type, see air source heat pump. For a similar device for cooling only, see air conditioner. For heat pumps used to keep food cool, see refrigerator. For other uses, see Heat pump (disambiguation).



External heat exchanger of an air-source heat pump for both heating and cooling



Mitsubishi heat pump interior air handler wall unit

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Part of a series on

Sustainable energy

A car drives past 4 wind turbines in a field, with more on the horizon



Energy conservation

- Arcology
- Building insulation
- Cogeneration
- Compact fluorescent lamp
- Eco hotel
- Eco-cities
- Ecohouse
- Ecolabel
- Efficient energy use
- Energy audit
- Energy efficiency implementation
- Energy recovery
- Energy recycling
- Energy saving lamp
- Energy Star
- Energy storage
- Environmental planning
- Environmental technology
- Fossil fuel phase-out
- Glass in green buildings
- Green building and wood
- Green building
- Heat pump
- List of low-energy building techniques
- Low-energy house
- Microgeneration
- Passive house
- Passive solar building design
- Sustainable architecture
- Sustainable city
- Sustainable habitat
- Sustainable refurbishment
- Thermal energy storage
- Tropical green building
- Waste-to-energy
- Zero heating building
- Zero-energy building

Renewable energy

- Biofuel
 - Sustainable
- Biogas
- Biomass
- Carbon-neutral fuel
- Geothermal energy
- Geothermal power
- Geothermal heating
- Hydropower
 - Hydroelectricity
 - Micro hydro
 - Pico hydro
 - Run-of-the-river
 - Small hydro
- Marine current power
- Marine energy
- Tidal power
 - Tidal barrage
 - Tidal farm
 - Tidal stream generator
- Ocean thermal energy conversion
- Renewable energy transition
- Renewable heat
- Solar
- Wave
- Wind
 - Community
 - Farm
 - Floating wind turbine
 - Forecasting
 - Industry
 - Lens
 - Outline
 - Rights
 - Turbine
 - Windbelt
 - Windpump

Sustainable transport

- Green vehicle
 - Electric vehicle
 - Bicycle
 - Solar vehicle
 - Wind-powered vehicle
- Hybrid vehicle
 - Human-electric
 - Twike
 - Plug-in
- Human-powered transport
 - Helicopter
 - Hydrofoil
 - Land vehicle
 - Bicycle
 - Cycle rickshaw
 - Kick scooter
 - Quadracycle
 - Tricycle
 - Velomobile
 - Roller skating
 - Skateboarding
 - Walking
 - Watercraft
- Personal transporter
- Rail transport
 - Tram
- Rapid transit
 - Personal rapid transit
-  Category
-  Renewable energy portal

A **heat pump** is a device that consumes energy (usually electricity) to transfer heat from a cold heat sink to a hot heat sink. Specifically, the heat pump transfers thermal energy using a refrigeration cycle, cooling the cool space and warming the warm space.^[1] In cold weather, a heat pump can move heat from the cool outdoors to warm a house (e.g. winter); the pump may also be designed to move heat from the house to the warmer outdoors in warm weather (e.g. summer). As they transfer heat rather than generating heat, they are more energy-efficient than other ways of heating or cooling a home.^[2]

A gaseous refrigerant is compressed so its pressure and temperature rise. When operating as a heater in cold weather, the warmed gas flows to a heat exchanger in the indoor space where some of its thermal energy is transferred to that indoor space, causing the gas to condense to its liquid state. The liquified refrigerant flows to a heat exchanger in the outdoor space where the pressure falls, the liquid evaporates and the temperature of the gas falls. It is now colder than the temperature of the outdoor space being used as a heat source. It can again take up energy from the heat source, be compressed and repeat the cycle.

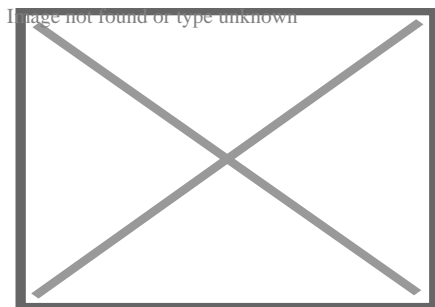
Air source heat pumps are the most common models, while other types include ground source heat pumps, water source heat pumps and exhaust air heat pumps.^[3] Large-scale heat pumps are also used in district heating systems.^[4]

The efficiency of a heat pump is expressed as a coefficient of performance (COP), or seasonal coefficient of performance (SCOP). The higher the number, the more efficient a heat pump is. For example, an air-to-water heat pump that produces 6kW at a SCOP of 4.62 will give over 4kW of energy into a heating system for every kilowatt of energy that the heat pump uses itself to operate. When used for space heating, heat pumps are typically more energy-efficient than electric resistance and other heaters.

Because of their high efficiency and the increasing share of fossil-free sources in electrical grids, heat pumps are playing a role in climate change mitigation.^[5]^[6] Consuming 1 kWh of electricity, they can transfer 1^[7] to 4.5 kWh of thermal energy into a building. The carbon footprint of heat pumps depends on how electricity is generated, but they usually reduce emissions.^[8] Heat pumps could satisfy over 80% of global space and water heating needs with a lower carbon footprint than gas-fired condensing boilers: however, in 2021 they only met 10%.^[4]

Principle of operation

[edit]

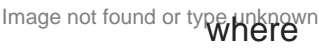


A: indoor compartment, B: outdoor compartment, I: insulation, 1: condenser, 2: expansion valve, 3: evaporator, 4: compressor

Main articles: Heat pump and refrigeration cycle and Vapor-compression refrigeration

Heat flows spontaneously from a region of higher temperature to a region of lower temperature. Heat does not flow spontaneously from lower temperature to higher, but it can be made to flow in this direction if work is performed. The work required to transfer a given amount of heat is usually much less than the amount of heat; this is the motivation for using heat pumps in applications such as the heating of water and the interior of buildings.^[9]

The amount of work required to drive an amount of heat Q from a lower-temperature reservoir such as ambient air to a higher-temperature reservoir such as the interior of a

building is:  where

- W is the work performed on the working fluid by the heat pump's compressor.
- Q is the heat transferred from the lower-temperature reservoir to the higher-temperature reservoir.
- COP is the instantaneous coefficient of performance for the heat pump at the temperatures prevailing in the reservoirs at one instant.

The coefficient of performance of a heat pump is greater than one so the work required is less than the heat transferred, making a heat pump a more efficient form of heating than electrical resistance heating. As the temperature of the higher-temperature reservoir increases in response to the heat flowing into it, the coefficient of performance decreases, causing an increasing amount of work to be required for each unit of heat being transferred.^[9]

The coefficient of performance, and the work required by a heat pump can be calculated easily by considering an ideal heat pump operating on the reversed Carnot cycle:

- If the low-temperature reservoir is at a temperature of 270 K (−3 °C) and the interior of the building is at 280 K (7 °C) the relevant coefficient of performance is 27. This means only 1 joule of work is required to transfer 27 joules of heat from a reservoir at 270 K to another at 280 K. The one joule of work ultimately ends up as thermal energy in the interior of the building so for each 27 joules of heat that are removed from the low-temperature reservoir, 28 joules of heat are added to the building interior, making the heat pump even more attractive from an efficiency perspective.^[note 1]
- As the temperature of the interior of the building rises progressively to 300 K (27 °C) the coefficient of performance falls progressively to 9. This means each joule of work is responsible for transferring 9 joules of heat out of the low-temperature reservoir and into the building. Again, the 1 joule of work ultimately ends up as thermal energy in the interior of the building so 10 joules of heat are added to the building interior.^[note 2]

This is the theoretical amount of heat pumped but in practice it will be less for various reasons, for example if the outside unit has been installed where there is not enough airflow. More data sharing with owners and academics—perhaps from heat meters—could improve efficiency in the long run.^[11]

History

[edit]

Milestones:

1748

William Cullen demonstrates artificial refrigeration.^[12]

1834

Jacob Perkins patents a design for a practical refrigerator using dimethyl ether.^[13]

1852

Lord Kelvin describes the theory underlying heat pumps.^[14]

1855–1857

Peter von Rittinger develops and builds the first heat pump.^[15]

1877

In the period before 1875, heat pumps were for the time being pursued for vapour compression evaporation (open heat pump process) in salt works with their obvious advantages for saving wood and coal. In 1857, Peter von Rittinger was the first to try to implement the idea of vapor compression in a small pilot plant. Presumably inspired by Rittinger's experiments in Ebensee, Antoine-Paul Piccard from the University of Lausanne and the engineer J. H. Weibel from the Weibel–Briquet company in Geneva built the world's first really functioning vapor compression system with a two-stage piston compressor. In 1877 this first heat pump in Switzerland was installed in the Bex salt works.^{[14][16]}

1928

Aurel Stodola constructs a closed-loop heat pump (water source from Lake Geneva) which provides heating for the Geneva city hall to this day.^[17]

1937–1945

During the First World War, fuel prices were very high in Switzerland but it had plenty of hydropower.^[14]

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In the period before and especially during the Second World War, when neutral Switzerland was completely surrounded by fascist-ruled countries, the coal shortage became alarming again. Thanks to their leading position in energy technology, the Swiss companies Sulzer, Escher Wyss and Brown Boveri built and put in operation around 35 heat pumps between 1937 and 1945. The main heat sources were lake water, river water, groundwater, and waste heat. Particularly noteworthy are the six historic heat pumps from the city of Zurich with heat outputs from 100 kW to 6 MW. An international milestone is the heat pump built by Escher

Wyss in 1937/38 to replace the wood stoves in the City Hall of Zurich. To avoid noise and vibrations, a recently developed rotary piston compressor was used. This historic heat pump heated the town hall for 63 years until 2001. Only then was it replaced by a new, more efficient heat pump.^[14]

1945

John Sumner, City Electrical Engineer for Norwich, installs an experimental water-source heat pump fed central heating system, using a nearby river to heat new Council administrative buildings. It had a seasonal efficiency ratio of 3.42, average thermal delivery of 147 kW, and peak output of 234 kW.^[18]

1948

Robert C. Webber is credited as developing and building the first ground-source heat pump.^[19]

1951

First large scale installation—the Royal Festival Hall in London is opened with a town gas-powered reversible water-source heat pump, fed by the Thames, for both winter heating and summer cooling needs.^[18]

2019

The Kigali Amendment to phase out harmful refrigerants takes effect.

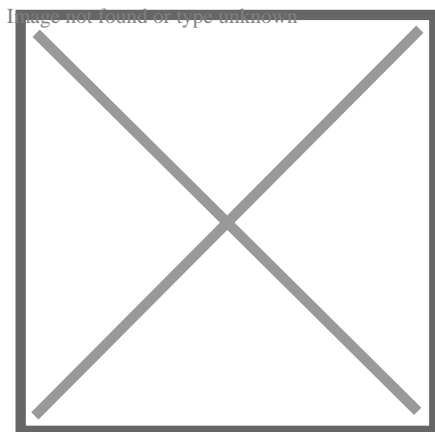
Types

[edit]

Air-source

[edit]

This section is an excerpt from Air source heat pump.[edit]



Heat pump on balcony of apartment

An air source heat pump (ASHP) is a heat pump that can absorb heat from air outside a building and release it inside; it uses the same vapor-compression refrigeration process

and much the same equipment as an air conditioner, but in the opposite direction. ASHPs are the most common type of heat pump and, usually being smaller, tend to be used to heat individual houses or flats rather than blocks, districts or industrial processes.[²⁰][²¹]

Air-to-air heat pumps provide hot or cold air directly to rooms, but do not usually provide hot water. *Air-to-water* heat pumps use radiators or underfloor heating to heat a whole house and are often also used to provide domestic hot water.

An ASHP can typically gain 4 kWh thermal energy from 1 kWh electric energy. They are optimized for flow temperatures between 30 and 40 °C (86 and 104 °F), suitable for buildings with heat emitters sized for low flow temperatures. With losses in efficiency, an ASHP can even provide full central heating with a flow temperature up to 80 °C (176 °F). [²²]

As of 2023 about 10% of building heating worldwide is from ASHPs. They are the main way to phase out gas boilers (also known as "furnaces") from houses, to avoid their greenhouse gas emissions.[²³]

Air-source heat pumps are used to move heat between two heat exchangers, one outside the building which is fitted with fins through which air is forced using a fan and the other which either directly heats the air inside the building or heats water which is then circulated around the building through radiators or underfloor heating which releases the heat to the building. These devices can also operate in a cooling mode where they extract heat via the internal heat exchanger and eject it into the ambient air using the external heat exchanger. Some can be used to heat water for washing which is stored in a domestic hot water tank.[²⁴]

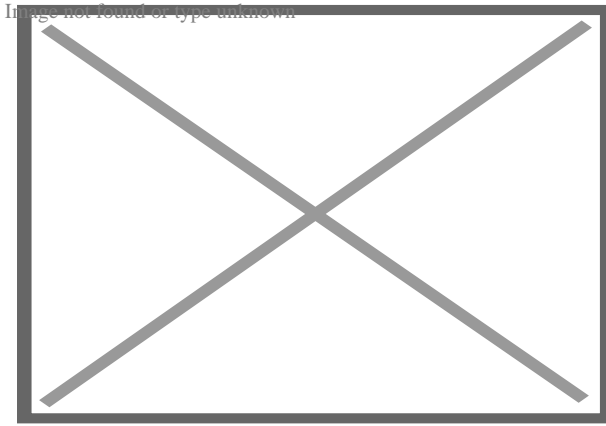
Air-source heat pumps are relatively easy and inexpensive to install, so are the most widely used type. In mild weather, coefficient of performance (COP) may be between 2 and 5, while at temperatures below around 7 °C (45 °F) an air-source heat pump may still achieve a COP of 1 to 4.[²⁵]

While older air-source heat pumps performed relatively poorly at low temperatures and were better suited for warm climates, newer models with variable-speed compressors remain highly efficient in freezing conditions allowing for wide adoption and cost savings in places like Minnesota and Maine in the United States.[²⁶]

Ground source

[edit]

This section is an excerpt from Ground source heat pump.[edit]



A heat pump in combination with heat and cold storage

A ground source heat pump (also geothermal heat pump) is a heating/cooling system for buildings that use a type of heat pump to transfer heat to or from the ground, taking advantage of the relative constancy of temperatures of the earth through the seasons. Ground-source heat pumps (GSHPs) – or geothermal heat pumps (GHP), as they are commonly termed in North America – are among the most energy-efficient technologies for providing HVAC and water heating, using far less energy than can be achieved by burning a fuel in a boiler/furnace or by use of resistive electric heaters.

Efficiency is given as a coefficient of performance (CoP) which is typically in the range 3 – 6, meaning that the devices provide 3 – 6 units of heat for each unit of electricity used. Setup costs are higher than for other heating systems, due to the requirement to install ground loops over large areas or to drill bore holes, and for this reason, ground source is often suitable when new blocks of flats are built.^[27] Otherwise air-source heat pumps are often used instead.

Heat recovery ventilation

[edit]

Main article: Heat recovery ventilation

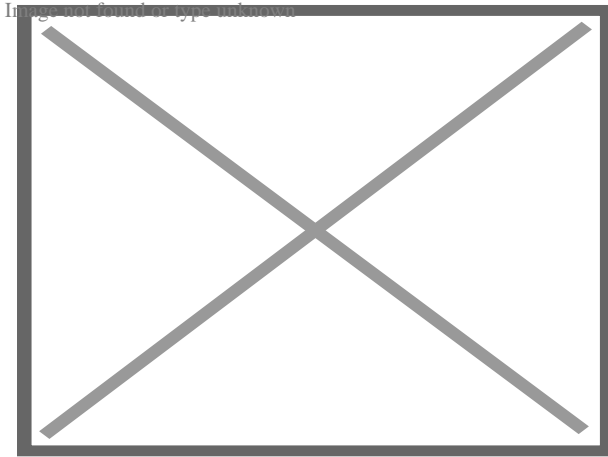
Exhaust air heat pumps extract heat from the exhaust air of a building and require mechanical ventilation. Two classes exist:

- Exhaust air-air heat pumps transfer heat to intake air.
- Exhaust air-water heat pumps transfer heat to a heating circuit that includes a tank of domestic hot water.

Solar-assisted

[edit]

This section is an excerpt from Solar-assisted heat pump.[edit]



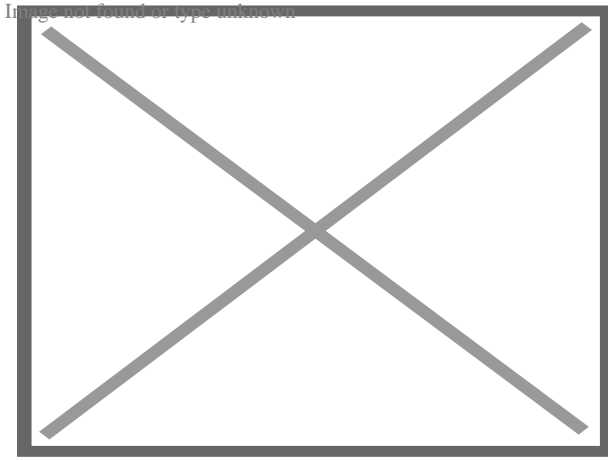
Hybrid photovoltaic-thermal solar panels of a SAHP in an experimental installation at Department of Energy at Polytechnic of Milan

A solar-assisted heat pump (SAHP) is a machine that combines a heat pump and thermal solar panels and/or PV solar panels in a single integrated system.^[28] Typically these two technologies are used separately (or only placing them in parallel) to produce hot water.^[29] In this system the solar thermal panel performs the function of the low temperature heat source and the heat produced is used to feed the heat pump's evaporator.^[30] The goal of this system is to get high coefficient of performance (COP) and then produce energy in a more efficient and less expensive way.

It is possible to use any type of solar thermal panel (sheet and tubes, roll-bond, heat pipe, thermal plates) or hybrid (mono/polycrystalline, thin film) in combination with the heat pump. The use of a hybrid panel is preferable because it allows covering a part of the electricity demand of the heat pump and reduce the power consumption and consequently the variable costs of the system.

Water-source

[edit]



Water-source heat exchanger being installed

A water-source heat pump works in a similar manner to a ground-source heat pump, except that it takes heat from a body of water rather than the ground. The body of water does, however, need to be large enough to be able to withstand the cooling effect of the unit without freezing or creating an adverse effect for wildlife.^[31] The largest water-source heat pump was installed in the Danish town of Esbjerg in 2023.^{[32][33]}

Others

[edit]

A thermoacoustic heat pump operates as a thermoacoustic heat engine without refrigerant but instead uses a standing wave in a sealed chamber driven by a loudspeaker to achieve a temperature difference across the chamber.^[34]

Electrocaloric heat pumps are solid state.^[35]

Applications

[edit]

The International Energy Agency estimated that, as of 2021, heat pumps installed in buildings have a combined capacity of more than 1000 GW.^[4] They are used for heating, ventilation, and air conditioning (HVAC) and may also provide domestic hot water and tumble clothes drying.^[36] The purchase costs are supported in various countries by consumer rebates.^[37]

Space heating and sometimes also cooling

[edit]

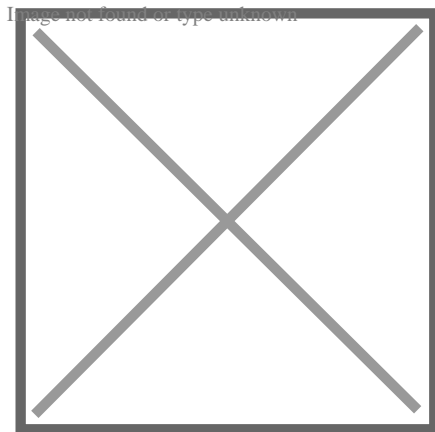
In HVAC applications, a heat pump is typically a vapor-compression refrigeration device that includes a reversing valve and optimized heat exchangers so that the direction of *heat flow* (thermal energy movement) may be reversed. The reversing valve switches the direction of refrigerant through the cycle and therefore the heat pump may deliver either heating or cooling to a building.

Because the two heat exchangers, the condenser and evaporator, must swap functions, they are optimized to perform adequately in both modes. Therefore, the Seasonal Energy Efficiency Rating (SEER in the US) or European seasonal energy efficiency ratio of a reversible heat pump is typically slightly less than those of two separately optimized machines. For equipment to receive the US Energy Star rating, it must have a rating of at least 14 SEER. Pumps with ratings of 18 SEER or above are considered highly efficient. The highest efficiency heat pumps manufactured are up to 24 SEER.^[38]

Heating seasonal performance factor (in the US) or Seasonal Performance Factor (in Europe) are ratings of heating performance. The SPF is Total heat output per annum / Total electricity consumed per annum in other words the average heating COP over the year.^[39]

Window mounted heat pump

[edit]



Saddle-style window mounted heat pump 3D sketch

Window mounted heat pumps run on standard 120v AC outlets and provide heating, cooling, and humidity control. They are more efficient with lower noise levels, condensation management, and a smaller footprint than window mounted air conditioners that just do cooling.^[40]

Water heating

[edit]

In water heating applications, heat pumps may be used to heat or preheat water for swimming pools, homes or industry. Usually heat is extracted from outdoor air and transferred to an indoor water tank.^[41]^[42]

District heating

[edit]

Large (megawatt-scale) heat pumps are used for district heating.^[43] However as of 2022 about 90% of district heat is from fossil fuels.^[44] In Europe, heat pumps account for a mere 1% of heat supply in district heating networks but several countries have targets to decarbonise their networks between 2030 and 2040.^[4] Possible sources of heat for such applications are sewage water, ambient water (e.g. sea, lake and river water), industrial waste heat, geothermal energy, flue gas, waste heat from district cooling and heat from solar seasonal thermal energy storage.^[45] Large-scale heat pumps for district heating combined with thermal energy storage offer high flexibility for the integration of variable renewable energy. Therefore, they are regarded as a key technology for limiting climate change by phasing out fossil fuels.^[45]^[46] They are also a crucial element of systems which can both heat and cool districts.^[47]

Industrial heating

[edit]

There is great potential to reduce the energy consumption and related greenhouse gas emissions in industry by application of industrial heat pumps, for example for process heat.^[48]^[49] Short payback periods of less than 2 years are possible, while achieving a high reduction of CO₂ emissions (in some cases more than 50%).^[50]^[51] Industrial heat

pumps can heat up to 200 °C, and can meet the heating demands of many light industries.^{[52][53]} In Europe alone, 15 GW of heat pumps could be installed in 3,000 facilities in the paper, food and chemicals industries.^[4]

Performance

[edit]

Main article: Coefficient of performance

The performance of a heat pump is determined by the ability of the pump to extract heat from a low temperature environment (the *source*) and deliver it to a higher temperature environment (the *sink*).^[54] Performance varies, depending on installation details, temperature differences, site elevation, location on site, pipe runs, flow rates, and maintenance.

In general, heat pumps work most efficiently (that is, the heat output produced for a given energy input) when the difference between the heat source and the heat sink is small. When using a heat pump for space or water heating, therefore, the heat pump will be most efficient in mild conditions, and decline in efficiency on very cold days. Performance metrics supplied to consumers attempt to take this variation into account.

Common performance metrics are the SEER (in cooling mode) and seasonal coefficient of performance (SCOP) (commonly used just for heating), although SCOP can be used for both modes of operation.^[54] Larger values of either metric indicate better performance.^[54] When comparing the performance of heat pumps, the term *performance* is preferred to *efficiency*, with coefficient of performance (COP) being used to describe the ratio of useful heat movement per work input.^[54] An electrical resistance heater has a COP of 1.0, which is considerably lower than a well-designed heat pump which will typically have a COP of 3 to 5 with an external temperature of 10 °C and an internal temperature of 20 °C. Because the ground is a constant temperature source, a ground-source heat pump is not subjected to large temperature fluctuations, and therefore is the most energy-efficient type of heat pump.^[54]

The "seasonal coefficient of performance" (SCOP) is a measure of the aggregate energy efficiency measure over a period of one year which is dependent on regional climate.^[54] One framework for this calculation is given by the Commission Regulation (EU) No. 813/2013.^[55]

A heat pump's operating performance in cooling mode is characterized in the US by either its energy efficiency ratio (EER) or seasonal energy efficiency ratio (SEER), both of which have units of BTU/(h·W) (note that 1 BTU/(h·W) = 0.293 W/W) and larger values indicate better performance.

COP variation with output temperature

Pump type and source	Typical use	35 °C (e.g. heated screed floor)	45 °C (e.g. heated screed floor)
High-efficiency air-source heat pump (ASHP), air at 20 °C [56]		2.2	2.0
Two-stage ASHP, air at 20 °C [57]	Low source temperature	2.4	2.2
High-efficiency ASHP, air at 0 °C [56]	Low output temperature	3.8	2.8
Prototype transcritical CO ₂ (R744) heat pump with tripartite gas cooler, source at 0 °C [58]	High output temperature	3.3	3.3
Ground-source heat pump (GSHP), water at 0 °C [56]		5.0	3.7
GSHP, ground at 10 °C [56]	Low output temperature	7.2	5.0

Theoretical Carnot cycle limit, source 20 °C	5.6	4.9
Theoretical Carnot cycle limit, source 0 °C	8.8	7.1
Theoretical Lorentzen cycle limit (CO 2 pump), return fluid 25 °C, source 0 °C ^[58]	10.1	8.8
Theoretical Carnot cycle limit, source 10 °C	12.3	9.1

Carbon footprint

[edit]

The carbon footprint of heat pumps depends on their individual efficiency and how electricity is produced. An increasing share of low-carbon energy sources such as wind and solar will lower the impact on the climate.

heating system	emissions of energy source	efficiency	resulting emissions for thermal energy
heat pump with onshore wind power	11 gCO ₂ /kWh ^[59]	400% (COP=4)	3 gCO ₂ /kWh
heat pump with global electricity mix	436 gCO ₂ /kWh ^[60] (2022)	400% (COP=4)	109 gCO ₂ /kWh

natural-gas thermal (high efficiency)	201 gCO ₂ /kWh ^[61]	90% ^[citation needed]	223 gCO ₂ /kWh
heat pump			
electricity by lignite (old power plant) and low performance	1221 gCO ₂ /kWh ^[61]	300% (COP=3)	407 gCO ₂ /kWh

In most settings, heat pumps will reduce CO₂ emissions compared to heating systems powered by fossil fuels.^[62] In regions accounting for 70% of world energy consumption, the emissions savings of heat pumps compared with a high-efficiency gas boiler are on average above 45% and reach 80% in countries with cleaner electricity mixes.^[4] These values can be improved by 10 percentage points, respectively, with alternative refrigerants. In the United States, 70% of houses could reduce emissions by installing a heat pump.^[63]^[4] The rising share of renewable electricity generation in many countries is set to increase the emissions savings from heat pumps over time.^[4]

Heating systems powered by green hydrogen are also low-carbon and may become competitors, but are much less efficient due to the energy loss associated with hydrogen conversion, transport and use. In addition, not enough green hydrogen is expected to be available before the 2030s or 2040s.^[64]^[65]

Operation

[edit]

See also: Vapor-compression refrigeration



This section **needs additional citations for verification**. Please help improve this article by adding citations to reliable sources in this section. Unsourced material may be challenged and removed. *(May 2021)* *(Learn how and when to remove this message)*

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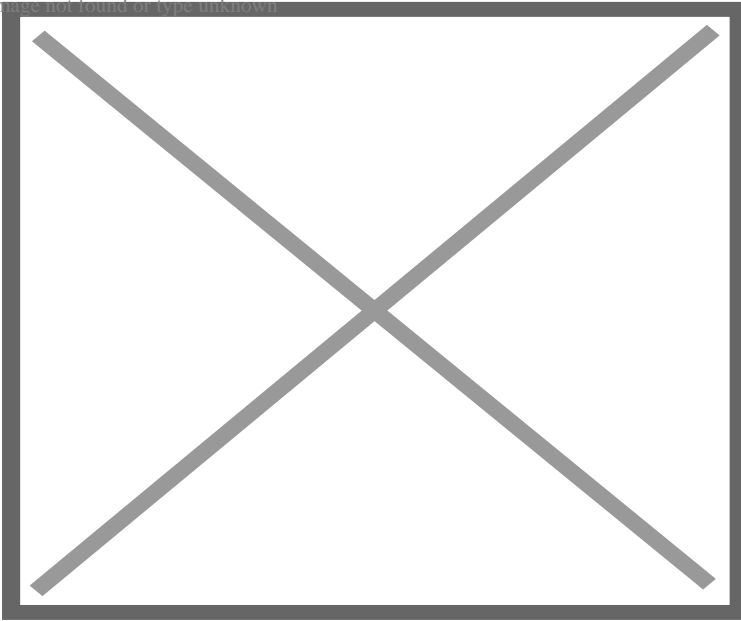
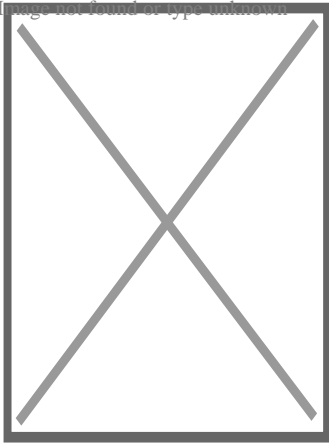


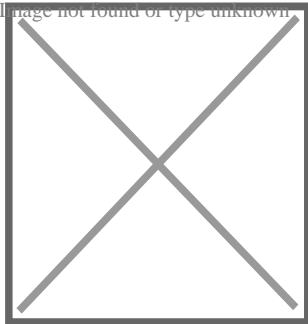
Figure 2: Temperature–entropy diagram of the vapor-compression cycle

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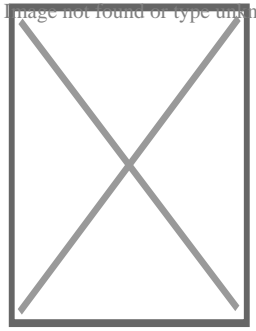


An internal view of the outdoor unit of an Ecodan air source heat pump

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Large heat pump
setup for a
commercial building



Wiring and connections to a central air unit inside

Vapor-compression uses a circulating refrigerant as the medium which absorbs heat from one space, compresses it thereby increasing its temperature before releasing it in another space. The system normally has eight main components: a compressor, a reservoir, a reversing valve which selects between heating and cooling mode, two thermal expansion valves (one used when in heating mode and the other when used in cooling mode) and two heat exchangers, one associated with the external heat source/sink and the other with the interior. In heating mode the external heat exchanger is the evaporator and the internal one being the condenser; in cooling mode the roles are reversed.

Circulating refrigerant enters the compressor in the thermodynamic state known as a saturated vapor^[66] and is compressed to a higher pressure, resulting in a higher temperature as well. The hot, compressed vapor is then in the thermodynamic state known as a superheated vapor and it is at a temperature and pressure at which it can be condensed with either cooling water or cooling air flowing across the coil or tubes. In heating mode this heat is used to heat the building using the internal heat exchanger, and in cooling mode this heat is rejected via the external heat exchanger.

The condensed, liquid refrigerant, in the thermodynamic state known as a saturated liquid, is next routed through an expansion valve where it undergoes an abrupt reduction in pressure. That pressure reduction results in the adiabatic flash evaporation of a part of the liquid refrigerant. The auto-refrigeration effect of the adiabatic flash evaporation lowers the temperature of the liquid and-vapor refrigerant mixture to where it is colder than the temperature of the enclosed space to be refrigerated.

The cold mixture is then routed through the coil or tubes in the evaporator. A fan circulates the warm air in the enclosed space across the coil or tubes carrying the cold refrigerant liquid and vapor mixture. That warm air evaporates the liquid part of the cold refrigerant mixture. At the same time, the circulating air is cooled and thus lowers the temperature of the enclosed space to the desired temperature. The evaporator is where the circulating refrigerant absorbs and removes heat which is subsequently rejected in

the condenser and transferred elsewhere by the water or air used in the condenser.

To complete the refrigeration cycle, the refrigerant vapor from the evaporator is again a saturated vapor and is routed back into the compressor.

Over time, the evaporator may collect ice or water from ambient humidity. The ice is melted through defrosting cycle. An internal heat exchanger is either used to heat/cool the interior air directly or to heat water that is then circulated through radiators or underfloor heating circuit to either heat or cool the buildings.

Improvement of coefficient of performance by subcooling

[edit]

Main article: Subcooling

Heat input can be improved if the refrigerant enters the evaporator with a lower vapor content. This can be achieved by cooling the liquid refrigerant after condensation. The gaseous refrigerant condenses on the heat exchange surface of the condenser. To achieve a heat flow from the gaseous flow center to the wall of the condenser, the temperature of the liquid refrigerant must be lower than the condensation temperature.

Additional subcooling can be achieved by heat exchange between relatively warm liquid refrigerant leaving the condenser and the cooler refrigerant vapor emerging from the evaporator. The enthalpy difference required for the subcooling leads to the superheating of the vapor drawn into the compressor. When the increase in cooling achieved by subcooling is greater than the compressor drive input required to overcome the additional pressure losses, such a heat exchange improves the coefficient of performance.^[67]

One disadvantage of the subcooling of liquids is that the difference between the condensing temperature and the heat-sink temperature must be larger. This leads to a moderately high pressure difference between condensing and evaporating pressure, whereby the compressor energy increases.

Refrigerant choice

[edit]

Main article: Refrigerant

Pure refrigerants can be divided into organic substances (hydrocarbons (HCs), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), hydrofluoroolefins (HFOs), and HCFOs), and inorganic substances (ammonia (NH₃), carbon dioxide (CO₂), and water (H₂O))^[68].^[69] Their boiling points are usually below 25 °C.^[70]

In the past 200 years, the standards and requirements for new refrigerants have changed. Nowadays low global warming potential (GWP) is required, in addition to all the previous requirements for safety, practicality, material compatibility, appropriate atmospheric life,^[clarification needed] and compatibility with high-efficiency products. By 2022, devices using refrigerants with a very low GWP still have a small market share but are expected to play an increasing role due to enforced regulations.^[71] as most countries have now ratified the Kigali Amendment to ban HFCs.^[72] Isobutane (R600A) and propane (R290) are far less harmful to the environment than conventional hydrofluorocarbons (HFC) and are already being used in air-source heat pumps.^[73] Propane may be the most suitable for high temperature heat pumps.^[74] Ammonia (R717) and carbon dioxide (R-744) also have a low GWP. As of 2023 smaller CO₂ heat pumps are not widely available and research and development of them continues.^[75] A 2024 report said that refrigerants with GWP are vulnerable to further international restrictions.^[76]

Until the 1990s, heat pumps, along with fridges and other related products used chlorofluorocarbons (CFCs) as refrigerants, which caused major damage to the ozone layer when released into the atmosphere. Use of these chemicals was banned or severely restricted by the Montreal Protocol of August 1987.^[77]

Replacements, including R-134a and R-410A, are hydrofluorocarbons (HFC) with similar thermodynamic properties with insignificant ozone depletion potential (ODP) but had problematic GWP.^[78] HFCs are powerful greenhouse gases which contribute to climate change.^[79]^[80] Dimethyl ether (DME) also gained in popularity as a refrigerant in combination with R404a.^[81] More recent refrigerants include difluoromethane (R32) with a lower GWP, but still over 600.

refrigerant	20-year GWP	100-year GWP
R-290 propane ^[82]	0.072	0.02
R-600a isobutane		3 ^[83]
R-32 ^[82]	491	136
R-410a ^[84]	4705	2285
R-134a ^[84]	4060	1470
R-404a ^[84]	7258	4808

Devices with R-290 refrigerant (propane) are expected to play a key role in the future.^[74]^[85] The 100-year GWP of propane, at 0.02, is extremely low and is approximately 7000 times less than R-32. However, the flammability of propane requires additional safety measures: the maximum safe charges have been set significantly lower than for lower flammability refrigerants (only allowing approximately 13.5 times less refrigerant in the system than R-32).^[86]^[87]^[88] This means that R-290 is not suitable for all situations or locations. Nonetheless, by 2022, an increasing number of devices with R-290 were offered for domestic use, especially in Europe.^[citation needed]

At the same time,^[when?] HFC refrigerants still dominate the market. Recent government mandates have seen the phase-out of R-22 refrigerant. Replacements such as R-32 and R-410A are being promoted as environmentally friendly but still have a high GWP.^[89] A heat pump typically uses 3 kg of refrigerant. With R-32 this amount still has a 20-year impact equivalent to 7 tons of CO₂, which corresponds to two years of natural gas heating in an average household. Refrigerants with a high ODP have already been phased out.^[citation needed]

Government incentives

[edit]

Financial incentives aim to protect consumers from high fossil gas costs and to reduce greenhouse gas emissions,^[90] and are currently available in more than 30 countries around the world, covering more than 70% of global heating demand in 2021.^[4]

Australia

[edit]

Food processors, brewers, petfood producers and other industrial energy users are exploring whether it is feasible to use renewable energy to produce industrial-grade heat. Process heating accounts for the largest share of onsite energy use in Australian manufacturing, with lower-temperature operations like food production particularly well-suited to transition to renewables.

To help producers understand how they could benefit from making the switch, the Australian Renewable Energy Agency (ARENA) provided funding to the Australian Alliance for Energy Productivity (A2EP) to undertake pre-feasibility studies at a range of sites around Australia, with the most promising locations advancing to full feasibility studies.^[91]

In an effort to incentivize energy efficiency and reduce environmental impact, the Australian states of Victoria, New South Wales, and Queensland have implemented rebate programs targeting the upgrade of existing hot water systems. These programs specifically encourage the transition from traditional gas or electric systems to heat pump based systems.^{[92][93][94][95][96]}

Canada

[edit]

In 2022, the Canada Greener Homes Grant^[97] provides up to \$5000 for upgrades (including certain heat pumps), and \$600 for energy efficiency evaluations.

China

[edit]

Purchase subsidies in rural areas in the 2010s reduced burning coal for heating, which had been causing ill health.^[98]

In the 2024 report by the International Energy Agency (IEA) titled "The Future of Heat Pumps in China," it is highlighted that China, as the world's largest market for heat pumps in buildings, plays a critical role in the global industry. The country accounts for over one-quarter of global sales, with a 12% increase in 2023 alone, despite a global sales dip of 3% the same year.^[99]

Heat pumps are now used in approximately 8% of all heating equipment sales for buildings in China as of 2022, and they are increasingly becoming the norm in central and southern regions for both heating and cooling. Despite their higher upfront costs and relatively low awareness, heat pumps are favored for their energy efficiency, consuming three to five times less energy than electric heaters or fossil fuel-based solutions. Currently, decentralized heat pumps installed in Chinese buildings represent a quarter of the global installed capacity, with a total capacity exceeding 250 GW, which covers around 4% of the heating needs in buildings.^[99]

Under the Announced Pledges Scenario (APS), which aligns with China's carbon neutrality goals, the capacity is expected to reach 1,400 GW by 2050, meeting 25% of heating needs. This scenario would require an installation of about 100 GW of heat pumps annually until 2050. Furthermore, the heat pump sector in China employs over

300,000 people, with employment numbers expected to double by 2050, underscoring the importance of vocational training for industry growth. This robust development in the heat pump market is set to play a significant role in reducing direct emissions in buildings by 30% and cutting PM2.5 emissions from residential heating by nearly 80% by 2030.^[99]
][^{100]}

European Union

[edit]

To speed up the deployment rate of heat pumps, the European Commission launched the Heat Pump Accelerator Platform in November 2024.^[101] It will encourage industry experts, policymakers, and stakeholders to collaborate, share best practices and ideas, and jointly discuss measures that promote sustainable heating solutions.^[102]

United Kingdom

[edit]

As of 2022: heat pumps have no Value Added Tax (VAT) although in Northern Ireland they are taxed at the reduced rate of 5% instead of the usual level of VAT of 20% for most other products.^[103] As of 2022 the installation cost of a heat pump is more than a gas boiler, but with the "Boiler Upgrade Scheme"^[104] government grant and assuming electricity/gas costs remain similar their lifetime costs would be similar on average.^[105] However lifetime cost relative to a gas boiler varies considerably depending on several factors, such as the quality of the heat pump installation and the tariff used.^[106] In 2024 England was criticised for still allowing new homes to be built with gas boilers, unlike some other counties where this is banned.^[107]

United States

[edit]

Further information: Environmental policy of the Joe Biden administration and Climate change in the United States

The High-efficiency Electric Home Rebate Program was created in 2022 to award grants to State energy offices and Indian Tribes in order to establish state-wide high-efficiency

electric-home rebates. Effective immediately, American households are eligible for a tax credit to cover the costs of buying and installing a heat pump, up to \$2,000. Starting in 2023, low- and moderate-level income households will be eligible for a heat-pump rebate of up to \$8,000.^[108]

In 2022, more heat pumps were sold in the United States than natural gas furnaces.^[109]

In November 2023 Biden's administration allocated 169 million dollars from the Inflation Reduction Act to speed up production of heat pumps. It used the Defense Production Act to do so, because according to the administration, energy that is better for the climate is also better for national security.^[110]

Notes

[edit]

- ¹ ^ As explained in Coefficient of performance TheoreticalMaxCOP = $(\text{desiredIndoorTempC} + 273) \div (\text{desiredIndoorTempC} - \text{outsideTempC}) = (7+273) \div (7 - (-3)) = 280 \div 10 = 28$ ^[10]
- ² ^ As explained in Coefficient of performance TheoreticalMaxCOP = $(\text{desiredIndoorTempC} + 273) \div (\text{desiredIndoorTempC} - \text{outsideTempC}) = (27+273) \div (27 - (-3)) = 300 \div 30 = 10$ ^[10]

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Heating, ventilation, and air conditioning

**Fundamental
concepts**

- Air changes per hour
- Bake-out
- Building envelope
- Convection
- Dilution
- Domestic energy consumption
- Enthalpy
- Fluid dynamics
- Gas compressor
- Heat pump and refrigeration cycle
- Heat transfer
- Humidity
- Infiltration
- Latent heat
- Noise control
- Outgassing
- Particulates
- Psychrometrics
- Sensible heat
- Stack effect
- Thermal comfort
- Thermal destratification
- Thermal mass
- Thermodynamics
- Vapour pressure of water

Technology

- Absorption-compression heat pump
- Absorption refrigerator
- Air barrier
- Air conditioning
- Antifreeze
- Automobile air conditioning
- Autonomous building
- Building insulation materials
- Central heating
- Central solar heating
- Chilled beam
- Chilled water
- Constant air volume (CAV)
- Coolant
- Cross ventilation
- Dedicated outdoor air system (DOAS)
- Deep water source cooling
- Demand controlled ventilation (DCV)
- Displacement ventilation
- District cooling
- District heating
- Electric heating
- Energy recovery ventilation (ERV)
- Firestop
- Forced-air
- Forced-air gas
- Free cooling
- Heat recovery ventilation (HRV)
- Hybrid heat
- Hydronics
- Ice storage air conditioning
- Kitchen ventilation
- Mixed-mode ventilation
- Microgeneration
- Passive cooling
- Passive daytime radiative cooling
- Passive house
- Passive ventilation
- Radiant heating and cooling
- Radiant cooling
- Radiant heating
- Radon mitigation
- Refrigeration
- Renewable heat
- Room air distribution
- Solar air heat
- Solar combisystem
- Solar cooling
- Solar heating

- Air conditioner inverter
- Air door
- Air filter
- Air handler
- Air ionizer
- Air-mixing plenum
- Air purifier
- Air source heat pump
- Attic fan
- Automatic balancing valve
- Back boiler
- Barrier pipe
- Blast damper
- Boiler
- Centrifugal fan
- Ceramic heater
- Chiller
- Condensate pump
- Condenser
- Condensing boiler
- Convection heater
- Compressor
- Cooling tower
- Damper
- Dehumidifier
- Duct
- Economizer
- Electrostatic precipitator
- Evaporative cooler
- Evaporator
- Exhaust hood
- Expansion tank
- Fan
- Fan coil unit
- Fan filter unit
- Fan heater
- Fire damper
- Fireplace
- Fireplace insert
- Freeze stat
- Flue
- Freon
- Fume hood
- Furnace
- Gas compressor
- Gas heater
- Gasoline heater
- Grease duct
- Grille

**Measurement
and control**

- Air flow meter
- Aquastat
- BACnet
- Blower door
- Building automation
- Carbon dioxide sensor
- Clean air delivery rate (CADR)
- Control valve
- Gas detector
- Home energy monitor
- Humidistat
- HVAC control system
- Infrared thermometer
- Intelligent buildings
- LonWorks
- Minimum efficiency reporting value (MERV)
- Normal temperature and pressure (NTP)
- OpenTherm
- Programmable communicating thermostat
- Programmable thermostat
- Psychrometrics
- Room temperature
- Smart thermostat
- Standard temperature and pressure (STP)
- Thermographic camera
- Thermostat
- Thermostatic radiator valve
- Architectural acoustics
- Architectural engineering
- Architectural technologist
- Building services engineering
- Building information modeling (BIM)
- Deep energy retrofit

**Professions,
trades,
and services**

- Duct cleaning
- Duct leakage testing
- Environmental engineering
- Hydronic balancing
- Kitchen exhaust cleaning
- Mechanical engineering
- Mechanical, electrical, and plumbing
- Mold growth, assessment, and remediation
- Refrigerant reclamation
- Testing, adjusting, balancing

Industry organizations

- AHRI
- AMCA
- ASHRAE
- ASTM International
- BRE
- BSRIA
- CIBSE
- Institute of Refrigeration
- IIR
- LEED
- SMACNA
- UMC
- Indoor air quality (IAQ)
- Passive smoking
- Sick building syndrome (SBS)
- Volatile organic compound (VOC)
- ASHRAE Handbook

Health and safety

- Building science
- Fireproofing
- Glossary of HVAC terms
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- World Refrigeration Day
- Template:Home automation
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See also

Authority control databases: National                                                            

Plains Conservation Center (Visitor Center)

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Meow Wolf Denver | Convergence Station

4.5 (14709)

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The Aurora Highlands North Sculpture

4.9 (11)

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Aurora History Museum

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Driving Directions in Arapahoe County

Driving Directions From King Soopers to Royal Supply South

Driving Directions From Costco Vision Center to Royal Supply South

Driving Directions From Walgreens to Royal Supply South

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Driving Directions From Museum of Outdoor Arts to Royal Supply South

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Frequently Asked Questions

How can I ensure that all scheduled HVAC service visits outlined in my agreement are completed on time?

To ensure timely completion of scheduled HVAC service visits, keep a copy of your service agreement handy and mark calendar reminders for each visit. Additionally, choose a reliable service provider who offers notifications or confirmations prior to scheduled appointments.

What details should I track during each HVAC service visit to align with my maintenance agreement?

During each HVAC service visit, track the date and duration of the visit, the specific services performed, any parts replaced or repaired, technicians notes or recommendations, and confirmation that all tasks listed in your maintenance agreement were addressed.

How can I verify that my HVAC system is serviced according to the terms specified in my maintenance contract?

Verify compliance with your maintenance contract by requesting detailed reports from your technician after each visit. Compare these reports against the checklist provided in your agreement to confirm that all required services were executed as promised.

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