

Air Quality



- **Mapping Duct Layouts for Cleaner Airflow in Mobile Homes**
Mapping Duct Layouts for Cleaner Airflow in Mobile Homes **Inspecting Vent Connections for Improved Air Quality** **Minimizing Drafts Through Sealed Mobile Home Duct Systems** **Scheduling Regular Cleanings for Mobile Home Ventilation** **Evaluating Filter Efficiency for Enhanced Mobile Home Air Quality** **Addressing Mold Risks in Mobile Home Ductwork** **Installing Air Purification Systems in Mobile Homes** **Checking Air Pressure to Reduce Allergens in Mobile Home Interiors** **Identifying Common Leaks in Flexible Mobile Home Ducts** **Balancing Humidity Levels for Healthier Mobile Home Air** **Considering UV Technology for Mobile Home Air Treatment** **Using Diagnostic Tools to Assess Air Quality in Mobile Homes**
- **Preparing Mobile Home HVAC Units for Intense Summer Heat**
Preparing Mobile Home HVAC Units for Intense Summer Heat **Protecting Mobile Home Furnaces During Low Temperature Periods** **Coping with Storm Related Damage to Mobile Home Air Conditioners** **Adjusting Climate Control in Mobile Homes for Coastal Humidity** **Handling Power Outages in Mobile Home Heating Systems** **Planning Winterization Steps for Mobile Home HVAC Equipment** **Adapting Mobile Homes to Rapid Seasonal Swings in Temperature** **Evaluating Wind Exposure Factors for Mobile Home AC Placement** **Addressing Extended Rainy Periods in Mobile Home Ventilation** **Considering Local Building Codes for Mobile Home Climate Adaptations** **Balancing Heat Needs in Mobile Homes Across Different Regions** **Checking Insurance Coverage for Storm Damaged Mobile Home AC Units**
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Coping with Storm Related Damage to Mobile Home Air Conditioners

Importance of Efficient Duct Layouts for Airflow

Mobile homes offer an affordable and flexible housing option, but they can be particularly vulnerable to storm-related damage due to their construction and location. One critical component of a mobile home that often suffers during severe weather is the air conditioning system. Proper vent placement ensures even distribution of heated or cooled air **best hvac system for mobile home** HVAC. Understanding common types of storm-related damage to mobile home air conditioners is essential for effective preparation, timely response, and efficient recovery.

Firstly, one of the most frequent issues faced during storms is physical damage caused by high winds. Mobile homes are generally more exposed to the elements compared to traditional houses, which makes their air conditioning units susceptible to debris impact.

Flying branches, loose shingles, or other materials can strike the external unit with significant force, damaging the condenser coils or fan blades. Such impacts not only impair functionality but can also lead to further mechanical problems if not addressed promptly.

Flooding poses another significant risk, especially in low-lying areas where mobile homes are often situated. Air conditioning units are typically installed close to ground

level, making them vulnerable when water levels rise. Floodwaters can infiltrate electrical components and wiring within the unit, leading to short circuits or complete system failure. Additionally, prolonged exposure to moisture can cause rust and corrosion over time, compromising the durability of these systems.

Power surges during storms represent another potential threat to air conditioners in mobile homes. Lightning strikes or sudden changes in electrical supply can lead to voltage spikes that overwhelm delicate electronics within the AC unit. These power surges may burn out vital components like capacitors or compressors, rendering the cooling system useless until repairs are made.

In light of these vulnerabilities, it is crucial for mobile home owners to take proactive measures both before and after a storm hits. Regular maintenance checks should include securing loose objects around the property that could become projectiles in high winds and ensuring proper drainage around the AC unit's base. Installing surge protectors can safeguard against electrical spikes that might otherwise damage sensitive components.

After a storm passes, prompt inspection of the air conditioning system can help identify any issues early on before they escalate into costly repairs or replacements. Checking for visible signs of damage such as bent fins or unusual noises is a good start; however, involving a professional technician ensures a thorough assessment and safe handling of any necessary repairs.

Coping with storm-related damage requires vigilance and preparedness from mobile home owners who rely on their air conditioners for comfort during hot weather months. By understanding common risks associated with severe weather events—and taking appropriate preventive actions—residents can enhance their resilience against nature's unpredictability while minimizing potential disruptions caused by damaged cooling systems.

When a storm passes, leaving behind a trail of debris and destruction, mobile home residents often find themselves facing the daunting task of assessing damage. One critical component that requires immediate attention is the air conditioning unit. Given its vital role in providing comfort and livability, understanding how to evaluate storm-related damage to mobile home air conditioners can help homeowners make informed decisions about repairs or replacements.

Firstly, it's important to visually inspect the exterior components of the air conditioner. Strong winds and flying debris can cause significant physical damage to the outdoor unit. Look for any visible dents or dislodged panels on the casing. The fan blades should be intact and free from obstructions like leaves or branches that might have been blown into them during the storm.

Next, consider the electrical connections. Power surges are common during storms and may lead to electrical malfunctions in your air conditioning system. Ensure that all wires are securely connected and look for any signs of burning or fraying which could indicate a more serious issue requiring professional intervention.

Additionally, check for water damage. Mobile homes are particularly vulnerable to flooding, which can wreak havoc on an air conditioner's internal components. Inspect the area around your AC unit for standing water or signs of water intrusion into electrical parts, as moisture can significantly impact performance and safety.

The refrigerant lines should also be examined closely. These lines can become punctured by sharp debris, leading to leaks that diminish cooling efficiency and can harm both your health and the environment if left unchecked.

Indoors, monitor how well your system is functioning post-storm. If you notice unusual noises when it runs or if it fails to cool effectively, this could indicate internal damage that wasn't immediately visible during your initial inspection.

Finally, while DIY assessments are beneficial for identifying obvious issues, it's crucial not to overlook professional evaluations. A qualified HVAC technician has the expertise needed to thoroughly assess less apparent damages such as those affecting internal components like compressors or coils.

In conclusion, coping with storm-related damage involves a comprehensive approach—starting with careful personal inspections followed by professional assessments when necessary—to ensure your mobile home's air conditioner is safe and operational post-storm. By being proactive in assessing potential damages early on, you not only safeguard against further deterioration but also enhance peace of mind knowing you've taken steps toward restoring comfort efficiently and effectively in your living space after nature's fury has passed.

Posted by on

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Techniques for Mapping Duct Layouts

When a storm rages through your area, leaving behind a trail of destruction, the aftermath can be overwhelming, especially for mobile home owners. The damage to property is often significant, and among the most vulnerable components are air conditioners. These systems are crucial for maintaining comfort in your living space, and when they are compromised by storm-related incidents, timely action is necessary to prevent further deterioration. Here are some immediate steps you can take to minimize additional damage to your mobile home's air conditioning unit.

First and foremost, ensure safety before approaching any damaged equipment. After a storm, there may be downed power lines or water accumulation around your mobile home. It is imperative to turn off the electricity supply to the air conditioner at the circuit breaker to prevent electrical hazards. This step not only protects you from potential injury but also safeguards the system from electrical surges that might occur during power restoration efforts.

Once safety is assured, conduct a preliminary assessment of visible damages. Check for debris such as branches or leaves that may have accumulated around or on top of the unit. Carefully remove these obstructions without causing further harm to any delicate components within the system. This simple task can prevent blockage and ensure adequate airflow once repairs commence.

Next, inspect the exterior of the air conditioning unit for dents or other physical damages caused by flying debris during high winds. Look specifically at areas like condenser coils and fan blades which are susceptible to bending or breaking under impact. If you notice any severe damage beyond superficial dents, it may require professional attention; however, light cleaning with a soft brush could help remove dirt and grime that might impede function.

Pay attention to water infiltration as well since storms often bring heavy rain that can cause flooding around your mobile home. If water has infiltrated your AC unit or its surrounding area, drying out these parts promptly is essential to avoid long-term issues like rusting or mold growth which could impair operation efficiency.

Additionally, consider covering your air conditioning unit with a tarp if another storm is imminent. This protective layer can shield it from further exposure while you arrange for professional inspection and repair services post-storm.

Finally, contact an HVAC technician as soon as possible for a comprehensive evaluation of both external and internal components of the system. While initial assessments made by homeowners can identify obvious problems, licensed professionals possess the tools and expertise needed for thorough diagnostics and repairs.

In conclusion, dealing with storm-related damage requires swift yet cautious actions aimed at preserving what remains functional until professional help arrives. By taking these immediate steps—securing electrical safety measures first followed by assessing physical conditions—you stand a better chance of minimizing additional harm while ensuring quicker restoration of comfort within your mobile home environment.



Tools and Technologies for Accurate Duct Mapping

When a storm barrels through and leaves a trail of destruction in its wake, those living in mobile homes face the daunting task of assessing damage to their property. Among the critical components that often bear the brunt of nature's fury is the air conditioning unit. As temperatures soar, especially during summer months, having a functional air conditioner becomes not just a matter of comfort but also one of safety. This brings us to an essential decision: Should you repair your storm-damaged air conditioner or replace it entirely? Evaluating these options requires careful consideration of several factors.

First and foremost, assess the extent of the damage. Minor damages such as bent fins or clogged filters might be easily repairable at a relatively low cost. However, if the storm has inflicted substantial harm—such as flooding that compromises electrical components or structural damage to the unit—replacement might be inevitable. A professional inspection can provide a thorough evaluation and help determine whether your air conditioner is salvageable.

Cost is another crucial factor in this decision-making process. Repairing an air conditioner might initially seem more economical than replacement, but it's vital to consider long-term expenses. Older units that sustain significant damage may become less efficient over time, leading to higher energy bills and frequent repairs down the line. In contrast, investing in a new unit could offer better efficiency and modern features that save money over time.

Moreover, consider the age and performance history of your current AC unit before making a choice. If your system has been underperforming or causing frequent issues even before storm damage occurred, replacing it with a newer model may prove beneficial. Newer models often come with improved technologies designed for greater energy efficiency and environmental friendliness—factors worth considering when aiming for sustainable living conditions.

Insurance coverage plays an influential role too in deciding between repair and replacement. Review your homeowner's insurance policy carefully; many policies cover storm-related damages to appliances like air conditioners. If replacement costs are covered substantially by insurance, opting for a new unit could be financially advantageous.

Lastly, think about future resilience against similar events when deciding between repairing or replacing your AC after storm-related damage. Modern systems are often built with enhanced durability designed specifically to withstand severe weather conditions better than older models can—a feature particularly beneficial for mobile home residents frequently exposed to storms.

In conclusion, navigating post-storm recovery involves weighing multiple factors when choosing between repairing versus replacing damaged mobile home air conditioners—each carrying its own set of implications on finances and comfort levels moving forward into potentially hotter days ahead without adequate cooling solutions at hand readily available otherwise altogether altogether altogether altogether altogether altogether altogether nonetheless indeed however therefore thus henceforth thenceforth wherefore thusly thereby wherein whereby wherebywhereinwherebythereforethenceforthhenceforthtogethertheretoheretowithalwithalwith

Best Practices for Cleaner Airflow

When it comes to coping with storm-related damage to mobile home air conditioners, preparation is key. Mobile homes are particularly vulnerable during severe weather events due to their lightweight construction and often exposed locations. Protecting the air conditioning unit, a vital component for comfort during sweltering summers, should be a priority as storms approach. By taking proactive measures, homeowners can mitigate potential damage and ensure the longevity of their cooling systems.

The first step in safeguarding your mobile home's air conditioner is conducting regular maintenance checks. Before the storm season begins, inspect your unit for any existing issues that might be exacerbated by high winds or heavy rain. Ensure that all connections are secure and free from corrosion, and clean or replace filters to keep the system running efficiently. A well-maintained unit is more likely to withstand the rigors of a storm without sustaining significant damage.

Installing a protective cover over your air conditioning unit can provide an additional layer of defense against flying debris and torrential downpours. These covers are typically made from durable materials designed to shield the unit while allowing it to breathe. When choosing a cover, make sure it fits snugly around the unit without obstructing airflow when the system is in use. A properly fitted cover can prevent physical damage and reduce the likelihood of water intrusion.

Another effective strategy is securing the air conditioning unit itself. Mobile homes often have outdoor units mounted on platforms or stands that might not be sturdy enough in extreme weather conditions. Reinforcing these stands with additional support or anchoring them securely to the ground can help prevent tipping or displacement caused by strong winds. Additionally, consider using hurricane straps or other tie-down methods specifically designed for HVAC units in order to keep them firmly in place.

For those living in areas prone to frequent storms, investing in professional installation of barrier systems like windbreaks or fences around your air conditioning unit may also prove beneficial. These structures can deflect wind and debris away from your equipment, significantly reducing its exposure during severe weather events.

Lastly, it's wise to have an emergency plan ready should a storm cause power outages or render your air conditioner unusable temporarily. Having alternative cooling methods such as battery-operated fans, portable generators, or even designated cool zones within your home can help maintain comfort until repairs are feasible.

In conclusion, while storms pose undeniable risks to mobile home air conditioners, implementing preventive measures can minimize potential damages and discomforts associated with such events. Regular maintenance checks, protective coverings, securing installations, professional barriers, and contingency plans form a comprehensive approach toward preserving this essential appliance through turbulent times. By fortifying our homes with these strategies today, we equip ourselves better for tomorrow's unforeseen challenges—ensuring that our sanctuaries remain cool havens even amidst nature's fiercest tempests.



Case Studies of Improved Air Quality in Mobile Homes

Experiencing a storm can be a harrowing ordeal, especially when it impacts your living space and essential utilities. For mobile home owners, the aftermath of a storm often presents unique challenges, particularly when it comes to understanding insurance coverage and managing the claims process for damage to air conditioners. Coping with such storm-related damage requires a blend of knowledge, patience, and proactive steps to ensure that repairs are effectively managed and financially covered.

First and foremost, it is crucial for mobile home owners to comprehend their insurance policies in detail before any storm hits. Insurance coverage for storm damage can vary significantly depending on the provider and specific terms of the policy. Typically, standard mobile home insurance covers structural damage caused by windstorms or hail; however, coverage specifics for external attachments like air conditioners may differ. Owners should review their policies closely to understand what types of storm-related damages are included. If there are gaps in coverage concerning air conditioning units or other critical components, homeowners might consider purchasing additional riders or endorsements.

When a storm does occur and damages are identified, documenting the extent of the harm promptly is vital. Taking photographs or videos of the damaged air conditioner immediately after the incident can serve as crucial evidence during the claims process. It's essential not only to capture images but also to keep detailed records of all communications with insurers and repair professionals.

Filing an insurance claim should be done as soon as possible after assessing the damage. Contact your insurance provider directly to report the incident and provide them with all necessary documentation. Be prepared to answer any questions they might have regarding the specifics of the damage and how it occurred. Some insurers may require an adjuster to assess the damage personally before approving any claims; thus, maintaining open lines of communication will facilitate this process.

During discussions with your insurer, clarity on what is included in your coverage plan becomes invaluable. Understand whether your policy will cover replacement costs or just actual cash value which considers depreciation. This distinction will significantly affect out-of-pocket expenses when repairing or replacing your air conditioning unit.

While waiting for claim approval can be trying, using this time wisely is beneficial by researching reputable contractors who specialize in repairing HVAC systems damaged by storms. Opting for experienced professionals ensures that repairs meet safety standards and restore functionality effectively.

Finally, patience plays a significant role in coping with post-storm recovery efforts related to mobile home air conditioners. The entire process—from filing a claim through securing funds for repairs—can take time due to high volumes following major storms affecting multiple homes within an area simultaneously.

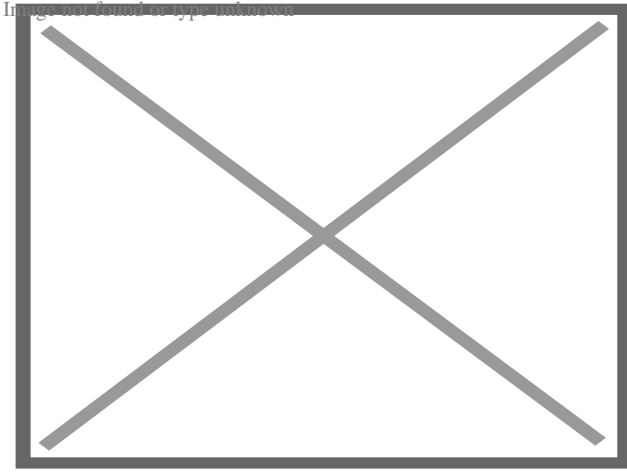
In conclusion, tackling storm-related damages demands preparedness through understanding one's insurance policy thoroughly beforehand while taking decisive action post-storm through documentation and timely communication with insurers. By mastering this challenging process step-by-step with diligence and care, mobile homeowners can navigate these tumultuous situations more smoothly while safeguarding their investments against nature's unpredictable forces.

About Manufactured housing



This article **needs additional citations for verification**. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.

Find sources: "Manufactured housing" – news · newspapers · books · scholar · JSTOR (May 2009) *(Learn how and when to remove this message)*



A modern "triple wide" home

Manufactured housing (commonly known as mobile homes in the United States) is a type of prefabricated housing that is largely assembled in factories and then transported to sites of use. The definition of the term in the United States is regulated by federal law (Code of Federal Regulations, 24 CFR 3280): "Manufactured homes are built as dwelling units of at least 320 square feet (30 m²) in size with a permanent chassis to assure the initial and continued transportability of the home."^[1] The requirement to have a wheeled chassis permanently attached differentiates "manufactured housing" from other types of prefabricated homes, such as modular homes.

United States

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Definition

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According to the Manufactured Housing Institute's National Communities Council (MHINCC), *manufactured homes*^[2]

are homes built entirely in the factory under a federal building code administered by the U.S. Department of Housing and Urban Development (HUD). The Federal Manufactured Home Construction and Safety Standards (commonly known as the HUD Code) went into effect June 15, 1976. Manufactured homes may be single- or multi-section and are transported to the site and installed.

The MHINCC distinguishes among several types of *factory-built housing*: manufactured homes, modular homes, panelized homes, pre-cut homes, and mobile homes.

From the same source, *mobile home* "is the term used for manufactured homes produced prior to June 15, 1976, when the HUD Code went into effect."^[2] Despite the formal definition, *mobile home* and *trailer* are still common terms in the United States for this type of housing.

History

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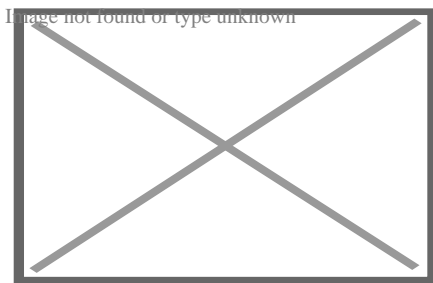
The original focus of this form of housing was its ability to relocate easily. Units were initially marketed primarily to people whose lifestyle required mobility. However, beginning in the 1950s, these homes began to be marketed primarily as an inexpensive form of housing designed to be set up and left in a location for long periods of time, or even permanently installed with a masonry foundation. Previously, units had been eight feet or less in width, but in 1956, the 10-foot (3.0 m) wide home was introduced. This helped solidify the line between mobile and house/travel trailers, since the smaller units could be moved simply with an automobile, but the larger, wider units required the services of a professional trucking company. In the 1960s and '70s, the homes became even longer and wider, making the mobility of the units more difficult. Today, when a factory-built home is moved to a location, it is usually kept there permanently. The mobility of the units has decreased considerably.

The factory-built homes of the past developed a negative stereotype because of their lower cost and the tendency for their value to depreciate more quickly than site-built homes. The tendency of these homes to rapidly depreciate in resale value made using them as collateral for loans far riskier than traditional home loans. Loan terms were usually limited to less than the 30-year term typical of the general home-loan market, and interest rates were considerably higher. In other words, these home loans resembled motor vehicle loans far more than traditional home mortgages. They have been consistently linked to lower-income families, which has led to prejudice and zoning restrictions, which include limitations on the number and density of homes permitted on any given site, minimum size requirements, limitations on exterior colors and finishes, and foundation mandates.

Many jurisdictions do not allow the placement of any additional factory-built homes, while others have strongly limited or forbidden all single-wide models, which tend to depreciate more rapidly than modern double-wide models. The derogatory concept of a "trailer park" is typically older single-wide homes occupying small, rented lots and remaining on wheels, even if the home stays in place for decades.

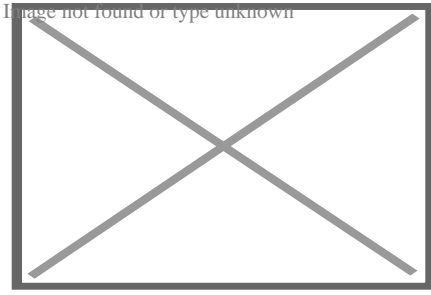
Modern manufactured homes

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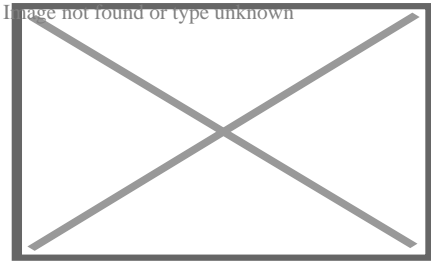


A manufactured house ready to be assembled in Grass Valley, California

Modern homes, especially modular homes, belie this image and can be identical in appearance to site-built homes. Newer homes, particularly double-wides, tend to be built to much higher standards than their predecessors. This has led to a reduction in the rate of value depreciation of many used units.



A manufactured house just before construction of its garage



Stick built garage being added to a new manufactured house

Although great strides have been made in terms of quality, manufactured homes do still struggle with construction problems. Author Wes Johnson has pointed out that the HUD code which governs manufactured homes desperately needs to be updated, quality control at manufacturing facilities are often lax, and set-up issues often compromise even a well-made manufactured home. Johnson states buyers need to be exceptionally cautious if they are entertaining the idea of purchasing any manufactured home by carefully checking it for defects before signing the contract and supervising the set-up process closely. These homes in the modern age are built to be beautiful and last longer than the typical old trailers.^[citation needed]

When FEMA studied the destruction wrought by Hurricane Andrew in Dade County Florida, they concluded that modular and masonry homes fared best compared to other construction.^[3]

High-performance manufactured housing

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While manufactured homes are considered to be affordable housing, older models can be some of the most expensive in the nation to heat due to energy inefficiency.^[4]] *High-performance manufactured housing* uses less energy and therefore increases life-cycle affordability by decreasing operating costs. High-performance housing is not only energy efficient, but also attractive, functional, water-efficient, resilient to wind, seismic forces, and moisture penetration, and has healthy indoor environmental quality. Achieving high-performance involves integrated, whole building design, involving many components, not one single technology. High-performance manufactured housing should also include energy efficient appliances, such as Energy Star qualified appliances.^[4] Energy Star requires ample insulation: 2x6 walls: R21, roof: R40, floor: R33.

Difference from modular homes

[edit]

Both types of homes – manufactured and modular – are commonly referred to as factory-built housing, but they are not identical. Modular homes are built to International Residential Code (IRC) code. Modular homes can be transported on flatbed trucks rather than being towed, and can lack axles and an automotive-type frame. However, some modular houses are towed behind a semi-truck or toter on a frame similar to that of a trailer. The house is usually in two pieces and is hauled by two separate trucks. Each frame has five or more axles, depending on the size of the house. Once the house has reached its location, the axles and the tongue of the frame are then removed, and the house is set on a concrete foundation by a large crane. Some modern modular homes, once fully assembled, are indistinguishable from site-built homes. In addition, modular homes:

- must conform to the same local, state and regional building codes as homes built on-site;
- are treated the same by banks as homes built on-site. They are easily refinanced, for example;
- must be structurally approved by inspectors;

- can be of any size, although the block sections from which they are assembled are uniformly sized;^[5]^[6]

Difference from IRC codes homes (site built)

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Manufactured homes have several standard requirements that are more stringent than International Residential Code homes.

Fire Protection

A National Fire Protection Association (NFPA) study from July 2011 shows that occurrence of fires is lower in manufactured housing and the injury rate is lower in manufactured housing. The justification behind the superior fire safety is due to the following higher standard requirements:

- The HUD standard requires a flame spread of 25 or less in water heater and furnace compartments.
- The HUD standard requires a flame spread of 50 or less on the wall behind the range.
- The HUD standard requires a flame spread of 75 or less on the ceilings.
- The HUD standard requires a flame spread of 25 or less to protect the bottoms and side of kitchen cabinets around the range.
- The HUD standard requires additional protection of cabinets above the range.
- The HUD standard requires trim larger than 6" to meet flame spread requirements.
- The HUD standard requires smoke detectors in the general living area.
- The HUD standard requires 2 exterior doors.
- The HUD standard requires bedroom doors to be within 35 feet of an exterior door.

Bay Area

[edit]

The San Francisco Bay Area, located in Northern California, is known for its high real estate prices, making manufactured housing an increasingly popular alternative to traditional real estate.^[7] It is mainly the value of the land that makes real estate in this area so expensive. As of May 2011, the median price of a home in Santa Clara was \$498,000,^[8] while the most expensive manufactured home with all the premium features was only \$249,000.^[9] This drastic price difference is due to the fact that manufactured homes are typically placed in communities where individuals do not own the land, but instead pay a monthly site fee. This enables a consumer, who could otherwise not afford to live in the Bay Area, the opportunity to own a new home in this location. There are various communities of manufactured homes in the Bay Area, the largest being Casa de Amigos, located in Sunnyvale, California.

Bulk material storage

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Bulk material storage

Construction starts with the frame

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Construction starts

with the frame

Interior wall assemblies are attached

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Interior wall assemblies
are attached
Exterior wall assemblies are set in place

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Exterior wall
assemblies are set in
place
Roof assembly is set atop the house

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Roof assembly is set
atop the house
Drywall completed

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Drywall completed
House is ready for delivery to site

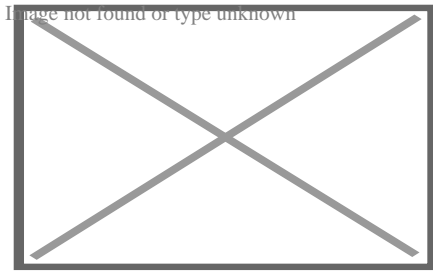
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House is ready for
delivery to site

Australia

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An Australian modern prefabricated house

In Australia these homes are commonly known as **transportable homes**, **relocatable homes** or **prefabricated homes** (not to be confused with the American meaning of the term). They are not as common as in the US, but the industry is expected to grow as this method of construction becomes more accepted.

Manufactured home parks refer to housing estates where the house owner rents the land instead of owning it. This is quite common in Queensland in both the form of tourist parks and over fifty estates. The term transportable homes tends to be used to refer to houses that are built on land that is owned by the house owner.^[*citation needed*]

Typically the homes are built in regional areas where the cost of organizing tradespeople and materials is higher than in the cities. In particular prefabricated homes have been popular in mining towns or other towns experiencing demand for new housing in excess of what can be handled by local builders. This method of construction is governed by state construction legislation and is subject to local council approval and homeowners' warranty or home warranty insurance.

Construction process

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A manufactured home is built entirely inside a huge, climate-controlled factory by a team of craftsmen. The first step in the process is the flooring, which is built in sections, each attached to a permanent chassis with its own wheels and secured for transport upon the home's completion. Depending on the size of the house and the floorplan's layout, there may be two, three or even four sections. The flooring sections have heating, electrical and plumbing connections pre-installed before they are finished with laminate, tile or hardwood. Next, the walls are constructed on a flat level

surface with insulation and interior Sheetrock before being lifted by crane into position and secured to the floor sections. The interior ceilings and roof struts are next, vapor sealed and secured to each section's wall frame before being shingled. Then, the exterior siding is added, along with the installation of doors and windows. Finally, interior finishing, such as sealing the drywall, is completed, along with fixture installation and finishing the electrical and plumbing connections. The exposed portions of each section, where they will eventually be joined together, are wrapped in plastic to protect them for transport.

With all the building site prep work completed, the building will be delivered by trucks towing the individual sections on their permanent chassis. The sections will be joined together securely, and all final plumbing and electrical connections are made before a decorative skirt or facade is applied to the bottom exterior of the house, hiding the chassis and finishing off the look of the home.

See also

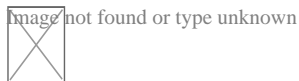
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- o Modular home
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- o Regulatory Barriers Clearinghouse
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- o Cardinal Industries, Inc.
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- o All American Homes
- o All Parks Alliance for Change

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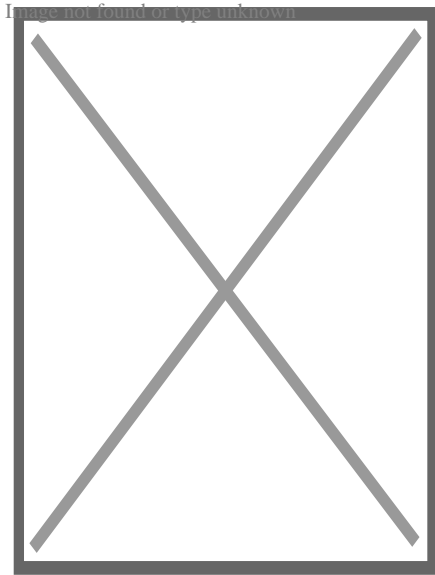
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4. ^ **a b** *Environmental and Energy Study Institute. "Issue Brief: High-Performance Manufactured Housing". eesi.org. Retrieved August 2, 2011.*
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6. ^ Kit Homes Guide
7. ^ *"2011 Coldwell Banker U.S. Home Listing Report". Coldwell Banker. Retrieved 6 July 2011.*
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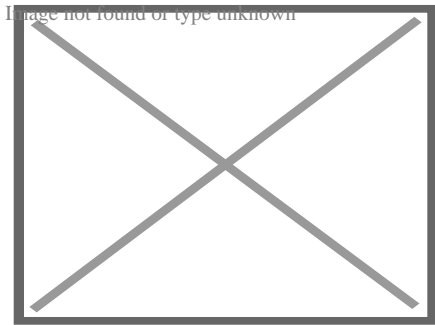
Wikimedia Commons has media related to ***Manufactured homes***.

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

Renewable energy

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

Sustainable transport

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

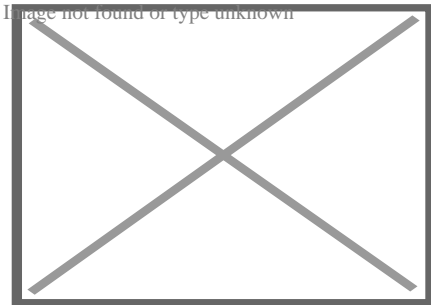
The efficiency of a heat pump is expressed as a coefficient of performance (COP), or seasonal coefficient of performance (SCOP). The higher the number, the more efficient a heat pump is. For example, an air-to-water heat pump that produces 6kW at a SCOP of 4.62 will give over 4kW of energy into a heating 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

$$W = \frac{Q}{\text{COP}}$$

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.
- W is the instantaneous work done by 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.

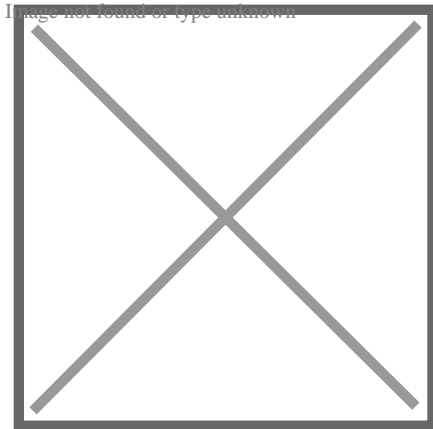
Types

[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]

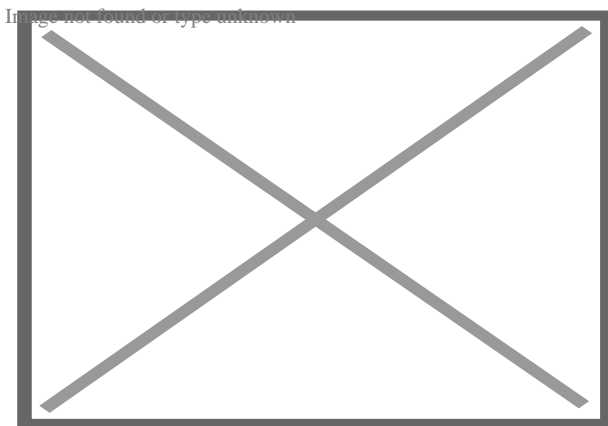
Air-source heat pumps are relatively easy and inexpensive to install, so are the most widely used type. In mild weather, coefficient of performance (COP) may be between 2 and 5, while at temperatures below around $-8\text{ }^{\circ}\text{C}$ ($18\text{ }^{\circ}\text{F}$) an air-source heat pump may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

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

Ground source

[edit]

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



A heat pump in combination with heat and cold storage

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

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

Heat recovery ventilation

[edit]

Main article: Heat recovery ventilation

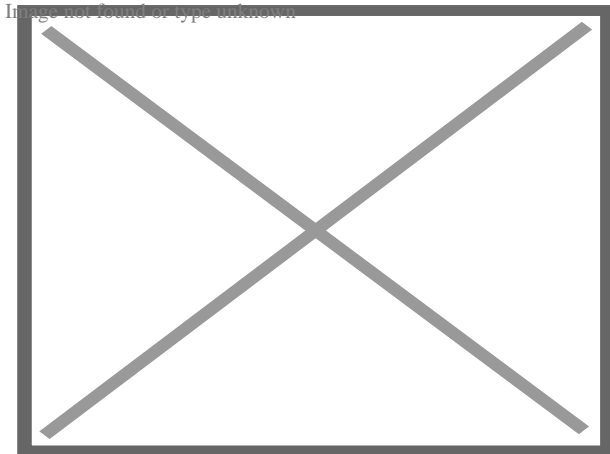
Exhaust air heat pumps extract heat from the exhaust air of a building and require mechanical ventilation. Two classes exist:

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

Solar-assisted

[edit]

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



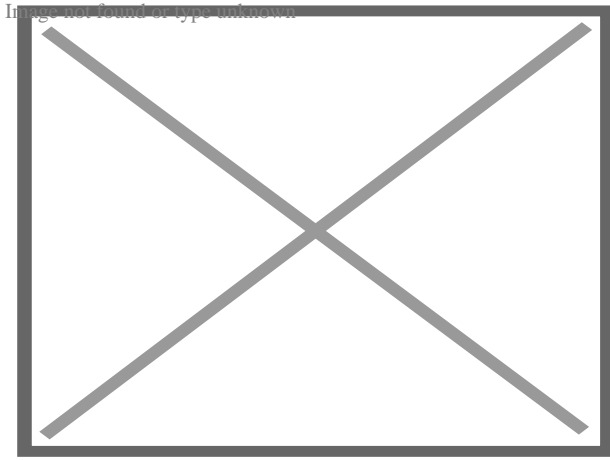
Hybrid photovoltaic-thermal solar panels of a SAHP in an experimental installation at Department of Energy at Polytechnic of Milan

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

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

Water-source

[edit]



Water-source heat exchanger being installed

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

Others

[edit]

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

Electrocaloric heat pumps are solid state.^[35]

Applications

[edit]

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

Space heating and sometimes also cooling

[edit]

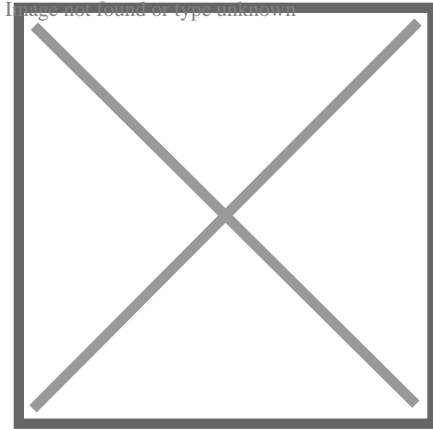
In HVAC applications, a heat pump is typically a vapor-compression refrigeration device that includes a reversing valve and optimized heat exchangers so that the direction of *heat flow* (thermal energy movement) may be reversed. The reversing valve switches the direction of refrigerant through the cycle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

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

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

Window mounted heat pump

[edit]



Saddle-style window mounted heat pump 3D sketch

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

Water heating

[edit]

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

District heating

[edit]

Large (megawatt-scale) heat pumps are used for district heating.^[43] However as of 2022 about 90% of district heat is from fossil fuels.^[44] In Europe, heat pumps

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

Industrial heating

[edit]

There is great potential to reduce the energy consumption and related greenhouse gas emissions in industry by application of industrial heat pumps, for example for process heat.^[48]^[49] Short payback periods of less than 2 years are possible, while achieving a high reduction of CO₂ emissions (in some cases more than 50%).^[50]^[51] Industrial heat pumps can heat up to 200 °C, and can meet the heating demands of many light industries.^[52]^[53] In Europe alone, 15 GW of heat pumps could be installed in 3,000 facilities in the paper, food and chemicals industries.^[4]

Performance

[edit]

Main article: Coefficient of performance

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

flow rates, and maintenance.

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

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

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

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

COP variation with output temperature

Pump type and source	Typical use	35 °C (e.g. heated screed floor)		
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	$\frac{1}{\eta_{HP}} \frac{Q_{HP}}{Q_{HP} + Q_{CO_2}} \approx \frac{1}{\eta_{HP}} \frac{Q_{HP}}{Q_{HP} + Q_{CO_2}}$

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)*

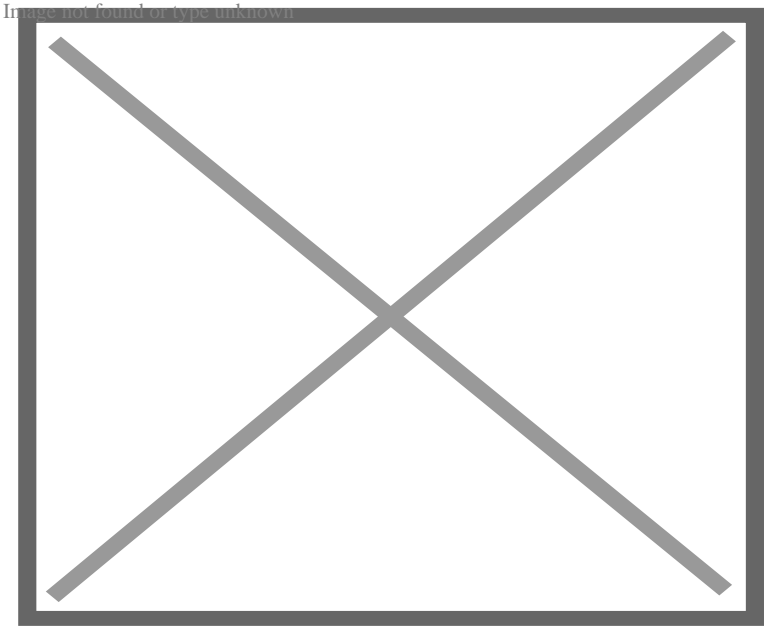
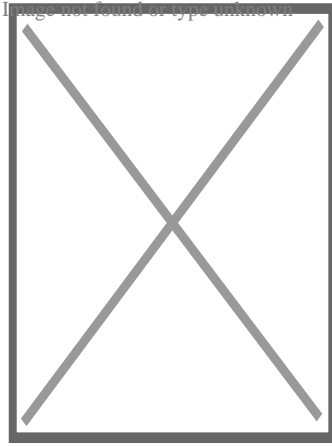
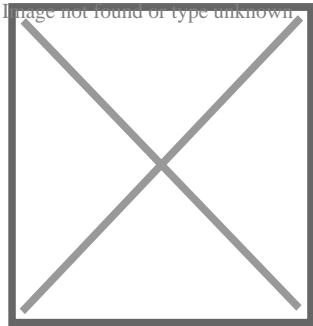


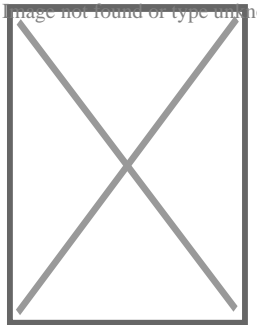
Figure 2: Temperature-entropy diagram of the vapor-compression cycle



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 (NH

₃), carbon dioxide (CO

₂), and water (H

₂O)^[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

[edit]

- [^] 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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External links

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Heating, ventilation, and air conditioning

**Fundamental
concepts**

- Air changes per hour
- Bake-out
- Building envelope
- Convection
- Dilution
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- Enthalpy
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- Latent heat
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- Outgassing
- Particulates
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- Sensible heat
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- Thermal comfort
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- Thermal mass
- Thermodynamics
- Vapour pressure of water

- Absorption-compression heat pump
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- 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

Technology

- 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

**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

**Professions,
trades,
and services**

- 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
- 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)

**Industry
organizations**

Health and safety

See also

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

- Germany
- United States
- France

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Things To Do in Tulsa County

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Bob Dylan Center

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Gathering Place

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Blue Whale of Catoosa

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Streetwalker Tours

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Tulsa Zoo

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Tulsa Botanic Garden

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Driving Directions From Waffle House to Durham Supply Inc

Driving Directions From Tulsa VA Behavioral Medicine Clinic to Durham Supply Inc

Driving Directions From East Central High School to Durham Supply Inc

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

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Driving Directions From Reception Jehovah's Witnesses to Durham Supply Inc

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Driving Directions From Oxley Nature Center to Durham Supply Inc

Driving Directions From OkieTundra to Durham Supply Inc

Driving Directions From Tulsa Air and Space Museum & Planetarium to Durham Supply Inc

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Reviews for Durham Supply Inc

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

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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!

Durham Supply Inc

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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

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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.

Coping with Storm Related Damage to Mobile Home Air Conditioners [View GBP](#)

Check our other pages :

- [Using Diagnostic Tools to Assess Air Quality in Mobile Homes](#)
- [Installing Air Purification Systems in Mobile Homes](#)
- [Preparing Mobile Home HVAC Units for Intense Summer Heat](#)

Frequently Asked Questions

How can I protect my mobile home air conditioner from storm-related damage?

To protect your mobile home air conditioner, secure any loose components and cover the unit with a weatherproof cover before a storm. Ensure the area around the AC is clear of debris that could become airborne and cause damage. Additionally, consider using straps or anchors to stabilize the unit against strong winds.

What steps should I take if my air conditioner is damaged by a storm?

First, ensure your safety by turning off power to the unit at the breaker box. Inspect for visible damage such as dents, broken parts, or dislodged components. Contact a professional HVAC technician to assess and repair any damage before attempting to use the system again.

Can insurance cover storm-related damages to my mobile homes air conditioner?

Yes, many homeowners insurance policies include coverage for storm-related damages, including those affecting an air conditioning unit. Review your policy details and contact your insurance provider promptly to file a claim if necessary. Document all damages with photos and keep records of repair estimates and costs for your claim.

Royal Supply Inc

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Google Business Profile

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

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