FACT SHEET: Solar Thermal Energy Technology

(General)

Solar Thermal Hot Water

Solar thermal hot water systems use the sun's unlimited light energy to produce hot water for both residential, recreational (pools) and commercial buildings as well as some industrial processes.

These systems can be either passive or active.

Passive Systems:

- use water to transfer heat.
- require no external power source.
- are reliable, low maintenance.
- are less expensive option.
- are typically less efficient.

Active Systems:

- require moving parts and external energy sources to operate control valves and pumps.
- are used in Canada as they can work in freezing temperatures by using glycol to transport heat instead of water.

Pros Solar thermal hot water heating:

- collects free, low carbon and unlimited solar energy.
- can provide the majority of your home's hot water needs.
- is effective in Northern climates.
- are affordable to operate as they do not require a lot of maintenance.
- come in different sizes and are scalable to meet your energy needs.

Cons Solar thermal hot water heating:

- can have a high upfront cost.
- is somewhat less effective in winter months when the sun is at a lower angle.
- often needs to be complimented with an existing electrical or natural gas hot water system.

More About Active Systems

Active systems work best in cold climates and they use technology called collectors.

- Collectors can be installed on roofs, walls or at ground level as long as there is no obstruction of sunlight.
- These collectors gather heat from sunlight and transfer it to a "heat transfer fluid".

  Heat transfer fluid is a mixture of water and a non-toxic antifreeze solution, such as glycol, to prevent freezing.

- The heat transfer fluid is heated up by the collectors before being pumped to a heat exchange tank where a home's potable water is heated by the fluid.
- Convection assures that the hottest water will rise to the top of the tank while the denser cold water will settle to the bottom.
- The hot water near the top of the exchanger is sent to a home's existing hot water tank, while the cooler fluid is recirculated from the bottom of the exchanger back up to the solar collectors to be reheated.

There are two common types of collectors:

Evacuated Tube Collectors

- As the name suggests, the glass tubes contain a vacuum space, similar to how a thermos works.
- This vacuum is located between the cylindrical glass tube which reflects little light, and an inner tube designed to absorb the light energy.
- The inner tube is often made of either copper or a darkly colored PEX tube and contains a heat transfer fluid.
- The vacuum does not allow heat to escape easily, to the point where the inner tube could be as hot as 150˚C while the outer tube is cold to the touch.
- This allows the evacuated tubes to work well in temperatures as low as -40 C and are among the most efficient collectors on the market.
- The larger horizontal cylinder on top is called the Manifold, this is where all the heated fluid is gathered and sent to the hot water system.
- Evacuated tubes are an efficient collector in Northern communities as they can be installed more upright to collect energy, while the sun is lower in the sky.

An example of a evacuated tube collector

stock.adobe.com/ca/free

commons.wikimedia.org

Flat Plate Collectors

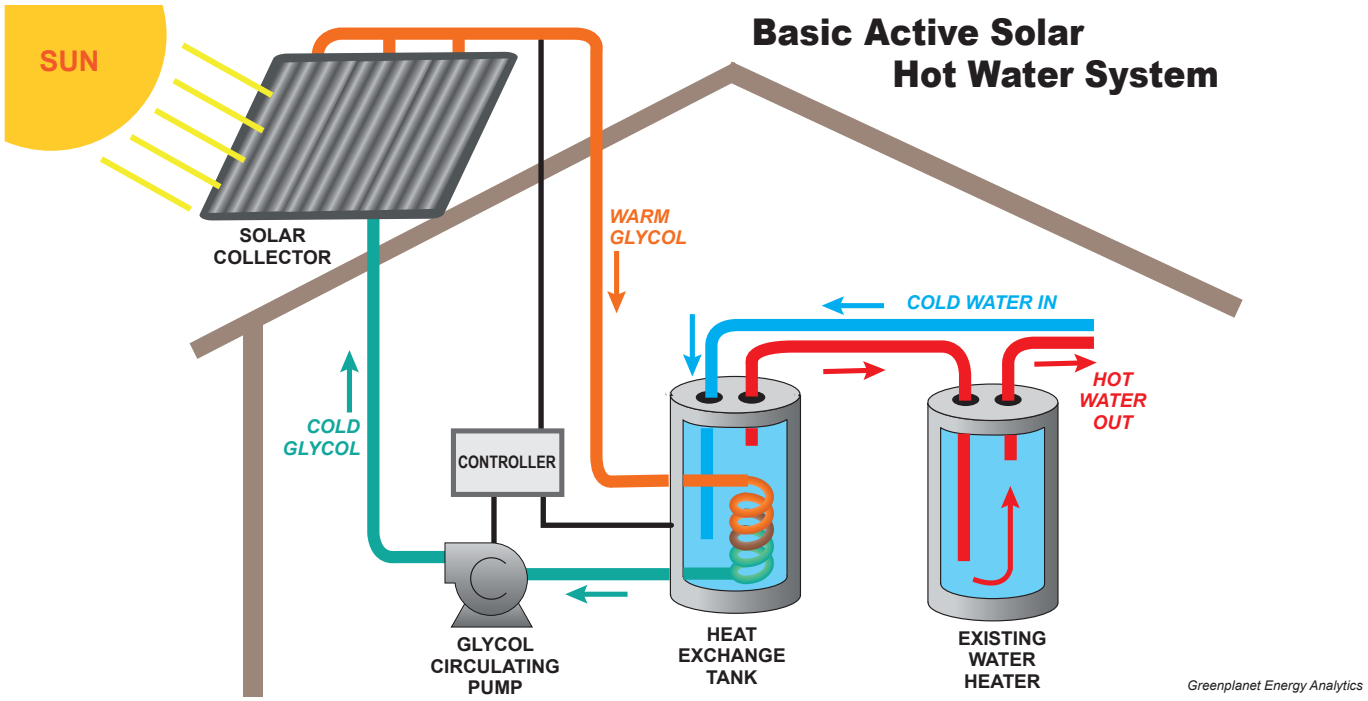
- These resemble a solar panel, are simple in design and come at a lower upfront cost.
- Flat absorber plates are assembled into an insulated box, behind tempered glass.
- Copper tubes are fitted to the flat absorber plates to transport the heating fluid. These flat absorbers are dark in color and insulated, in order to trap heat.
- Flat plates are not as efficient as evacuated tubes, especially in cold weather as snow will build up on the flat plates blocking sunlight from reaching the collector.

For more information, visit:

Simple Solar
https://www.simplesolar.ca/

GreenLearning Canada - Solar Heat and Electricity Download
http://www.greenlearning.ca/programs/re-energy/

Video - GEF Solar Thermal 101
https://www.youtube.com/watch?v=CTpEj5XPpc0&feature=youtu.be



Solar Air Heating Technology

Similar to hot water systems, solar air heating technologies collect free thermal energy from sunlight to heat buildings. This clean, renewable energy technology collects thermal energy in either an active or passive design.

Passive Systems:

- have no moving parts or external energy sources and can be as uncomplicated as having winter sunlight enter a south facing window.
- can be made more complex by using a heat absorbing, darkly colored material located behind glass.
  - the heat from this dark material is then transferred into the building by convection.

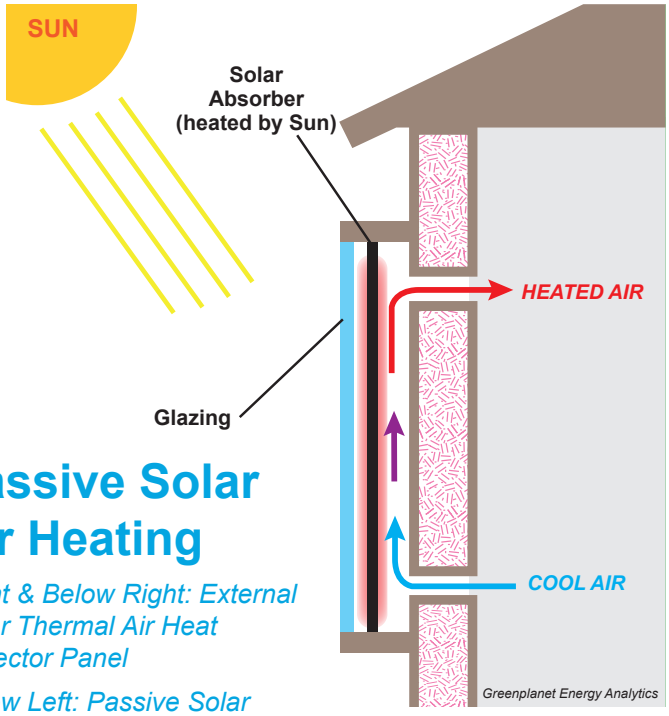
Convection - warm air rises and cool air falls to create a circular current.

  - slots near the bottom of a building allow cool air to escape while slots near the top of the building allow warm air to replace it.
- They are so simple that they make a fun DIY project.

Passive House Design

Instead of just adding panels to a house, the entire building can be constructed to take advantage of passive solar heating. This takes advantage of the sun's heat in the winter and avoids absorbing the sun's thermal energy in summers.

- Passive homes consume very little mechanical energy for heating and cooling, relying on building position, natural seasonal cycles and an air tight design.
- In the Northern Hemisphere, passive house designs have South facing windows that;
  - allow thermal energy to enter the home for the majority of daylight hours, like a greenhouse.
  - are designed to be as large as possible, maximizing the amount of thermal energy entering the home.
  - take advantage of the winter months when the sun is lower in the sky.
  - Passive design requires very little additional energy input to heat the home, unlike most Canadian homes, where heating is the largest energy demand.
- During the summer months, the South facing windows are protected by an overhang or shutters to block the high summer sun
- A passive home is equipped with much more insulation than a typical home, with the purpose of trapping and storing as much thermal energy as possible. This also prevents the summer heat from entering the home, keeping it nice and cool with little need for air conditioning.

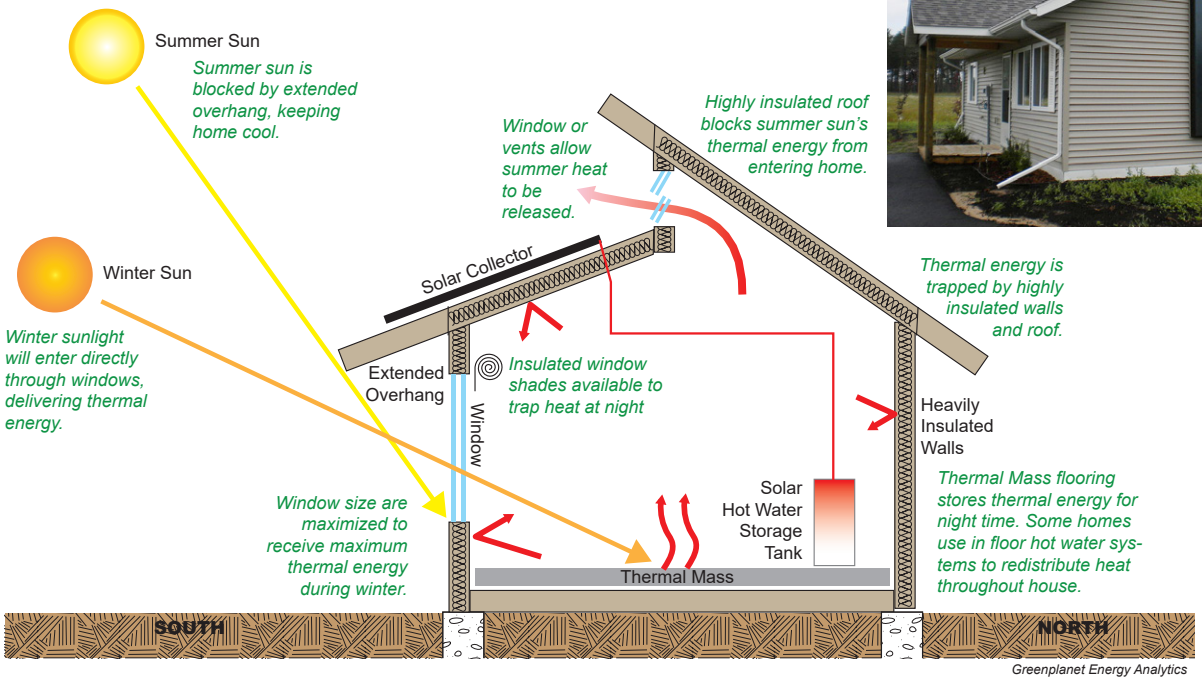


Passive Solar Air Heating

Right & Below Right: External Solar Thermal Air Heat Collector Panel

Below Left: Passive Solar building design


wikipedia.org



Active Systems

Example: Perforated Cladding System.

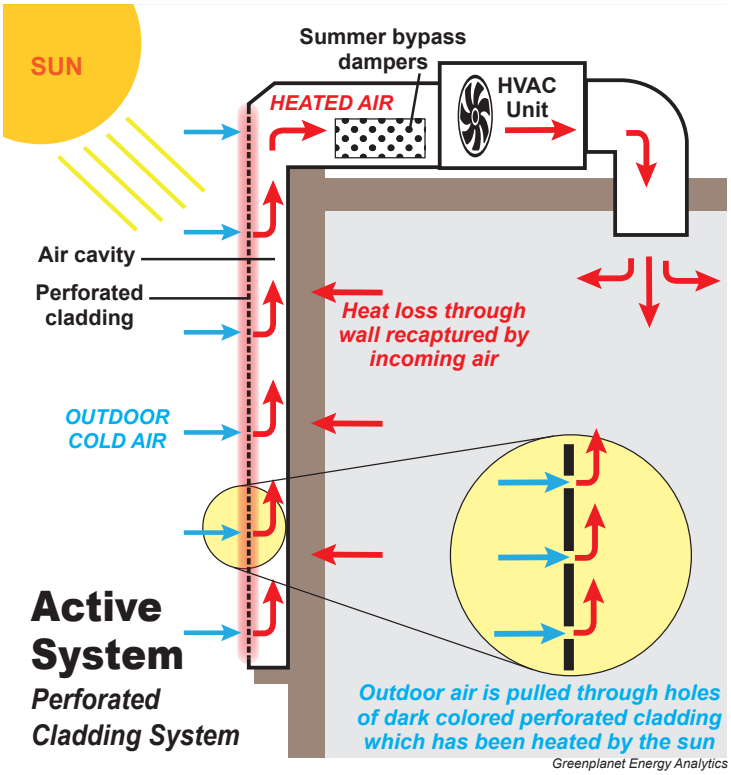
- Installed like siding on the outside of a building, this cladding is made of an unglazed dark metal plating that is covered with thousands of tiny holes.
- The dark color absorbs the sun's energy (high albedo) and heats up. Fans pull the cold outside air in through the holes in the cladding, allowing the air to warm up before entering the building.
- This reduces the amount of work an HVAC (Heating, Ventilation, and Air Conditioning) unit needs to do to get internal temperatures comfortable.
- These systems work well in both winter and summer seasons. (See diagram on next page.)

For more information, visit:

https://www.solarwall.com/technology/solar-wall-single-stage/

https://www.ecohome.net/guides/1075/all-about-solar-air-heaters-diy-or-purchased/

Video - Green Energy Futures Solar Air Heating
https://www.youtube.com/watch?v=A0fLm7YmbkU&feature=youtu.be



Greenplanet Energy Analytics


wikipedia.org

Example of a perforated cladding system.

Electricity

Example - Concentrated Solar Power

CSP systems use thermal energy to produce electricity, which is very different from Solar PV (photovoltaic / solar panel) systems. Solar panels do not capture thermal energy, they actually convert solar radiation straight into electricity. CSP systems use carefully placed mirrors to concentrate thermal energy to a central collector. These collectors become superheated to the point where it can convert water to steam, which is used to turn a turbine to generate electricity.

For more information, visit:

https://www.solarpaces.org/how-csp-works/


stock.adobe.com/ca/free

Pros and Cons of Solar Thermal Air Heating Systems

Pros

Solar thermal air heating systems;

- collect free, low carbon and unlimited solar energy.
- work well in Canadian climates.
- can be used to heat buildings independent of existing systems or be used to preheat air that will be introduced to natural gas or electrical furnaces.
- are affordable to operate as they do not require a lot of maintenance.
- are versatile as they are scalable to any energy requirement.

Cons

Solar thermal air heating systems;

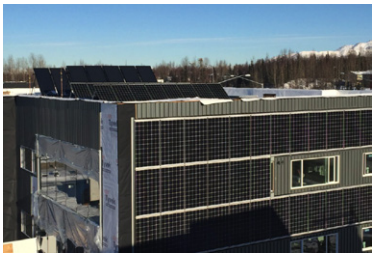
- rely on additional heating equipment.
- can have a high upfront costs.
- often need to be complimented with an existing electrical or natural gas furnace.

For more information, visit:

https://www.solarpaces.org/what-are-the-pros-and-cons-of-longer-solar-contracts/

Case Study - Alaska Village Housing Project in Anchorage, AK

Even at the high latitude of Anchorage, AK, more than 60 degrees north of the equator, solar hot water systems are an effective form of energy. On the winter solstice, Anchorage receives about six and a half hours of daylight, while six months later on summer solstice, the sun shines for 21 straight hours. When designed correctly, solar hot water systems can be convenient and economical, even in Anchorage.




arcticsolarventures.com

System Description

Arctic Solar Ventures installed 3 solar hot water systems on buildings at the Alaska Village Housing Project. These 3 systems have a total of 30 SunEarth EC-40 collectors, mounted in banks of 5, tilted at 45 degree angles.

- Total Rated Power Output: 80 kWh
- Yearly Energy Output: 24,370 kWh
- Yearly CO_2 Reduction: 4,438 kg / 9,780 lbs
- Storage Capacity: 500 gal

For more information, visit:

https://arcticsolarventures.com/