

ARAS Community Greenhouse

ARAS is planning a year-round passive solar greenhouse. Our vision is a

***thriving, connected, food aware
rural community.***

JOIN THE COMMUNITY!
aras.greetings@gmail.com



What is a Passive Solar Greenhouse?

A passive solar greenhouse is an ideal design for our long, cold winters. It is also sometimes referred to as a "deep winter greenhouse" or "Chinese style greenhouse" when the south wall is curved. The key principle of a passive solar greenhouse is to maximize solar gain while minimizing heat loss. This is achieved through careful orientation and design. Solar panels are not part of the basic design.

Passive solar greenhouses generally incorporate a glazing wall on the south and an insulated wall on the north. A thermal mass is incorporated and is "charged" by the heat energy of the sun then transfers the heat to the greenhouse when it is colder. These structures are heavily insulated and are designed to prevent heat loss through the foundation. Standard considerations of greenhouses are incorporated such as ventilation and humidity control.

These greenhouses operate with a fraction of the heating and electricity costs associated with conventional designs. They can be used to grow food year-round, as well as provide a comfortable environment to spend time in during winter.



Gao Xinsheng, www.chinadaily.com



www.patmorrow.com

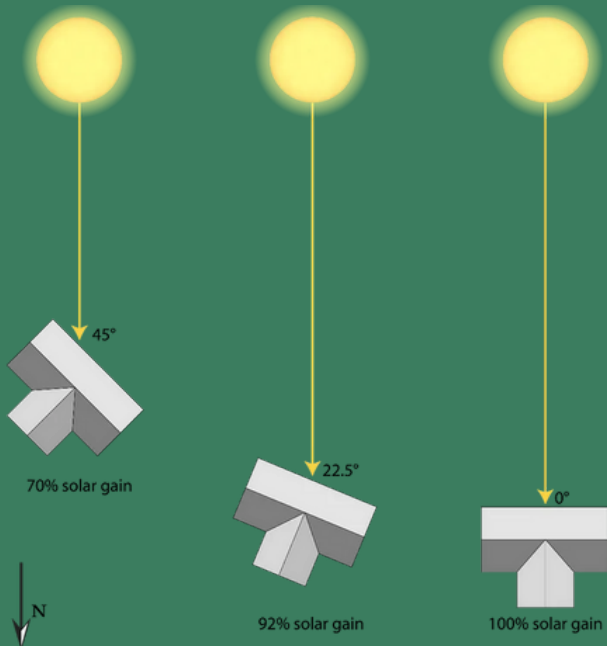
Groundswell community passive solar greenhouse in Invermere, BC, built in 2008.

Numerous passive solar greenhouses in Shanxi province, China, where winter temperatures average -15°C .

Siting & Angles

ORIENTATION

The orientation of the glazing wall should be ~15° to the east of South in the Northern Hemisphere. This optimizes morning light and heat when the greenhouse is coldest.



Rob Avis, www.medium.com

OTHER CONSIDERATIONS

The building should not be sited in a shadow but can be in a position that offers wind protection as wind can increase heat loss through convection.

The construction site should be well-drained to avoid flooding and facilitate access to equipment and materials in and out of the greenhouse.

The site should be assessed for any unique microclimate effects such as temperature variations or frost pockets.

If conventional utilities will be connected (i.e., gas, grid-tied electricity, municipal water), the distance to hook-ups should be considered.

www.buildsowgrow.com

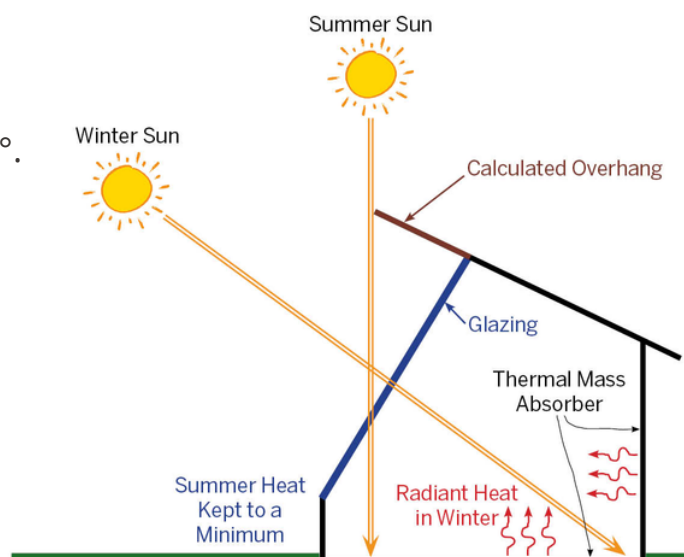
GLAZING ANGLE

One recommendation for the glazing angle for winter growing is latitude + 15°.

56° (Ardrossan) + 15 = 71°

However, a glazing angle within 45 and 75° will be within 5% of optimum.

Overhangs can be built to moderate summer sun without interfering with winter sun.



Architectural Design

PROFILE

Both curved (Chinese-style) and straight glazing surfaces can be used in a passive solar design. A knee wall may be used to allow for ventilation, better height clearance, and enough vertical space for snow to accumulate as it slides off.

ATTACHED BUILDING

The greenhouse structure can include an additional built component serving other uses, like a kitchen. This would affect heat transfer to the north wall.

FOOTPRINT

The shape of a passive solar greenhouse is generally rectangular. The size of the ARAS Community Greenhouse is not yet determined. For reference,

- FreshPal Farms is 9,000 sq ft
- Arkopia is 3,000 sq ft
- Groundswell is 2,400 sq ft
- Normandeau School is 1,100 sq ft

Normandeau School (Red Deer)



@ArkopiaYouTube (Saskatoon)



Groundswell Community Network (Invermere, BC)

IN-GROUND OR RAISED BEDS

Raised beds are used in the Groundswell greenhouse; in-ground beds are used in the Arkopia greenhouse.

Thermal Mass

CLAY/STONE WALL

The north wall can incorporate clay, bricks or stone to retain solar heat. In the FreshPal Farms greenhouse in Olds, Alberta, the north wall is built with clay 1/2 m thick and a black interior surface.

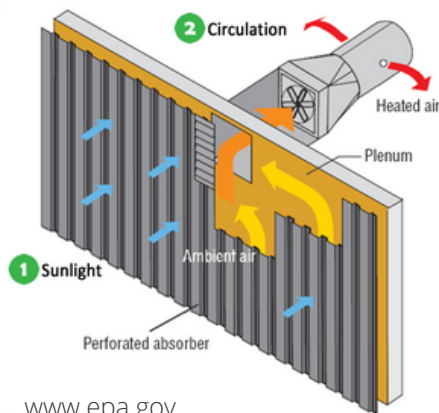
CEMENT FLOOR

Cement has a moderate specific heat capacity and relatively good thermal conductivity. Radiant in-floor heating can enhance the heating effect. Cement can be painted black in the north section and a light colour in the south section.



@ArkopiaYouTube (Saskatoon)

Transpired Solar Collector



www.epa.gov

AIR

A solar air heater may be built with expanded tin with perforations enclosing an air space and a black surface facing south. This design was incorporated into Verge Permaculture greenhouses in Kamloops, BC and Normandeu School (Red Deer).

WATER

Water is a more efficient thermal mass than earth and can be installed along the north wall to absorb solar heat. In the Arkopia greenhouse, cubes of water are elevated on racks so that only the low winter sun warms them, not the hot summer sun. Any water in the greenhouse will act as a thermal mass, even an aquaponics installation. A suggested rule is to use 8-12 L of water per sq ft of glazing wall.

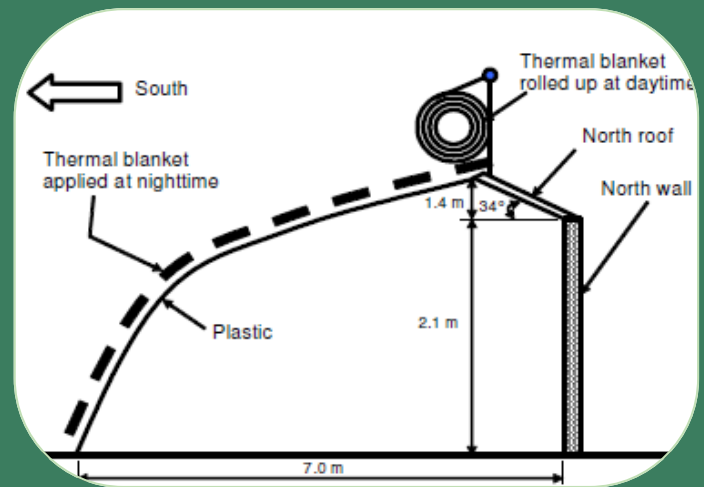


Simon Giebler,
www.grit.com (Colorado)

Heat Conservation

INSULATED BLANKET

This can be drawn at night and raised in the morning. It can be on the exterior or between two layers of glazing and controlled by an electric motor.



Beshada, Zhang & Boris, 2006 (Manitoba)

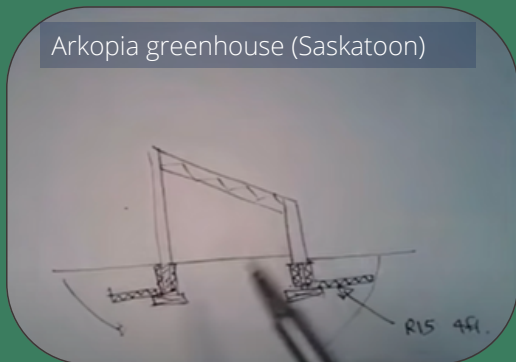
BUILDING INSULATION

Passive solar greenhouses are super-insulated on all non-lazing sides including the ceiling. The Arkopia greenhouse in Saskatchewan uses R60 insulation.

BELOWGROUND INSULATION

To prevent frost from approaching the ground beneath the greenhouse, insulated walls can be built to several feet underground and also project out horizontally.

Arkopia greenhouse (Saskatoon)



ADDITIONAL HEAT

After incorporating heat conservation measures, the greenhouse may still need additional heat. A wood burning stove or propane, for example, can add winter heat.

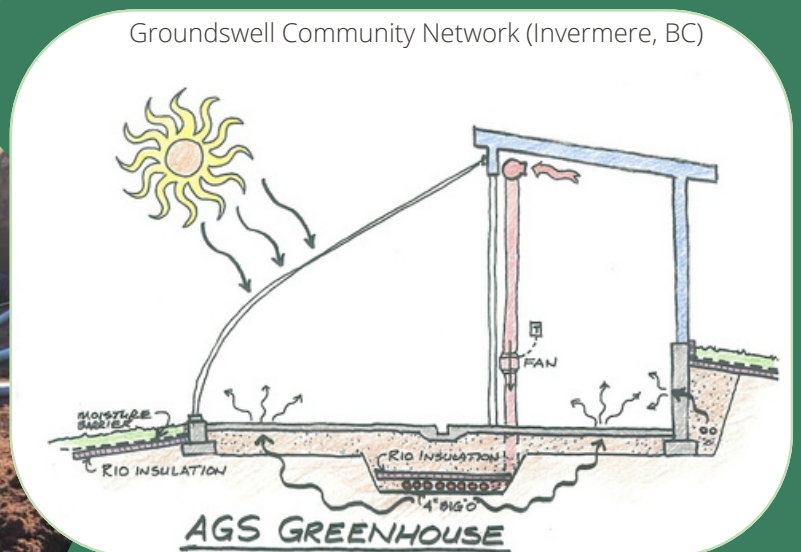
ANNUALIZED GEOSOLAR

Also called a "climate battery," hot air is pushed underground and stored in tubes then pulled up during colder periods.

Groundswell Community Network (Invermere, BC)



Abundant Acres (Nova Scotia)

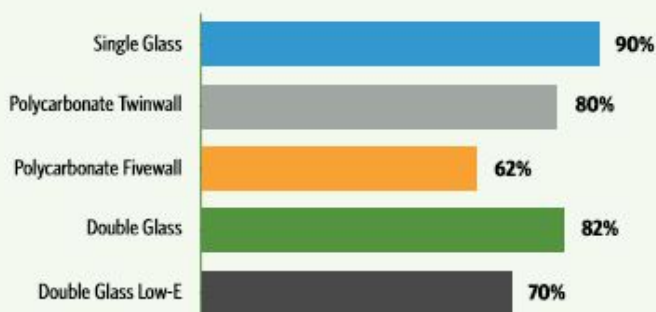


Glazing

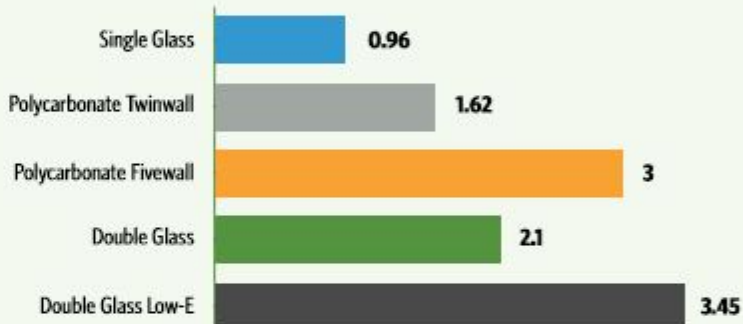
As the R-value (thermal resistance) of a glazing surface goes up (less heat is lost), the transmissivity goes down (less light gets through). Plants need at least 70% transmission to stay healthy. Polycarbonate diffuses light, blocks out UV radiation and is far sturdier than glass. Another consideration is the glazing surface's ability to handle our snow load.

www.bcgreenhouses.com

VISIBLE LIGHT TRANSMISSION

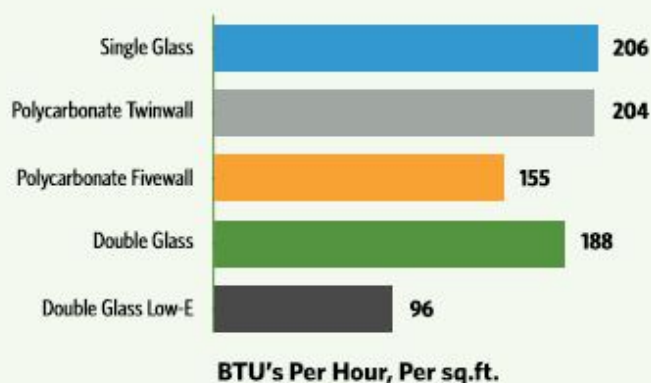


INSULATING R-VALUE



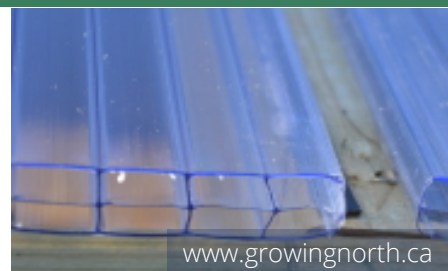
RELATIVE HEAT GAIN

Greenhouse glazing effectively functions as a heater when solar energy is available. The more BTU's, the warmer the greenhouse. Typically a lower number is preferred for keeping greenhouses from overheating in the warm months. The exception would be for greenhouses in cold but sunny climates, where higher heat gain will reduce winter heating costs.



FreshPal Farms (Alberta)

16 mm triple-wall polycarbonate with 74% light transmission and an R-value of 2.5



www.growingnorth.ca

POLYCOVER

Polycover is a flexible plastic covering suitable for the curved Chinese-style. A 6 mil polyfilm will have ~ 0.8 R-value. In the Freshpal Farms greenhouse, two layers are used with a large airspace and an insulating blanket in between.

Add-ons

AQUAPONICS

Aquaponics combines aquaculture (the cultivation of aquatic animals like fish) with hydroponics (the cultivation of plants in nutrient-rich water) in a symbiotic environment. The waste produced by the aquatic animals serves as a nutrient source for the plants, while the plants help purify the water for the aquatic animals.

KITCHEN

A kitchen is a natural addition to a food-growing greenhouse. Produce can be prepped for eating or preserving. Collective cooking can bring people together to create meals.

CLASSROOM

A meeting space with sightlines to the greenery of the greenhouse can be a retreat in winter months and can serve as a classroom for learning about gardening, permaculture, animal husbandry, cooking, preserving, passive solar design and more.

ROOT CELLAR

This classic mode of storing food keeps vegetables and preserves in a cool, dark underground space. Modern root cellars are equipped with carbon dioxide monitors indicate dangerously high levels of gas produced from slow decomposition of produce.

Adaptive Habitat,
Verge Permaculture

