COLD CLIMATE HOUSING RESEARCH CENTER
CCHRC

Solar Thermal Energy

A solar thermal system is a heating system that uses the sun's rays to heat water for domestic purposes to provide the energy required to heat water. Some examples of solar thermal systems include a flat plate collector or an evacuated tube collector.

A typical flat plate collector consists of a fairly shallow insulated metal box with a clear face to let sunlight in, and a dark colored absorptive plate on the bottom which heats up when exposed to the suns rays. Copper tubing containing glycol is attached to the absorber plate . As the tubing heats up with the heat transferred from the absorber plate, it transfers the heat energy to the glycol which circulates through the system and is used to heat up a water tank via a heat exchanger. The water can then be used to meet domestic or hydronic heating needs.
An evacuated tube collector has a series of glass tubes that each contain a smaller copper tube (or tubes) filled with fluid. The vacuum in the tube is designed to boost efficiency by reducing heat losses via convection and radiation. When the sun's rays strike the copper tube it brings the fluid inside to a boil. The resulting vapor then rises to the top of the tube where the heat is transferred to a manifold circulating glycol that picks up the heat. Once the heat has been exchanged in the manifold the vapor returns to the liquid stage and runs back to the bottom of the tube, repeating the cycle.

Solar thermal in the arctic climate
There is no clear answer to which system is better. Which one is optimal is a matter of install design criteria and location. Some points to consider when choosing in the arctic are as follows. The evacuated tubes don't shed snow or melt off frost accumulation as well as the flat plat collectors.

An angle steeper than 70° or even vertical under a building overhang is optimal for late and early season sun while keeping them free of snow so they could function in the low temperature conditions. The down side of this install arrangement is more collector area would be needed.

The up side is gathering heat throughout a longer portion of the year while minimizing over heating and or heat dumping in the hot summer months.
The same can be said for the flat plate collectors in arctic regions. But the flat plate collectors do lose more heat back to the atmosphere and thus do a better job of melting off the snow and frost accumulations. A less sever inclination would be needed to help shed the snow.

If remote shipping is a consideration then the evacuated tube systems are preferable. They are glass and care must be taken, but the tubes can be boxed in variable quantities to fit in small plane cargo holds etc. Installing the evacuated tube systems can be done without any lifting equipment and by one person. A flat plate collector will require multiple people or a boom truck for lifting.

In the arctic there are limited choices for freeze protection. Fill the system with a propylene glycol mixture for burst protection or use a drain back approach.

Glycol solutions will reduce the systems ability to transfer heat from the collector to the storage tank. The glycol can also be damaged, (turned acidic) by overheating. If the glycol is damage it must be replaced or the system will be corroded. Evacuated tube systems must be filled with glycol solutions to protect from freezing. A drain back approach keeps all the system fluid inside the building in a "drain back tank" until the collector temperature is 10°+ F above the storage tank temperature. When the sun goes down the system shuts off and the fluid is drained from the piping. Water can be the system fluid in a drain back system. CCRHC offers material on solar thermal systems for anyone interested in this clean technology.