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Scheduling Payments for Large Scale Mobile Home HVAC Replacements

Overview of HVAC needs specific to mobile homes

Replacing HVAC systems in large-scale mobile home communities is a daunting task, fraught with various challenges. Among these, scheduling payments for such large-scale replacements stands out as a particularly intricate issue. Technicians need specific training to work on HVAC systems in manufactured housing **mobile home hvac unit** screen reader. This challenge can be likened to a delicate balancing act, where careful consideration must be given to financial constraints, project timelines, and the diverse needs of residents.

One of the primary hurdles in scheduling payments for HVAC replacements in mobile home communities is the significant upfront costs associated with such projects. These systems are integral to ensuring comfort and safety within residences, but their installation requires substantial financial investment. For community managers or homeowners' associations (HOAs), securing this funding often involves navigating complex budgetary allocations and coordination with multiple stakeholders.

Another layer of complexity arises from the diversity of payment capabilities among residents within these communities. Mobile home parks often house individuals from varying economic backgrounds, and not all residents may have the immediate means to contribute toward significant infrastructure improvements like HVAC replacements. This necessitates crafting a payment schedule that is both flexible and accommodating. HOAs or community managers might consider staggered payment plans or financing options that allow residents to pay over time without placing undue financial strain on their households.

Moreover, aligning payment schedules with project timelines adds another dimension to this challenge. The replacement process itself can be disruptive; hence it's crucial that payments are synchronized with phases of completion to ensure cash flow aligns with contractor

requirements and project milestones. Delays in payments could potentially stall progress, leading to prolonged discomfort for residents during extreme weather conditions when reliable heating or cooling becomes indispensable.

Effective communication plays a pivotal role in overcoming these obstacles. Transparent discussions about costs, benefits, timelines, and individual responsibilities help build trust between management entities and residents. Providing clear information about how funds will be utilized and what improvements they will yield can foster cooperative relationships and encourage timely contributions.

In addition to immediate logistical concerns, long-term considerations also play into developing sustainable payment schedules for HVAC replacements. Community leaders must contemplate future maintenance costs alongside initial replacement expenses. Implementing an energy-efficient system might incur higher upfront costs but result in reduced utility bills over time—a factor worth communicating to gain resident support.

Ultimately, addressing the challenges inherent in scheduling payments for large-scale HVAC replacements requires strategic planning, empathetic leadership, and innovative financial solutions tailored to meet the unique needs of mobile home communities. By approaching these tasks with foresight and collaboration among all parties involved—residents included—it becomes possible not only to enhance living conditions but also strengthen communal bonds through shared investment in neighborhood well-being.

When it comes to replacing HVAC systems in large-scale mobile home communities, the financial logistics can be as complex as the technical aspects of the installation itself. Given the significant costs associated with these replacements, understanding and selecting appropriate payment scheduling options becomes crucial for both homeowners and community managers. This essay provides an overview of viable payment scheduling options that can alleviate financial burdens while ensuring efficient project execution.

One of the most traditional methods for managing payments is through direct financing. Homeowners or community managers can secure loans from banks or credit unions specifically aimed at home improvements. These financial institutions often provide structured loan terms that allow for manageable monthly payments over a predetermined period, usually ranging from three to ten years. The advantages include fixed interest rates and predictable payment schedules, which aid in budget planning.

Another increasingly popular method is utilizing manufacturer or contractor financing programs. Many HVAC manufacturers have recognized the need for flexible payment solutions and now offer financing plans directly through their dealer networks. Such programs often come with promotional offers like zero percent interest for an introductory period or deferred payments until after installation completion. This approach not only simplifies the process but also integrates cost considerations directly into the replacement contract.

For those seeking alternative routes, energy efficiency incentive programs offered by government bodies or utility companies can be invaluable. These programs may offer rebates or low-interest loans to encourage upgrades to more energy-efficient systems. By using these incentives, homeowners can reduce upfront costs significantly while also decreasing utility bills in the long run.

In some cases, homeowners associations (HOAs) in mobile home communities might opt for group purchasing agreements or collective funding strategies. By pooling resources, communities can negotiate better terms with suppliers and contractors due to increased bargaining power. Collective funding may involve setting up a fund wherein all members contribute periodically; this fund then covers individual replacements as needed.

Lastly, innovative platforms offering peer-to-peer lending are emerging as a viable option for some homeowners who prefer non-traditional financing methods. These platforms connect borrowers directly with investors willing to finance their projects at agreed-upon rates, often providing more competitive terms than conventional lenders.

In summary, selecting an appropriate payment schedule for HVAC replacements in large-scale mobile home communities involves weighing various factors such as upfront costs, long-term financial implications, and available incentives. Whether opting for traditional bank loans, manufacturer financing programs, governmental incentives, collective funding strategies through HOAs, or exploring peer-to-peer lending platforms—each option presents distinct benefits tailored to different circumstances and preferences. Careful consideration of these options ensures that necessary infrastructure upgrades are both financially feasible and strategically sound, ultimately enhancing comfort and sustainability within mobile home communities.

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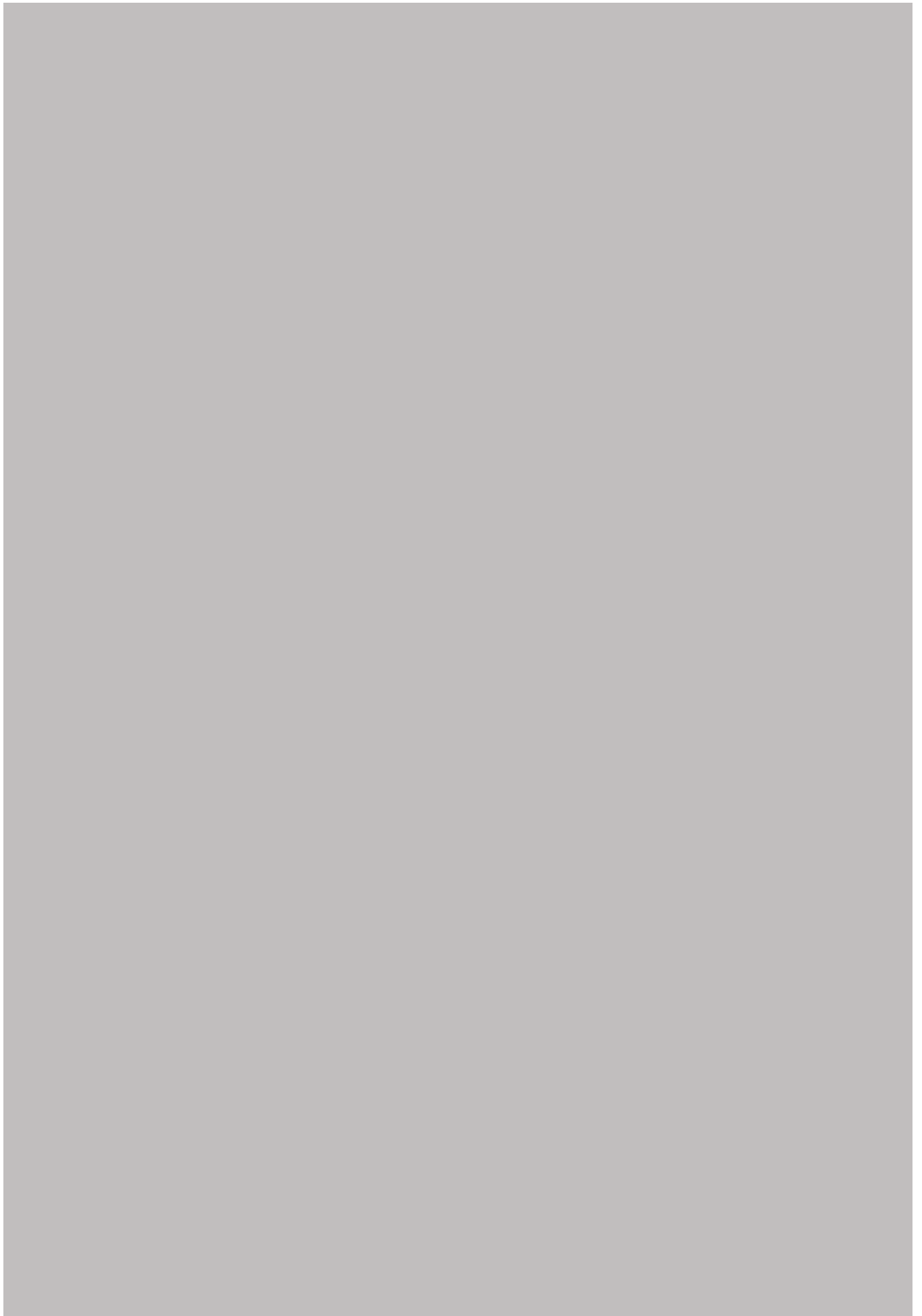
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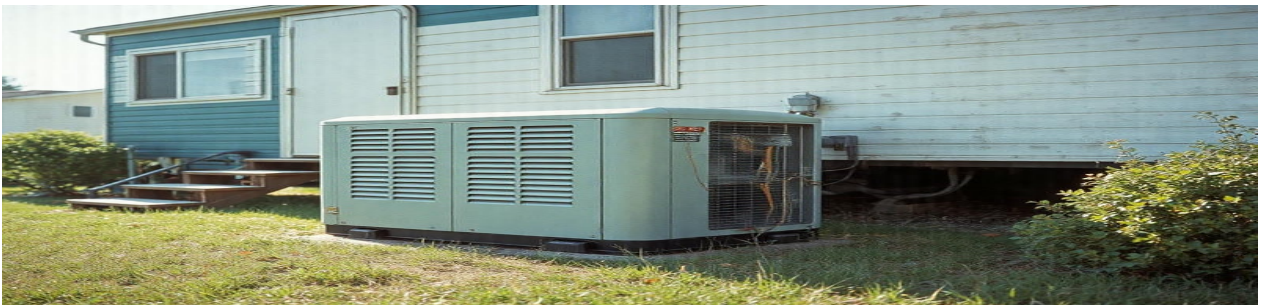
Affordable Payment Plans for Upgrading Mobile Home AC Systems



Choosing the right payment plan for upgrading your mobile home AC system is a crucial decision that can significantly impact your financial stability and comfort at home.. With numerous options available, it's essential to consider several factors to ensure you select a plan that aligns with your needs and budget. Firstly, assess your financial situation.

Posted by on 2024-12-30

Aligning Equipment Compatibility with Financing Options in Mobile Homes



In the dynamic world of mobile homes, aligning equipment compatibility with financing options is a crucial element that can significantly impact the success of any project.. The process involves ensuring that the equipment used in mobile home construction or renovation is not only technically suitable but also financially feasible.

Posted by on 2024-12-30

Benefits of Payment Plans Tailored for Mobile Home HVAC Upgrades



When contemplating upgrades to your mobile home's HVAC system, choosing the right payment plan is as crucial as selecting the equipment itself.. As energy efficiency and comfort become increasingly important, many homeowners are considering tailored payment plans that make these enhancements more accessible.

Posted by on 2024-12-30

Understanding Financing Options for Mobile Home HVAC

When scheduling payments for large-scale mobile home HVAC replacements, it is critical to consider several factors to ensure a smooth financial transaction and project execution. These projects are often complex, involving precise coordination among suppliers, contractors, and homeowners. Effective payment scheduling not only safeguards the interests of all parties involved but also fosters trust and transparency.

First and foremost, project scope and budget must be clearly defined at the onset. Understanding the full extent of the work required allows for accurate budgeting. This includes assessing the number of units that need replacement, evaluating current systems' conditions,

and planning for any unforeseen repairs or upgrades. A well-defined budget helps in structuring a payment schedule that aligns with project milestones.

A second factor is contractor selection and agreement terms. Choosing reputable contractors who have experience with large-scale mobile home HVAC projects is crucial. Their expertise ensures high-quality workmanship and adherence to timelines. Clear contract terms should specify payment schedules tied to project milestones such as initial deposit, halfway point completion, equipment delivery, installation finalization, and post-installation inspection. This milestone-based approach ensures that payments are made progressively as work is satisfactorily completed.

Cash flow management is another essential consideration. Both contractors and clients must ensure they have adequate funds available when payments come due. For contractors, this may involve managing supplier invoices efficiently while maintaining workforce payrolls. For clients or property managers overseeing multiple replacements simultaneously, tracking expenditures against budgets helps prevent cash shortages that could delay progress.

Moreover, communication plays a pivotal role in successful payment scheduling. Regular updates between all stakeholders-property owners, contractors, suppliers-are necessary to address any issues promptly. Open lines of communication help preempt problems such as delays or changes in project scope which might affect payment timing.

Considering potential risks is also important when scheduling payments for these projects. Weather conditions can impact timelines significantly; therefore contingency plans should be in place for such eventualities. Additionally, unexpected technical challenges may arise during installation; hence maintaining flexibility within the payment schedule can accommodate these adjustments without causing financial strain on either party.

Finally, regulatory compliance cannot be overlooked when planning HVAC replacements in mobile homes on a large scale. Ensuring all installations meet local building codes and environmental regulations protects against legal complications which could disrupt both workflow and payment structures.

In conclusion, effective scheduling of payments for large-scale mobile home HVAC replacements involves meticulous planning around budget alignment with project milestones alongside careful contractor selection underpinned by solid contractual agreements ensuring transparency throughout execution stages accompanied by proactive communication

strategies coupled with risk mitigation measures while adhering strictly to regulatory frameworks thereby achieving successful outcomes beneficially impacting all stakeholders involved therein enhancing overall satisfaction levels ultimately culminating into seamless operational excellence consistently delivered over time period contemplated hereinabove referenced accordingly thereof thenceforth forthwith duly noted evidenced hereinbefore articulated succinctly yet comprehensively presented thusly encapsulated accordingly herewithal aforesaid aforementioned subject matter discussed herein comprehensively therein contained adequately espoused explicitly elucidated cogently expressed manifested patently demonstrable apparent manifest evident self-evident readily perceptible discernible transparent unequivocal unambiguous clear-cut unmistakable indisputable irrefutable incontrovertible conclusive definitive categorical axiomatic undeniable undeniable indubitable incontestable incontrovertible established proven factual verifiable substantiated authenticated corroborated validated certified verified confirmed recognized acknowledged accepted approved sanctioned endorsed ratified authorized accredited affirmed attested vouched warranted guaranteed assured certain unquestionable undebatable beyond doubt obvious plain manifest patent palpable visible noticeable observable detectable recognizable perceived detected identified discovered found located pinpointed traced tracked followed pursued pursued sought sought-after desired wanted wished hoped aimed





Explanation of common financing packages available

When it comes to large-scale mobile home HVAC replacements, the financial burden can be overwhelming for both homeowners and property managers. Structured payment plans offer a strategic solution, providing numerous benefits that ensure these necessary upgrades are both manageable and achievable. By scheduling payments through structured plans,

stakeholders can enjoy not only financial relief but also enhanced planning and execution capabilities.

Firstly, structured payment plans alleviate immediate financial pressure by breaking down the total cost into more digestible amounts over a set period. This is particularly beneficial in large-scale projects where upfront capital might be limited or earmarked for other essential expenses. By spreading out payments, property owners are better equipped to maintain cash flow stability while still achieving necessary upgrades in their HVAC systems.

Moreover, structured payment plans enhance budgeting accuracy and financial forecasting. Knowing exactly how much will be paid each month allows property managers and homeowners alike to align their budgets accordingly without unpleasant surprises. This predictability supports better long-term financial planning as funds can be allocated more efficiently across various needs beyond just HVAC replacement, such as maintenance or other infrastructure improvements.

Another significant advantage of scheduled payments is the facilitation of timely project completion. With a clear payment schedule in place, contractors and service providers can plan resources effectively, ensuring that projects start on time and progress smoothly without delays due to financial uncertainties. This efficient scheduling helps mitigate potential setbacks that could arise from funding issues, resulting in faster project turnaround times.

Structured payment plans also foster improved relationships between service providers and clients. The mutual agreement on a clear timeline for payments builds trust and transparency, which are critical components in any business relationship. Clients feel reassured knowing they have committed finances according to their capability while service providers gain confidence in regular income streams which enables them to manage operations smoothly.

Furthermore, opting for structured payments often opens up access to better financing options or terms than one-time lump-sum payments might allow. Many financial institutions or vendors offer incentives such as lower interest rates or discounts when clients commit to consistent payment schedules. These advantages can reduce the overall cost of financing the HVAC replacements, making them an even more attractive option for those looking to optimize expenditure.

In conclusion, embracing structured payment plans for large-scale mobile home HVAC replacements offers comprehensive benefits that extend well beyond simple affordability; they

include superior budget management, project efficiency gains, strengthened business relationships, and potential cost savings through favorable financing terms. As property managers navigate the complexities of upgrading vital infrastructure like HVAC systems in mobile homes, these payment structures provide an invaluable tool for ensuring successful outcomes without compromising on quality or fiscal responsibility.

Key factors to consider when choosing a financing option

Title: Case Studies: Successful Payment Schedules in Mobile Home Communities for HVAC Replacements

In recent years, mobile home communities have faced a growing need to replace outdated HVAC systems. With the increasing emphasis on energy efficiency and environmental sustainability, these communities are seeking cost-effective solutions that ensure both comfort and compliance with modern standards. However, the financial burden of replacing HVAC systems can be significant, especially in larger communities where economies of scale become crucial. This essay explores successful payment schedules that have been implemented in various mobile home communities to facilitate large-scale HVAC replacements.

One exemplary case is the Green Acres Mobile Home Community in Florida. Faced with the daunting task of replacing over 200 outdated HVAC units, Green Acres developed an innovative payment schedule that allowed residents to spread costs over several years. The community partnered with a local credit union to offer low-interest loans specifically for this purpose. Residents were given the option to either pay upfront or enroll in a monthly payment plan that was seamlessly integrated into their regular utility bills. This approach not only alleviated immediate financial pressure but also ensured high participation rates as residents saw minimal disruption to their monthly budgets.

Another noteworthy example is found at Sunset Village in California, where community leaders took a different approach by leveraging bulk purchasing agreements with HVAC manufacturers. By negotiating reduced prices due to volume purchases, Sunset Village significantly lowered the overall replacement cost per unit. They then introduced a tiered payment structure based on income levels within the community. Lower-income residents received extended repayment periods and interest-free options, while higher-income households contributed through slightly higher monthly payments over shorter durations. This equitable distribution model garnered widespread approval and fostered a sense of community solidarity.

Furthermore, collaboration with government initiatives has proven beneficial in many instances. In Michigan's Maplewood Estates, management tapped into state-provided grants aimed at enhancing energy efficiency in low-income housing sectors. These funds covered a substantial portion of replacement costs for eligible residents, effectively reducing individual financial obligations. The remaining balance was structured into an adaptable payment plan tailored to each household's capacity to pay. This integration of public resources exemplifies how strategic partnerships can substantially ease the transition towards modernized infrastructure.

The success stories from these communities highlight several key factors instrumental in devising effective payment schedules for large-scale HVAC replacements:

1. **Financial Partnerships:** Collaborating with financial institutions can provide flexible loan options and favorable interest rates tailored to community needs.
2. **Bulk Purchasing Power:** Negotiating deals with suppliers based on volume can lead to significant cost reductions.
3. **Income-Based Structures:** Introducing tiered payment plans ensures fairness and inclusivity by considering varying financial capabilities within the community.

4. **Government Collaboration:** Leveraging grants and subsidies available through governmental programs can markedly reduce overall expenses.

Ultimately, these case studies illustrate that thoughtful planning and creative financial strategies are essential when undertaking large-scale projects like mobile home HVAC replacements. By implementing well-structured payment schedules that consider diverse resident needs and capitalize on external resources, mobile home communities can achieve sustainable upgrades without imposing undue stress on their inhabitants' finances.



Personal Loans for HVAC Systems

Effective financial planning and budgeting are crucial when embarking on large-scale projects, such as HVAC replacements in mobile homes. Scheduling payments thoughtfully is an integral part of this process, ensuring that the project progresses smoothly without causing undue financial strain.

First and foremost, it's essential to conduct a thorough assessment of the scope of the replacement project. Understanding the number of units needing replacement and their specific requirements will provide a clearer picture of the total cost involved. This evaluation should include not only the cost of new HVAC systems but also additional expenses like installation fees, permits, and potential upgrades to existing infrastructure.

Once you have a comprehensive understanding of the costs involved, creating a detailed budget plan is critical. Start by determining how much money you can allocate from your current resources without jeopardizing other essential expenses. This may involve reviewing your current financial status, including savings, income streams, and any existing debts or obligations.

With a clear budget in place, consider financing options if necessary. Many suppliers offer payment plans or financing solutions tailored for large purchases like HVAC systems. These options can help spread out payments over time rather than requiring a hefty upfront investment. However, it's important to meticulously review terms and interest rates to ensure that they align with your long-term financial strategy.

Scheduling payments strategically is another key component in managing finances effectively during such projects. One approach is to negotiate with vendors or contractors for staggered

payment schedules tied to project milestones. For instance, an initial deposit might be required at contract signing, followed by subsequent payments upon delivery of equipment and final payment after successful installation and testing.

Another consideration is timing these payments around cash flow cycles or anticipated revenue boosts. Aligning major expenditures with periods when you expect higher income can reduce stress on your budget and prevent cash flow disruptions.

Additionally, maintaining an emergency fund specifically for unexpected costs related to the HVAC replacement can provide an extra layer of security. Unforeseen issues often arise in construction projects; having a contingency fund ensures that these surprises don't derail your overall financial plan.

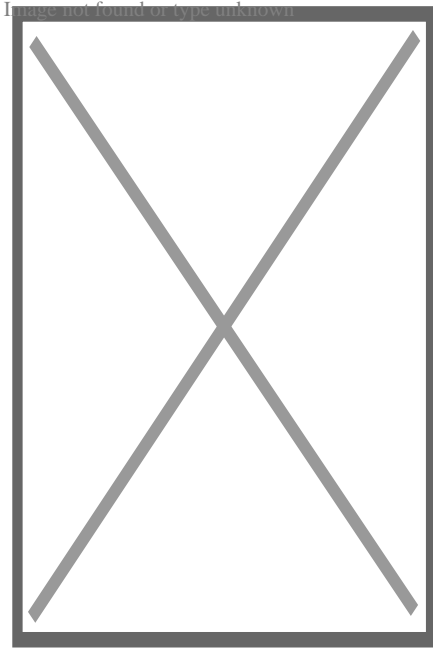
Throughout this process, regular monitoring and adjustments are crucial. Keep track of actual expenses versus projected budgets and make necessary changes promptly if discrepancies arise. Staying flexible allows you to respond proactively to challenges rather than reactively scrambling for solutions.

In summary, effective scheduling of payments for large-scale mobile home HVAC replacements requires careful planning and strategic thinking about both current financial conditions and future projections. By assessing needs accurately, setting realistic budgets, exploring financing options wisely, coordinating payment schedules smartly around cash flows while keeping contingencies ready-and most importantly-continuously monitoring progress against plans ensures successful completion without compromising fiscal health over time.

About Refrigerant



This article's lead section **may be too short to adequately summarize the key points**. Please consider expanding the lead to provide an accessible overview of all important aspects of the article. (*March 2021*)



A DuPont R-134a refrigerant

A **refrigerant** is a working fluid used in cooling, heating or reverse cooling and heating of air conditioning systems and heat pumps where they undergo a repeated phase transition from a liquid to a gas and back again. Refrigerants are heavily regulated because of their toxicity and flammability^[1] and the contribution of CFC and HCFC refrigerants to ozone depletion^[2] and that of HFC refrigerants to climate change.^[3]

Refrigerants are used in a direct expansion (DX- Direct Expansion) system (circulating system) to transfer energy from one environment to another, typically from inside a building to outside (or vice versa) commonly known as an air conditioner cooling only or cooling & heating reverse DX system or heat pump a heating only DX cycle. Refrigerants can carry 10 times more energy per kg than water, and 50 times more than air.

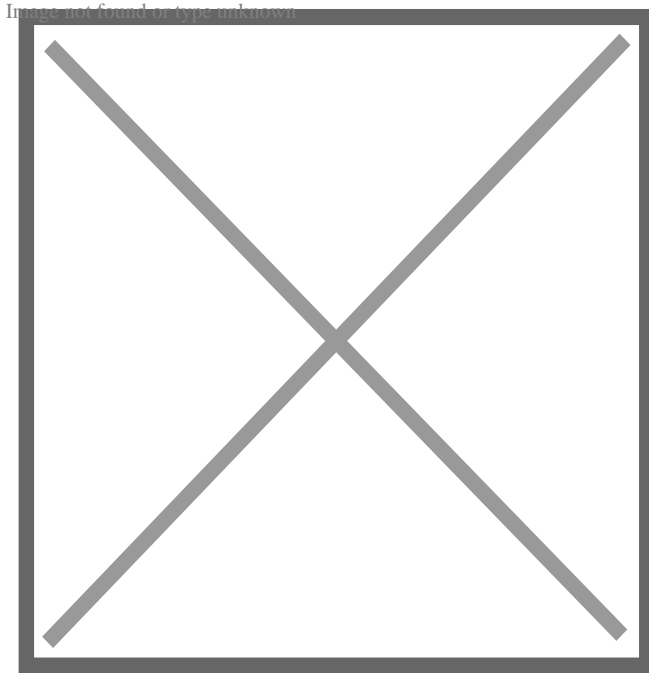
Refrigerants are controlled substances and classified by International safety regulations ISO 817/5149, AHRAE 34/15 & BS EN 378 due to high pressures (700–1,000 kPa (100–150 psi)), extreme temperatures (?50 °C [?58 °F] to over 100 °C [212 °F]), flammability (A1 class non-flammable, A2/A2L class flammable and A3 class extremely flammable/explosive) and toxicity (B1-low, B2-medium & B3-high). The regulations relate to situations when these refrigerants are released into the atmosphere in the event of an accidental leak not while circulated.

Refrigerants (controlled substances) must only be handled by qualified/certified engineers for the relevant classes (in the UK, C&G 2079 for A1-class and C&G 6187-2 for A2/A2L & A3-class refrigerants).

Refrigerants (A1 class only) Due to their non-flammability, A1 class non-flammability, non-explosivity, and non-toxicity, non-explosivity they have been used in open systems (consumed when used) like fire extinguishers, inhalers, computer rooms fire extinguishing and insulation, etc.) since 1928.

History

[edit]



The observed stabilization of HCFC concentrations (left graphs) and the growth of HFCs (right graphs) in earth's atmosphere.

The first air conditioners and refrigerators employed toxic or flammable gases, such as ammonia, sulfur dioxide, methyl chloride, or propane, that could result in fatal accidents when they leaked.^[4]

In 1928 Thomas Midgley Jr. created the first non-flammable, non-toxic chlorofluorocarbon gas, *Freon* (R-12). The name is a trademark name owned by DuPont (now Chemours) for any chlorofluorocarbon (CFC), hydrochlorofluorocarbon (HCFC), or hydrofluorocarbon (HFC) refrigerant. Following the discovery of better synthesis methods, CFCs such as R-11,^[5] R-12,^[6] R-123^[5] and R-502^[7] dominated the market.

Phasing out of CFCs

[edit]

See also: Montreal Protocol

In the mid-1970s, scientists discovered that CFCs were causing major damage to the ozone layer that protects the earth from ultraviolet radiation, and to the ozone holes over polar regions.^{[8][9]} This led to the signing of the Montreal Protocol in 1987 which aimed to phase out CFCs and HCFC^[10] but did not address the contributions that HFCs made to climate change. The adoption of HCFCs such as R-22,^{[11][12][13]} and R-123^[5] was accelerated and so were used in most U.S. homes in air conditioners and in chillers^[14] from the 1980s as they have a dramatically lower Ozone Depletion Potential (ODP) than CFCs, but their ODP was still not zero which led to their eventual phase-out.

Hydrofluorocarbons (HFCs) such as R-134a,^{[15][16]} R-407A,^[17] R-407C,^[18] R-404A,^[7] R-410A^[19] (a 50/50 blend of R-125/R-32) and R-507^{[20][21]} were promoted as replacements for CFCs and HCFCs in the 1990s and 2000s. HFCs were not ozone-depleting but did have global warming potentials (GWPs) thousands of times greater than CO₂ with atmospheric lifetimes that can extend for decades. This in turn, starting from the 2010s, led to the adoption in new equipment of Hydrocarbon and HFO (hydrofluoroolefin) refrigerants R-32,^[22] R-290,^[23] R-600a,^[23] R-454B,^[24] R-1234yf,^{[25][26]} R-514A,^[27] R-744 (CO₂),^[28] R-1234ze(E)^[29] and R-1233zd(E),^[30] which have both an ODP of zero and a lower GWP. Hydrocarbons and CO₂ are sometimes called natural refrigerants because they can be found in nature.

The environmental organization Greenpeace provided funding to a former East German refrigerator company to research alternative ozone- and climate-safe refrigerants in 1992. The company developed a hydrocarbon mixture of propane and isobutane, or pure isobutane,^[31] called "Greenfreeze", but as a condition of the contract with Greenpeace could not patent the technology, which led to widespread adoption by other firms.^{[32][33][34]} Policy and political influence by corporate executives resisted change however,^{[35][36]} citing the flammability and explosive properties of the refrigerants,^[37] and DuPont together with other companies blocked them in the U.S. with the U.S. EPA.^{[38][39]}

Beginning on 14 November 1994, the U.S. Environmental Protection Agency restricted the sale, possession and use of refrigerants to only licensed technicians, per rules under sections 608 and 609 of the Clean Air Act.^[40] In 1995, Germany made CFC refrigerators illegal.^[41]

In 1996 Eurammon, a European non-profit initiative for natural refrigerants, was established and comprises European companies, institutions, and industry experts.^{[42][43][44]}

In 1997, FCs and HFCs were included in the Kyoto Protocol to the Framework Convention on Climate Change.

In 2000 in the UK, the Ozone Regulations^[45] came into force which banned the use of ozone-depleting HCFC refrigerants such as R22 in new systems. The Regulation banned the use of R22 as a "top-up" fluid for maintenance from 2010 for virgin fluid and from 2015 for recycled fluid.^[citation needed]

Addressing greenhouse gases

[edit]

With growing interest in natural refrigerants as alternatives to synthetic refrigerants such as CFCs, HCFCs and HFCs, in 2004, Greenpeace worked with multinational corporations like Coca-Cola and Unilever, and later Pepsico and others, to create a corporate coalition called Refrigerants Naturally!.^[41]^[46] Four years later, Ben & Jerry's of Unilever and General Electric began to take steps to support production and use in the U.S.^[47] It is estimated that almost 75 percent of the refrigeration and air conditioning sector has the potential to be converted to natural refrigerants.^[48]

In 2006, the EU adopted a Regulation on fluorinated greenhouse gases (FCs and HFCs) to encourage to transition to natural refrigerants (such as hydrocarbons). It was reported in 2010 that some refrigerants are being used as recreational drugs, leading to an extremely dangerous phenomenon known as inhalant abuse.^[49]

From 2011 the European Union started to phase out refrigerants with a global warming potential (GWP) of more than 150 in automotive air conditioning (GWP = 100-year warming potential of one kilogram of a gas relative to one kilogram of CO₂) such as the refrigerant HFC-134a (known as R-134a in North America) which has a GWP of 1526.^[50] In the same year the EPA decided in favour of the ozone- and climate-safe refrigerant for U.S. manufacture.^[32]^[51]^[52]

A 2018 study by the nonprofit organization "Drawdown" put proper refrigerant management and disposal at the very top of the list of climate impact solutions, with an impact equivalent to eliminating over 17 years of US carbon dioxide emissions.^[53]

In 2019 it was estimated that CFCs, HCFCs, and HFCs were responsible for about 10% of direct radiative forcing from all long-lived anthropogenic greenhouse gases.^[54]] and in the same year the UNEP published new voluntary guidelines,^[55] however many countries have not yet ratified the Kigali Amendment.

From early 2020 HFCs (including R-404A, R-134a and R-410A) are being superseded: Residential air-conditioning systems and heat pumps are increasingly

using R-32. This still has a GWP of more than 600. Progressive devices use refrigerants with almost no climate impact, namely R-290 (propane), R-600a (isobutane) or R-1234yf (less flammable, in cars). In commercial refrigeration also CO₂ (R-744) can be used.

Requirements and desirable properties

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A refrigerant needs to have: a boiling point that is somewhat below the target temperature (although boiling point can be adjusted by adjusting the pressure appropriately), a high heat of vaporization, a moderate density in liquid form, a relatively high density in gaseous form (which can also be adjusted by setting pressure appropriately), and a high critical temperature. Working pressures should ideally be containable by copper tubing, a commonly available material. Extremely high pressures should be avoided.^[citation needed]

The ideal refrigerant would be: non-corrosive, non-toxic, non-flammable, with no ozone depletion and global warming potential. It should preferably be natural with well-studied and low environmental impact. Newer refrigerants address the issue of the damage that CFCs caused to the ozone layer and the contribution that HCFCs make to climate change, but some do raise issues relating to toxicity and/or flammability.^[56]

Common refrigerants

[edit]

Refrigerants with very low climate impact

[edit]

With increasing regulations, refrigerants with a very low global warming potential are expected to play a dominant role in the 21st century,^[57] in particular, R-290 and R-1234yf. Starting from almost no market share in 2018,^[58] low GWPO devices are gaining market share in 2022.

Code	Chemical	Name	GWP		Status	Commentary
			20yr ^[59]	100yr ^[59]		

R-290	C_3H_8	Propane	3.3[60]	Increasing use	Low cost, widely available and efficient. They also have zero ozone depletion potential. Despite their flammability, they are increasingly used in domestic refrigerators and heat pumps. In 2010, about one-third of all household refrigerators and freezers manufactured globally used isobutane or an isobutane/propane blend, and this was expected to increase to 75% by 2020.[61]
R-600a	$HC(CH_3)_3$	Isobutane	3.3	Widely used	See R-290. Commonly used before the popularisation of CFCs, it is again being considered but does suffer from the disadvantage of toxicity, and it requires corrosion-resistant components, which restricts its domestic and small-scale use.
R-717	NH_3	Ammonia	0	0[62]	Widely used Anhydrous ammonia is widely used in industrial refrigeration applications and hockey rinks because of its high energy efficiency and low cost.

R-1234yf
 HFO-1234yf
 $C_3H_2F_4$
 2,3,3,3-Tetrafluoropropene
 <1

Less performance but also less flammable than R-290.^[57] GM announced that it would start using "hydro-fluoro olefin", HFO-1234yf, in all of its brands by 2013.^[63]

Was used as a refrigerant prior to the discovery of CFCs (this was also the case for propane)^[4] and now having a renaissance due to it being non-ozone depleting, non-toxic and non-flammable. It may become the working fluid of choice to replace current HFCs in cars, supermarkets, and heat pumps. Coca-Cola has fielded CO₂-based beverage coolers and the U.S. Army is considering CO₂ refrigeration.^{[64][65]} Due to the need to operate at pressures of up to 130 bars (1,900 psi; 13,000 kPa), CO₂ systems require highly resistant components, however these have already been developed for mass production in many sectors.

R-744 CO₂ Carbon dioxide 1 1 In use

Most used

[edit]

Code	Chemical	Name	Global warming potential 20yr ^[59]	GWP 100yr ^[59]	Status	Commentary
R-32 HFC-32	CH ₂ F ₂	Difluoromethane	2430	677	Widely used	Promoted as climate-friendly substitute for R-134a and R-410A, but still with high climate impact. Has excellent heat transfer and pressure drop performance, both in condensation and vaporisation. ^[66] It has an atmospheric lifetime of nearly 5 years. ^[67] Currently used in residential and commercial air-conditioners and heat pumps.
R-134a HFC-134a	CH ₂ FCF ₃	1,1,1,2-Tetrafluoroethane	3790	1550	Widely used	Most used in 2020 for hydronic heat pumps in Europe and the United States in spite of high GWP. ^[58] Commonly used in automotive air conditioners prior to phase out which began in 2012.
R-410A		50% R-32 / 50% R-125 (pentafluoroethane)	Between 2430 (R-32) and 6350 (R-125)	> 677	Widely Used	Most used in split heat pumps / AC by 2018. Almost 100% share in the USA. ^[58] Being phased out in the US starting in 2022. ^[68] ^[69]

Banned / Phased out

[edit]

Code	Chemical	Name	Global warming potential 20yr ^[59]	GWP 100yr ^[59]	Status	Commentary
R-11 CFC-11	CCl ₃ F	Trichlorofluoromethane	6900	4660	Banned	<p>Production was banned in developed countries by Montreal Protocol in 1996</p> <p>Also known as Freon, a widely used chlorofluorocarbon halomethane (CFC).</p>
R-12 CFC-12	CCl ₂ F ₂	Dichlorodifluoromethane	10800	10200	Banned	<p>Production was banned in developed countries by Montreal Protocol in 1996, and in developing countries (article 5 countries) in 2010.^[70]</p> <p>A widely used hydrochlorofluorocarbon (HCFC) and powerful greenhouse gas with a GWP equal to 1810.</p>
R-22 HCFC-22	CHClF ₂	Chlorodifluoromethane	5280	1760	Being phased out	<p>Worldwide production of R-22 in 2008 was about 800 Gg per year, up from about 450 Gg per year in 1998. R-438A (MO-99) is a R-22 replacement.^[71]</p>

R-123 HCFC-123	CHCl_2CF_3	2,2-Dichloro-1,1,1-trifluoroethane	292	79	US phase-out	Used in large tonnage centrifugal chiller applications. All U.S. production and import of virgin HCFCs will be phased out by 2030, with limited exceptions. ^[72] R-123 refrigerant was used to retrofit some chiller that used R-11 refrigerant Trichlorofluoromethane. The production of R-11 was banned in developed countries by Montreal Protocol in 1996. ^[73]
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Other

[edit]

Code	Chemical	Name	Global warming potential 20yr ^[59]	GWP 100yr ^[59]	Commentary
R-152a HFC-152a	CH_3CHF_2	1,1-Difluoroethane	506	138	As a compressed air duster
R-407C		Mixture of difluoromethane and pentafluoroethane and 1,1,1,2-tetrafluoroethane			A mixture of R-32, R-125, and R-134a
R-454B		Difluoromethane and 2,3,3,3-Tetrafluoropropene			HFOs blend of refrigerants Difluoromethane (R-32) and 2,3,3,3-Tetrafluoropropene (R-1234yf). ^[74] ^[75] ^[76] ^[77]

R-513A	An HFO/HFC blend (56% R-1234yf/44%R-134a)	May replace R-134a as an interim alternative ^[78]
R-514A	HFO-1336mzz-Z/trans-1,2-dichloroethylene (t-DCE)	An hydrofluoroolefin (HFO)-based refrigerant to replace R-123 in low pressure centrifugal chillers for commercial and industrial applications. ^{[79][80]}

Refrigerant reclamation and disposal

[edit]

Main article: Refrigerant reclamation

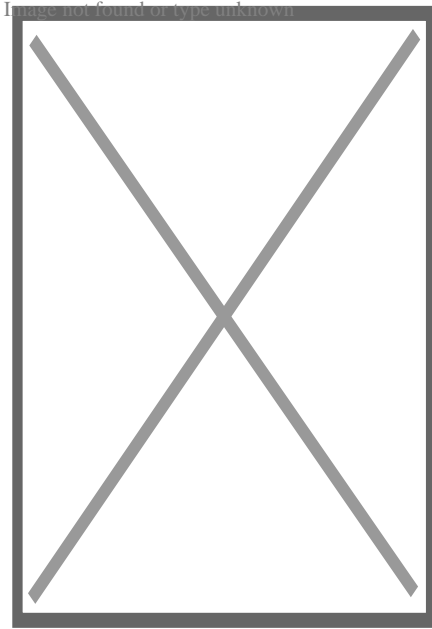
Coolant and refrigerants are found throughout the industrialized world, in homes, offices, and factories, in devices such as refrigerators, air conditioners, central air conditioning systems (HVAC), freezers, and dehumidifiers. When these units are serviced, there is a risk that refrigerant gas will be vented into the atmosphere either accidentally or intentionally, hence the creation of technician training and certification programs in order to ensure that the material is conserved and managed safely. Mistreatment of these gases has been shown to deplete the ozone layer and is suspected to contribute to global warming.^[81]

With the exception of isobutane and propane (R600a, R441A and R290), ammonia and CO₂ under Section 608 of the United States' Clean Air Act it is illegal to knowingly release any refrigerants into the atmosphere.^{[82][83]}

Refrigerant reclamation is the act of processing used refrigerant gas which has previously been used in some type of refrigeration loop such that it meets specifications for new refrigerant gas. In the United States, the Clean Air Act of 1990 requires that used refrigerant be processed by a certified reclaimer, which must be licensed by the United States Environmental Protection Agency (EPA), and the material must be recovered and delivered to the reclaimer by EPA-certified technicians.^[84]

Classification of refrigerants

[edit]



R407C pressure-enthalpy diagram, isotherms between the two saturation lines

Main article: List of refrigerants

Refrigerants may be divided into three classes according to their manner of absorption or extraction of heat from the substances to be refrigerated:^{*[citation needed]*}

- Class 1: This class includes refrigerants that cool by phase change (typically boiling), using the refrigerant's latent heat.
- Class 2: These refrigerants cool by temperature change or 'sensible heat', the quantity of heat being the specific heat capacity x the temperature change. They are air, calcium chloride brine, sodium chloride brine, alcohol, and similar nonfreezing solutions. The purpose of Class 2 refrigerants is to receive a reduction of temperature from Class 1 refrigerants and convey this lower temperature to the area to be cooled.
- Class 3: This group consists of solutions that contain absorbed vapors of liquefiable agents or refrigerating media. These solutions function by nature of their ability to carry liquefiable vapors, which produce a cooling effect by the absorption of their heat of solution. They can also be classified into many categories.

R numbering system

[edit]

The R- numbering system was developed by DuPont (which owned the Freon trademark), and systematically identifies the molecular structure of refrigerants made

with a single halogenated hydrocarbon. ASHRAE has since set guidelines for the numbering system as follows:[⁸⁵]

R-X₁X₂X₃X₄

- X₁ = Number of unsaturated carbon-carbon bonds (omit if zero)
- X₂ = Number of carbon atoms minus 1 (omit if zero)
- X₃ = Number of hydrogen atoms plus 1
- X₄ = Number of fluorine atoms

Series

[edit]

- **R-xx** Methane Series
- **R-1xx** Ethane Series
- **R-2xx** Propane Series
- **R-4xx** Zeotropic blend
- **R-5xx** Azeotropic blend
- **R-6xx** Saturated hydrocarbons (except for propane which is R-290)
- **R-7xx** Inorganic Compounds with a molar mass < 100
- **R-7xxx** Inorganic Compounds with a molar mass ? 100

Ethane Derived Chains

[edit]

- **Number Only** Most symmetrical isomer
- **Lower Case Suffix (a, b, c, etc.)** indicates increasingly unsymmetrical isomers

Propane Derived Chains

[edit]

- **Number Only** If only one isomer exists; otherwise:
- **First lower case suffix (a-f):**
 - **a Suffix** Cl₂ central carbon substitution
 - **b Suffix** Cl, F central carbon substitution
 - **c Suffix** F₂ central carbon substitution
 - **d Suffix** Cl, H central carbon substitution
 - **e Suffix** F, H central carbon substitution
 - **f Suffix** H₂ central carbon substitution
- **2nd Lower Case Suffix (a, b, c, etc.)** Indicates increasingly unsymmetrical isomers

Propene derivatives

[edit]

- **First lower case suffix (x, y, z):**
 - **x Suffix** Cl substitution on central atom
 - **y Suffix** F substitution on central atom
 - **z Suffix** H substitution on central atom
- **Second lower case suffix (a-f):**
 - **a Suffix** =CCl₂ methylene substitution
 - **b Suffix** =CClF methylene substitution
 - **c Suffix** =CF₂ methylene substitution
 - **d Suffix** =CHCl methylene substitution
 - **e Suffix** =CHF methylene substitution
 - **f Suffix** =CH₂ methylene substitution

Blends

[edit]

- **Upper Case Suffix (A, B, C, etc.)** Same blend with different compositions of refrigerants

Miscellaneous

[edit]

- **R-Cxxx** Cyclic compound
- **R-Exxx** Ether group is present
- **R-CExxx** Cyclic compound with an ether group
- **R-4xx/5xx + Upper Case Suffix (A, B, C, etc.)** Same blend with different composition of refrigerants
- **R-6xx + Lower Case Letter** Indicates increasingly unsymmetrical isomers
- **7xx/7xxx + Upper Case Letter** Same molar mass, different compound
- **R-xxxxB#** Bromine is present with the number after B indicating how many bromine atoms
- **R-xxxxI#** Iodine is present with the number after I indicating how many iodine atoms
- **R-xxx(E)** Trans Molecule
- **R-xxx(Z)** Cis Molecule

For example, R-134a has 2 carbon atoms, 2 hydrogen atoms, and 4 fluorine atoms, an empirical formula of tetrafluoroethane. The "a" suffix indicates that the isomer is unbalanced by one atom, giving 1,1,1,2-Tetrafluoroethane. R-134 (without the "a"

suffix) would have a molecular structure of 1,1,2,2-Tetrafluoroethane.

The same numbers are used with an R- prefix for generic refrigerants, with a "Propellant" prefix (e.g., "Propellant 12") for the same chemical used as a propellant for an aerosol spray, and with trade names for the compounds, such as "**Freon** 12". Recently, a practice of using abbreviations HFC- for hydrofluorocarbons, CFC- for chlorofluorocarbons, and HCFC- for hydrochlorofluorocarbons has arisen, because of the regulatory differences among these groups.^[*citation needed*]

Refrigerant safety

[edit]

ASHRAE Standard 34, *Designation and Safety Classification of Refrigerants*, assigns safety classifications to refrigerants based upon toxicity and flammability.

Using safety information provided by producers, ASHRAE assigns a capital letter to indicate toxicity and a number to indicate flammability. The letter "A" is the least toxic and the number 1 is the least flammable.^[⁸⁶]

See also

[edit]

- Brine (Refrigerant)
- Section 608
- List of Refrigerants

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External links

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- Green Cooling Initiative on alternative natural refrigerants cooling technologies

- International Institute of Refrigeration Archived 2018-09-25 at the Wayback Machine

- v
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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

- 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

**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
- 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

**Professions,
trades,
and services**

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
- Building science
- Fireproofing
- Glossary of HVAC terms
- Warm Spaces
- World Refrigeration Day
- Template:Home automation
- Template:Solar energy

Health and safety

See also

Authority control databases: National                      

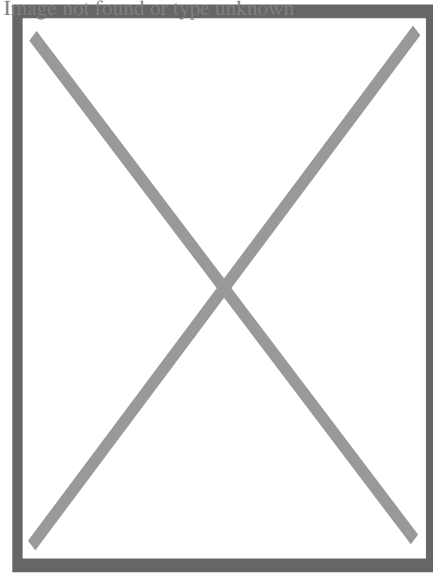
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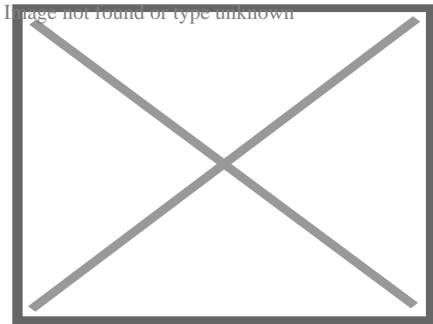
About Heat pump

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

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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
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- Wave
- Wind
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 - Farm
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 - Forecasting
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 - 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
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 - Walking
 - Watercraft
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 - 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.

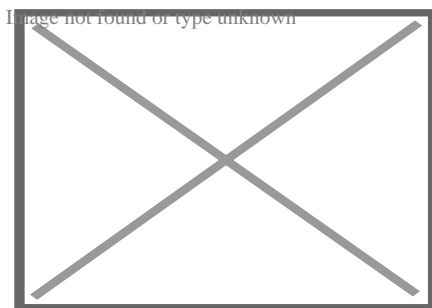
Air source heat pumps are the most common models, while other types include ground source heat pumps, water source heat pumps and exhaust air heat pumps.^[3] Large-scale heat pumps are also used in district heating systems.^[4]

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.

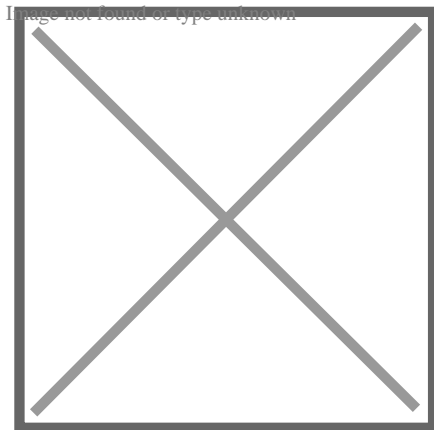
Types

[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]

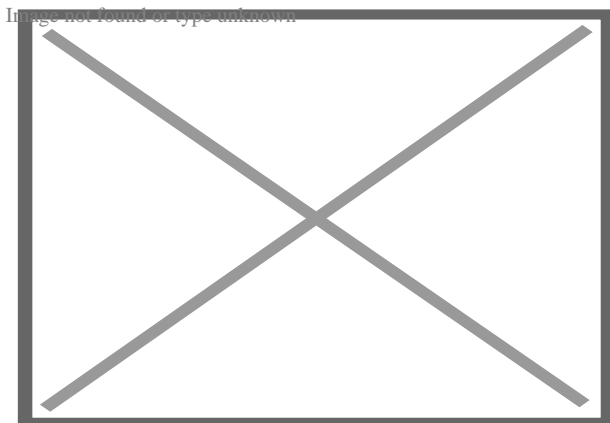
Air-source heat pumps are relatively easy and inexpensive to install, so are the most widely used type. In mild weather, coefficient of performance (COP) may be between 2 and 5, while at temperatures below around 8 °C (18 °F) an air-source heat pump may still achieve a COP of 1 to 4.^[25]

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

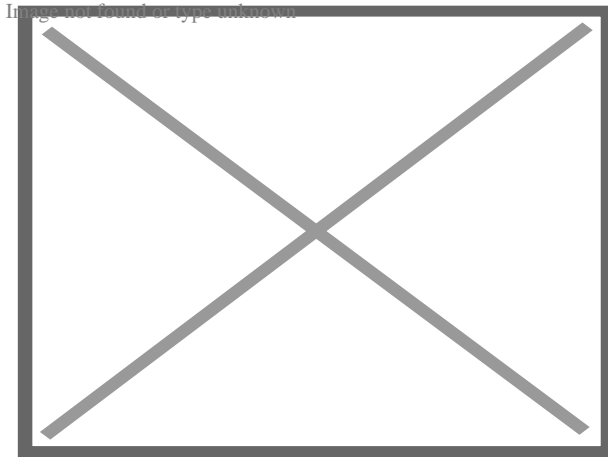
Exhaust air heat pumps extract heat from the exhaust air of a building and require mechanical ventilation. Two classes exist:

- 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]



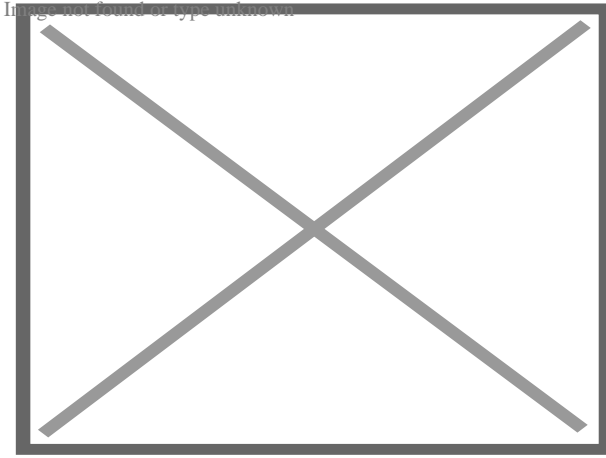
Hybrid photovoltaic-thermal solar panels of a SAHP in an experimental installation at Department of Energy at Polytechnic of Milan

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]

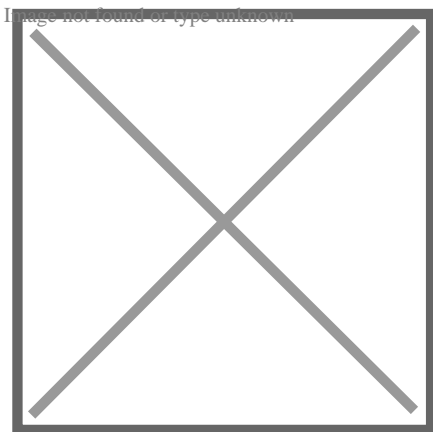
In HVAC applications, a heat pump is typically a vapor-compression refrigeration device that includes a reversing valve and optimized heat exchangers so that the direction of *heat flow* (thermal energy movement) may be reversed. The reversing valve switches the direction of refrigerant through the cycle 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		
35 °C		
Pump type and source	Typical use	(e.g. heated screed floor)

High-efficiency air-source heat pump (ASHP), air at 20 °C [56]		2.2	
Two-stage ASHP, air at 20 °C [57]	Low source temperature	2.4	
High-efficiency ASHP, air at 0 °C [56]	Low output temperature	3.8	
Prototype transcritical CO ₂ (R744) heat pump with tripartite gas cooler, source at 0 °C [58]	High output temperature	3.3	
Ground-source heat pump (GSHP), water at 0 °C [56]		5.0	
GSHP, ground at 10 °C [56]	Low output temperature	7.2	
Theoretical Carnot cycle limit, source 20 °C		5.6	

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

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)*

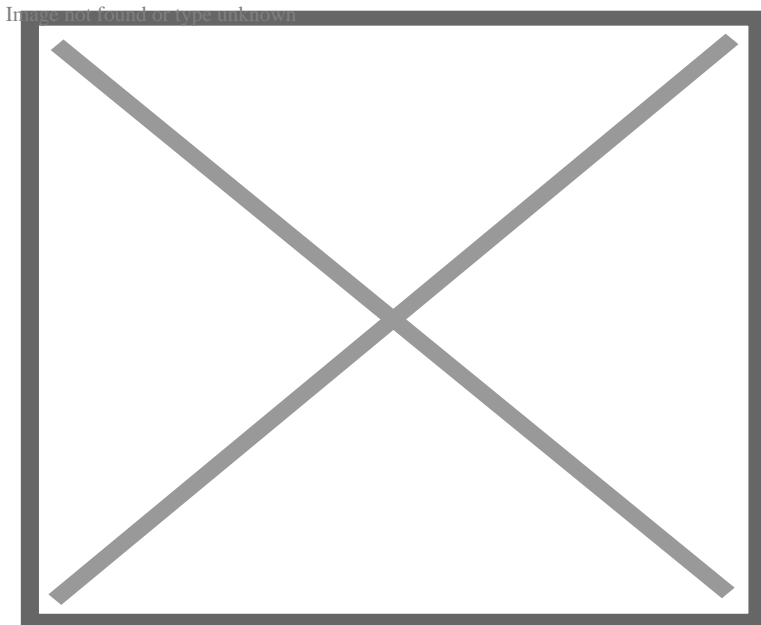
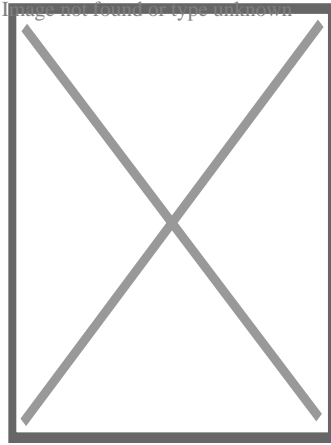
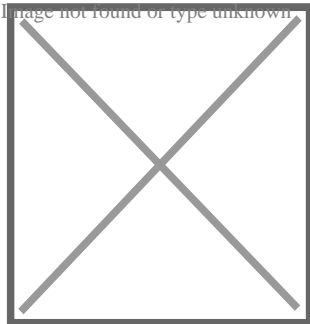


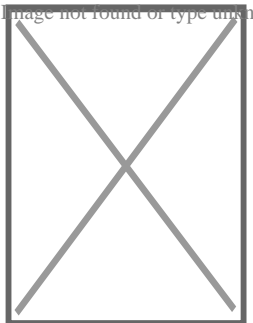
Figure 2: Temperature–entropy diagram of the vapor-compression cycle



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



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 CO

2 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

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- [^] 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]
- [^] 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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Other

[edit]

- Quaschnig, Volker. "Specific Carbon Dioxide Emissions of Various Fuels". Retrieved 22 February 2022.

External links

[edit]

-  Media related to Heat pumps at Wikimedia Commons

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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

- 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

**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
- 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

**Professions,
trades,
and services**

Industry organizations

- AHRI
- AMCA
- ASHRAE
- ASTM International
- BRE
- BSRIA
- CIBSE
- Institute of Refrigeration
- IIR
- LEED
- SMACNA
- UMC
- Indoor air quality (IAQ)

Health and safety

- Passive smoking
- Sick building syndrome (SBS)
- Volatile organic compound (VOC)
- ASHRAE Handbook
- Building science
- Fireproofing

See also

- Glossary of HVAC terms
- Warm Spaces
- World Refrigeration Day
- Template:Home automation
- Template:Solar energy

Authority control databases: National

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- France
- Japan
- Czech Republic
- Israel

About Durham Supply Inc

Photo

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Photo

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Photo

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Photo

Image not found or type unknown

Things To Do in Tulsa County

Photo

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Golden Driller Statue

4.6 (1935)

Photo

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Tulsa Zoo

4.5 (10481)

Photo

Tulsa Air and Space Museum & Planetarium

4.3 (419)

Photo

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Tours of Tulsa

4.9 (291)

Photo

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Center of the Universe

4.4 (4471)

Photo

Route 66 Historical Village

4.4 (718)

Driving Directions in Tulsa County

Driving Directions From Catoosa to Durham Supply Inc

Driving Directions From Brookhaven Hospitales to Durham Supply Inc

Driving Directions From Harmon Security Group LLC. to Durham Supply Inc

Driving Directions From Country Inn & Suites by Radisson, Tulsa, OK to Durham Supply Inc

Driving Directions From ALDI to Durham Supply Inc

[Furnace store](#)

[Heating contractor](#)

[HVAC contractor](#)

Driving Directions From Streetwalker Tours to Durham Supply Inc

Driving Directions From Tulsa Zoo to Durham Supply Inc

Driving Directions From The Tulsa Arts District to Durham Supply Inc

Driving Directions From The Blue Dome to Durham Supply Inc

Driving Directions From Gathering Place to Durham Supply Inc

Driving Directions From Philbrook Museum of Art to Durham Supply Inc

Mobile home supply store

Air conditioning repair service

Air conditioning store

Air conditioning system supplier

Reviews for Durham Supply Inc

Durham Supply Inc

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B Mann

(5)

I was in need of some items for a double wide that I am remodeling and this place is the only place in town that had what I needed (I didn't even try the other rude place)while I was there I learned the other place that was in Tulsa that also sold mobile home supplies went out of business (no wonder the last time I was in there they were VERY RUDE and high priced) I like the way Dunham does business they answered all my questions and got me the supplies I needed, very friendly, I will be back to purchase the rest of my items when the time comes.

Durham Supply Inc

Image not found or type unknown

Ty Spears

(5)

Bought a door/storm door combo. Turns out it was the wrong size. They swapped it out, quick and easy no problems. Very helpful in explaining the size differences from standard door sizes.

Durham Supply Inc

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Dennis Champion

(5)

Durham supply and Royal supply seems to find the most helpful and friendly people to work in their stores, we are based out of Kansas City out here for a few remodels and these guys treated us like we've gone there for years.

Durham Supply Inc

Image not found or type unknown

Ethel Schiller

(5)

This place is really neat, if they don't have it they can order it from another of their stores and have it there overnight in most cases. Even hard to find items for a trailer! I definitely recommend this place to everyone! O and the prices is awesome too!

Durham Supply Inc

Image not found or type unknown

Gerald Clifford Brewster

(5)

We will see, the storm door I bought says on the tag it's 36x80, but it's 34x80. If they return it.....they had no problems returning it. And it was no fault of there's, you measure a mobile home door different than a standard door!

Scheduling Payments for Large Scale Mobile Home HVAC Replacements [View GBP](#)

Frequently Asked Questions

What factors should be considered when scheduling payments for large-scale mobile home HVAC replacements?

Key factors include the total cost of the project, available budget, financing options, contractor payment terms, and potential savings from energy efficiency improvements.

How can one determine the best payment schedule for an HVAC replacement project?

Evaluate cash flow projections, consider any upfront discounts offered by contractors or manufacturers, assess financing plans with low interest rates, and align payments with expected income or funding availability.

Are there specific financing options available for mobile home HVAC system replacements?

Yes, options may include personal loans, credit cards with promotional rates, manufacturer/contractor financing programs, government energy efficiency incentives or rebates, and specialized home improvement loans.

What are typical payment terms that contractors might offer for such projects?

Contractors often require a deposit upfront (usually 10-30% of the total cost), followed by progress payments at key milestones (e.g., completion of installation phases) and a final payment upon satisfactory project completion.

How can energy savings impact the scheduling of payments for new HVAC systems in mobile homes?

Energy savings from more efficient HVAC systems can offset monthly expenses. These savings may be used to service loan repayments or reinvested into additional home improvements. Estimating these savings helps optimize the payment schedule.

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Company Website : <https://royal-durhamsupply.com/locations/oklahoma-city-oklahoma/>

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