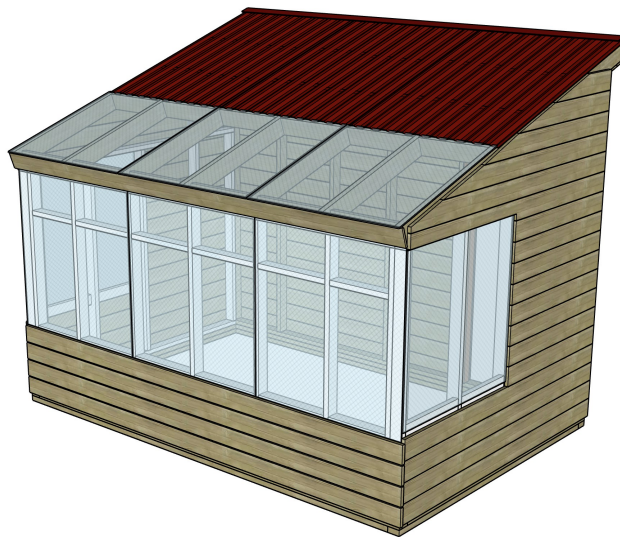


Hempcrete Passive-Solar Northern Greenhouse

12x8' (96 sq-ft)

3DSpaceTerraform.com

A free step-by-step concept guide to framing and using hempcrete in your own backyard greenhouse.



See a built hempcrete version at:
www.3dspaceterraform.com

Note: This is a basic greenhouse package that can be put together by any DIY person. The basics are explained in the package but user assumes all risk in modification, application, and practice.

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8' x 12' Northern Greenhouse (96 square feet)

Design notes

This design is based on a horse shed, and is simple to adapt to various configurations (cabin, chicken coop, etc.)

This package covers the greenhouse option for central & south Alberta.

This is an easy-to-build project that can be framed in a few days using dimensional lumber from Home Depot, Home Hardware, Rona, etc. The greenhouse will work best with ventilation – a couple solar fans from Princess Auto and a heat-activated window opener over the door will work perfectly for this size. Please see ventilation section for details.

This basic greenhouse design works as frost, wind, and hail protection to extend the growing season. Using hempcrete in the walls will manage humidity to lower heat stress of the plants, and provide insulation/thermal mass. The open interior concept is perfect for the addition of wicking beds.

The framing sits on treated 4x4s. The base of the greenhouse can be raised on a well-draining level tamped gravel bed, or it can be built on cement blocks or patio stones, etc. The bottom is intentionally left open for drainage. Building planting beds in the greenhouse will be easier to manage if they have ground contact.

Please note that these plans do not imply engineering approval for your region or land-use bylaws. If that is needed or required by your local building officials please contact your local officials or feel free to contact me at 3dspaceterraform@gmail.com

Design goals

The design goals of this greenhouse are focused on the best performance in our climate for an affordable cost. This passive solar greenhouse is designed for a northern climate, to provide season extension. It can be modified to provide more glazing, more insulation, a different roof angle (and therefore change the seasonal optimization) as needed.

Customization or Paid Design Version

We have released this free version as an effort to help people adapt to the effects of tariffs and to encourage backyard growing and food security. We do have a paid version that includes more detail, design options (like the coop and tiny house version) and more.

[Any questions?](#)

Contact

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Material List

Lumber

Base

(4) 2x4 treated - 7' 8.5" (92.5")

(4) 2x4 treated - 11' 8.5" (140.5")

Sidewalls (makes 2)

(12) 2x4 - 6' (72")

(4) 2x4 - 7' 8.5" (92.5")

(4) 2x4 blocking - 23.5"

Front wall

(2) 2x4 - 11'5" (137")

(7) 2x4 - 6' (72")

Extra 2x4 for blocking (2)

Back wall

(2) 2x4 - 12' (144")

(6) 2x4 - 8' 8 1/4" (104-1/4")

(3) 2x4 - 17 1/4", cut & angled to fit.

(2) 2x6 - 3' 7" (43")

Roof

(2) 2x6 - 12' (144")

(7) 2x6 - 9' 1 3/4" (109 3/4")

Extra 2x6 for blocking (2)

Vents:

1-2: Solar vents

1x heat activated window opener. See notes.

1x Door See notes.

Glazing:

4x 8mm polycarbonate double wall panels, or similar. See notes.

Siding:

Reclaimed pallet wood, or similar. See notes.

3' framing nails.

8d 1-1/2" nails to attach roof rafters and strong-ties.

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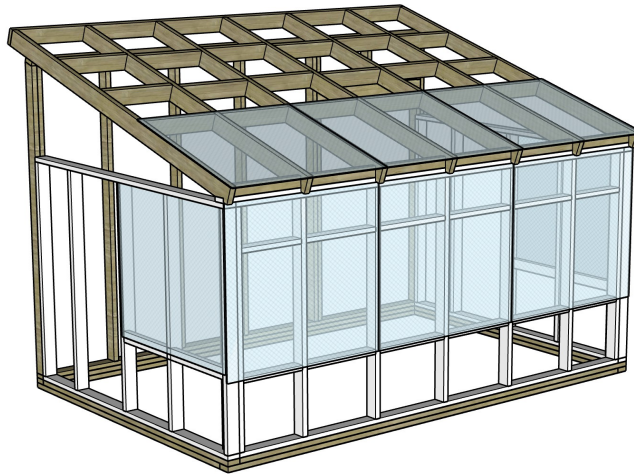


Use strongties to secure roofing to framing. Minimum one each end (14).

Add additional strongtie straps between framing sections (back & side wall) and front and side walls.

Passive solar orientation details

The lowest side of the freestanding greenhouse is designed to face south, or as close to south as possible, varying no more than 20 degrees east or west. If it can't face exactly south, try to angle it towards the east (sunrise).



Amount of glazing & Ventilation

Glazing is another name for the percentage of the greenhouse surface that sunlight can pass through.

There are two factors when considering glazing:

1. How much sunlight it lets through (transmission).
2. How much it protects against heat loss at night (thickness).

In general, look for the thickest glazing, to provide the most insulation against heat loss at night, but that also has a transmission higher than 70% (it lets through 70% or more of sunlight). The sheets should be no thicker than 8-10mm, as any thicker will impact the amount of light that makes it through the sheets.

Polycarbonate is an excellent choice for greenhouses. It is secure, hail resistant, insulating, and has a diffusion effect on sunlight to the benefit of plants within.

Key points:

- The thicker the glazing, the less sunlight gets through, but the better insulating it is.
- The glazing must let at least 70% of sunlight through (transmission of 70% or greater).
- An 8mm twin-wall polycarbonate is an economical choice, and has 80% transmission.

Edmonton area:

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<https://plasticsplusltd.com/collections/twinwall-polycarbonate/products/twinwall-polycarbonate-thermoclear-8-mm>

How much glazing do you need?

For Alberta you will need a minimum of 4 polycarbonate sheets (48x96). This suitable for a sunny year, with good orientation, with **three** of the sheets cut in 2, horizontally so that 5' of the sheet is on the front, and 3' is on the roof, and **one sheet** cut in half to have each half on each sides.

See glazing section below for more details on placement and installation.

Solar gain (heat input from sun) considerations

There is a direct relationship between the amount of glazing, as sized to roof angle and season extension – maximizing capture of shoulder season sunlight—and ventilation requirements. Each glazing panel is approx. 32 square feet. Based on the number of panels used, we will size the ventilation.

Ventilation

Central and southern Alberta have a lot of sun. We have to be careful to balance the amount of glazing to the ventilation requirements. There are two types of ventilation – passive and mechanical (fan).

It is important to have a flow of air across the greenhouse, both to cool the air and to keep the plants healthy. Stagnant air will impact the health of the greenhouse. For best ventilation, there should be a low intake or opening on the north side, and a higher opening at the top of the greenhouse to vent the hot air.

Passive ventilation basic guidelines

Based on a floor area of 96 square feet

# of panels	Glazing sq-ft	High ventilation (vent out)	Low ventilation (input air)
3	96	19 sq-ft	10 sq-ft
4	128	19 sq-ft	10 sq-ft
6	192	29 sq-ft	15 sq-ft
8	256	29 sq-ft	15 sq-ft

The opened north door counts as part of this ventilation area (high and low), but a fan and a high heat activated panel is also recommended.

A high ventilation window can be placed on the north wall above the door - using a heat activated opener (like those from Lee Valley). It is recommended a solar fan also be placed on the west wall, to manage afternoon heat build up. This will also provide a gentle cross breeze that will help maintain healthy growing conditions.

Depending on your location, orientation, and exposure, this should be enough ventilation when

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combined with the door. Add more as needed to maintain ideal temperature range.



(A) Solar fan from Princess Auto



(B) Heat activated window opener

Hempcrete as insulation and thermal mass

This greenhouse relies on hempcrete as a highly efficient insulation, that also has properties of thermal mass. Thermal mass is what stores heat. Insulation is what stops heat loss. Hempcrete will also act as a humidity buffer to low heat stress on the plants and cleans the air, it is anti-fungal, anti-bacterial, and mold resistant. Do not put siding on until hempcrete has dried for a couple days. It will continue to dry for another 4-5 weeks to the inside surface, which should not be covered.

Hempcrete provides some protection against lateral loads, usually managed with sheeting, but it is suggested that the greenhouse exterior be made with repurposed pallet boards or similar instead. Pallet boards will allow the hempcrete to breathe, and provide protection against elements and lateral loads.

Once hempcrete has completed a cure/dry, it becomes vapour-open. It will store and release water vapor as needed.

If you have a custom idea please make sure to run it past a qualified professional.

Thermal mass options:

- Bricks, cement blocks, gabion walls.
- Cob benches, or other clay structures.
- Water barrels (be careful with freeze-thaw events).

The majority of heat loss will be through the glazing, particularly the roof. Low-cost insulation options in the shoulder seasons include bubble wrap, or insulated tarps.

Please see attached hempcrete guide for technique and recipes.

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Building the Base

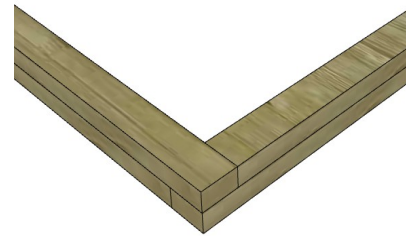
The ideal site for your greenhouse will be on a slight rise, where water doesn't pool when it rains. The site should get good sun though the early to later day. If possible, prepare the site with gravel, cement blocks, or bricks, etc., to keep it off the ground and prevent rotting.

Key points:

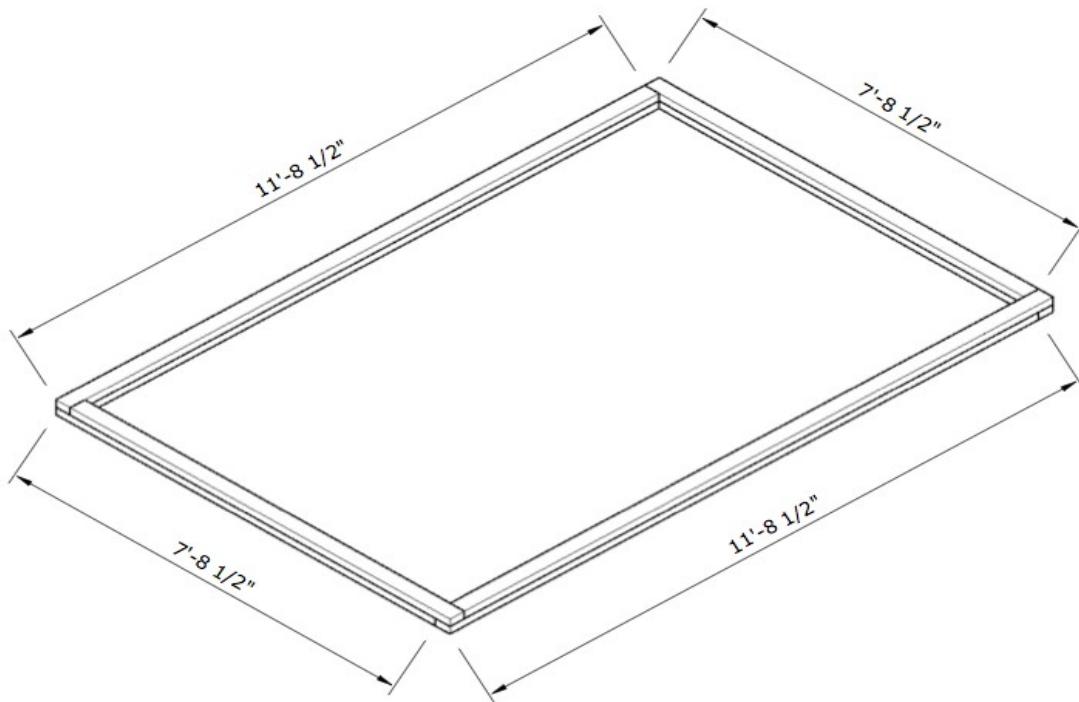
- Level ground
- Raise base plate with blocks/etc. To keep from wicking moisture from ground.
- Full sun exposure.
- Overlap 2x4s as shown.
- Make sure base is square.

Materials:

- (4) 2x4 treated - 7' 8.5" (92.5")
- (4) 2x4 treated - 11' 8.5" (140.5")



*Overlapping (lap joint)
corner patterns*



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Building the End Walls

The side walls are identical, build two with the materials specified.

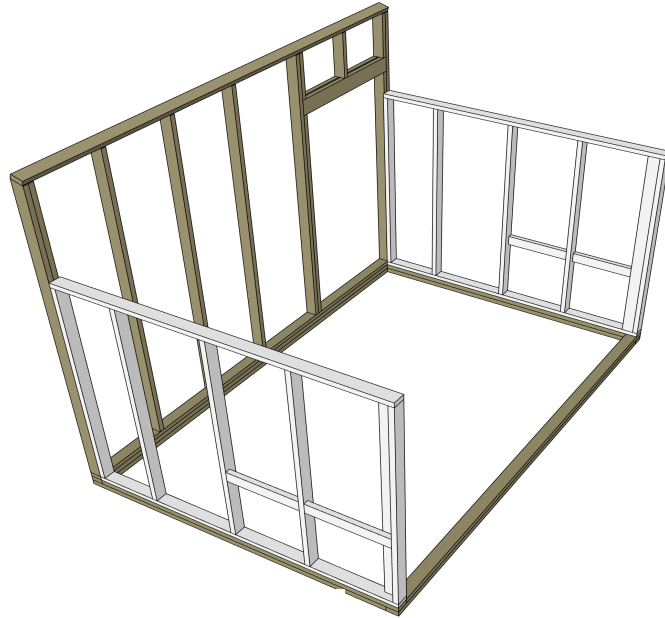
Key points:

- Build two (mirrored)

Materials (each wall, make two):

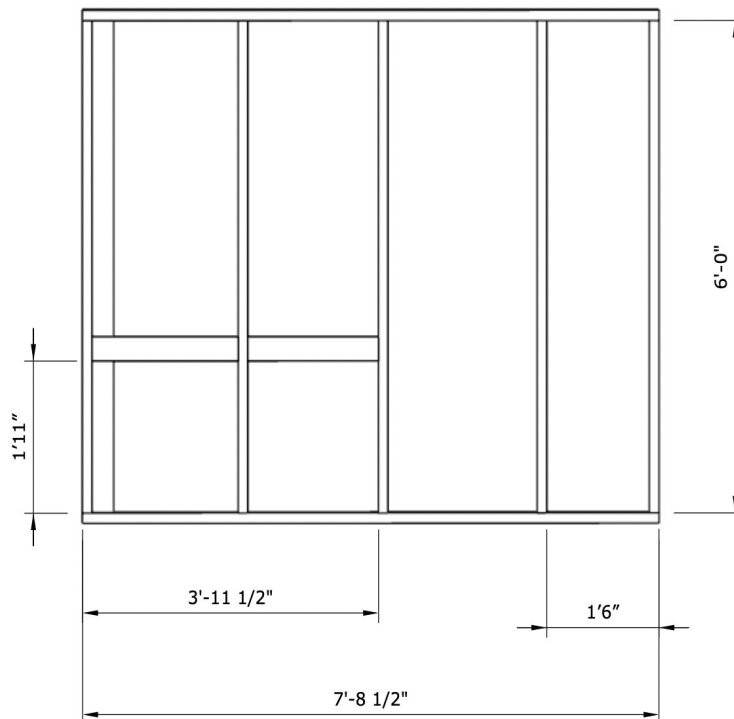
- (6) 2x4 – 6' (72")
- (2) 2x4 – 7' 8.5" (92.5")
- (4) 2x4 blocking – 23.5"

Mirror east wall for west wall.



FRONT

EAST WALL



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Building the Front Wall

Key points:

- Assemble the frame, and then add the blocking.

Materials:

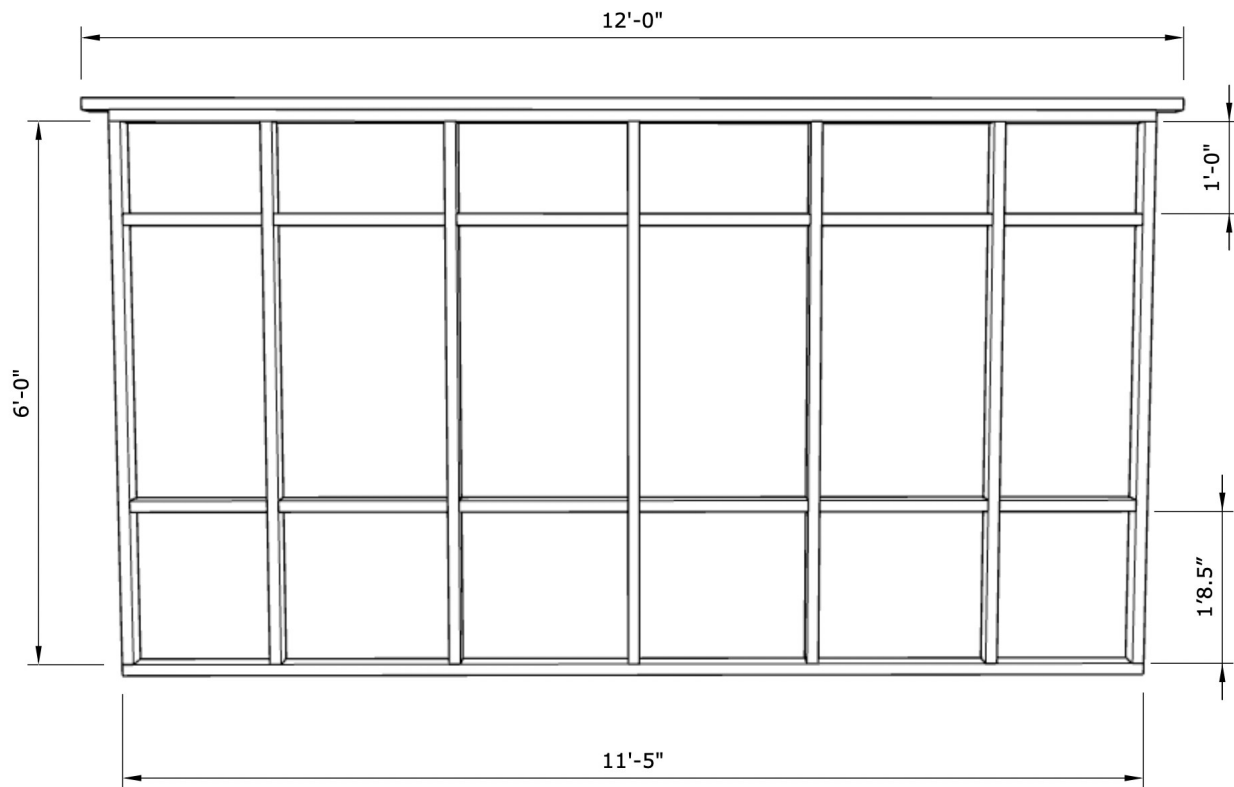
(2) 2x4 – 11'5" (137")

(7) 2x4 – 6' (72")

Blocking 2x4 spaced as shown. Align bottom blocking with exterior sheathing, if using.

Assembly notes:

Consider polycarbonate attachment when placing blocking.



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Building the Back Wall

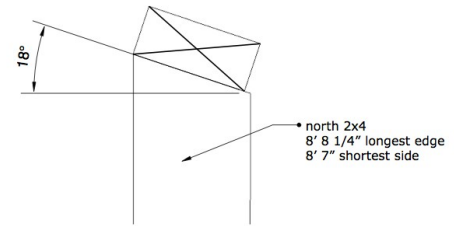
The side walls are identical, build two with the materials specified.

Key points:

- Angled cut for top studs (see cut detail)
- Door opening: 40" x 81-1/2" (adjust if needed)
- Ventilation space: 40" x 17-1/4"

Materials:

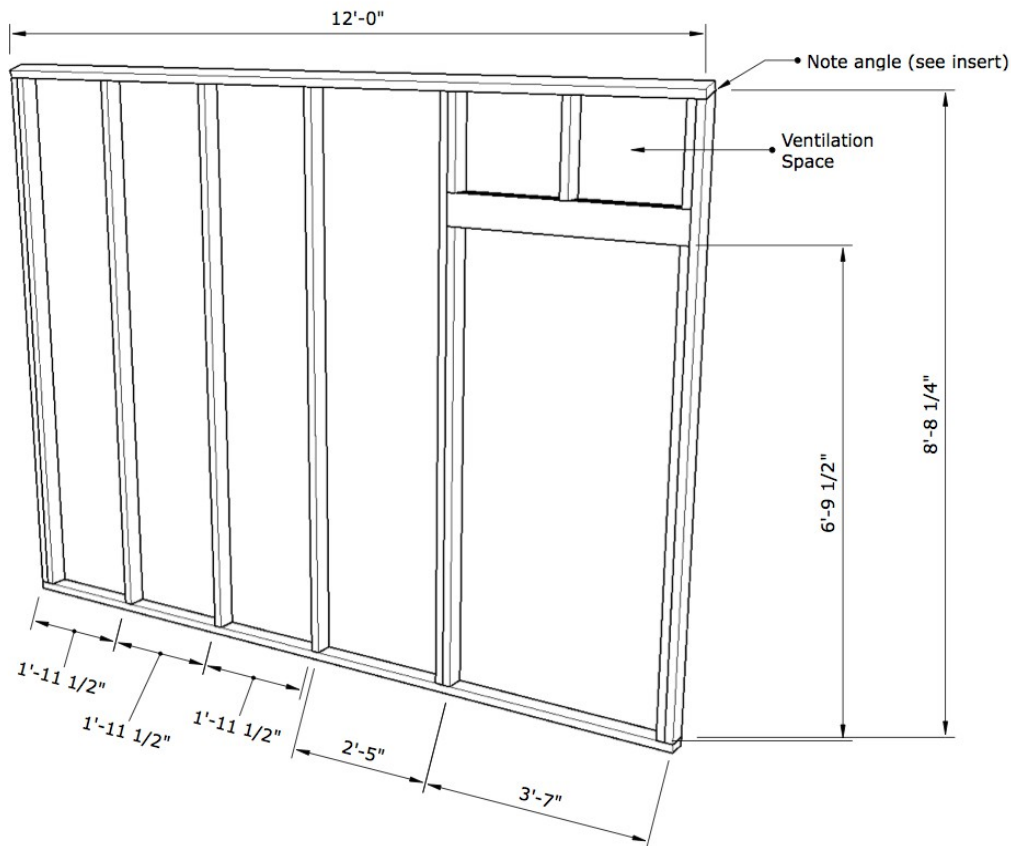
- (2) 2x4 – 12' (144")
- (6) 2x4 – 8' 8 1/4" (104-1/4")
- (3) 2x4 – 17 1/4", cut & angled to fit.
- (2) 2x6 – 3' 7" (43")



North studs angle guide

Assembly notes:

- Ventilation space for heat activated window instalment. See ventilation detail.
- Door (rough) space sized at 81 1/2 x 40"



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Assembly of walls

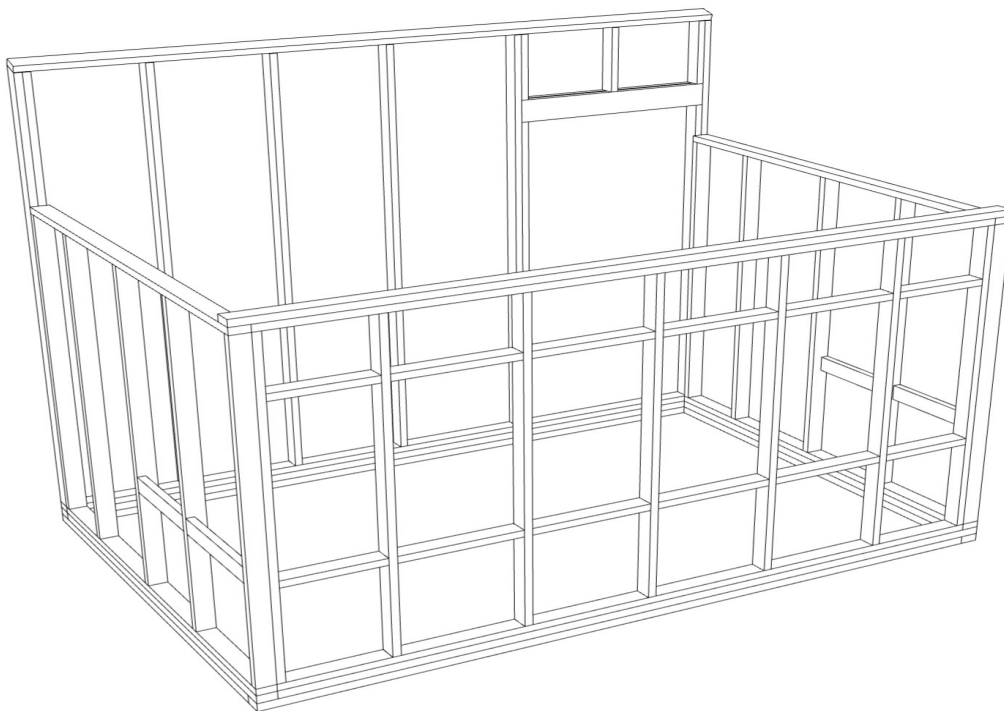
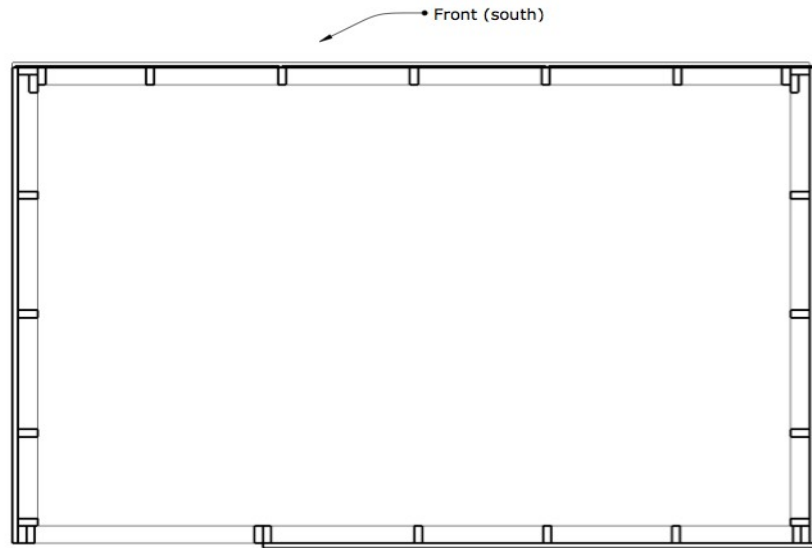
Assemble front and side walls as shown, and add the 12' 2x4 on the top of the south wall as shown.

Key points:

- Brace and assemble the side walls to the front wall.

Materials:

(1) 2x4 – 12' (144")



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Roof Rafter Measurements and Cut

The roofing for the greenhouse is made with 2x6 lumber on 24" centres.

Key points:

- See rafter cut detail below.
- Standard nailing pattern, using 3" framing nails.
- Strong ties to attach rafter ends to framing

Materials:

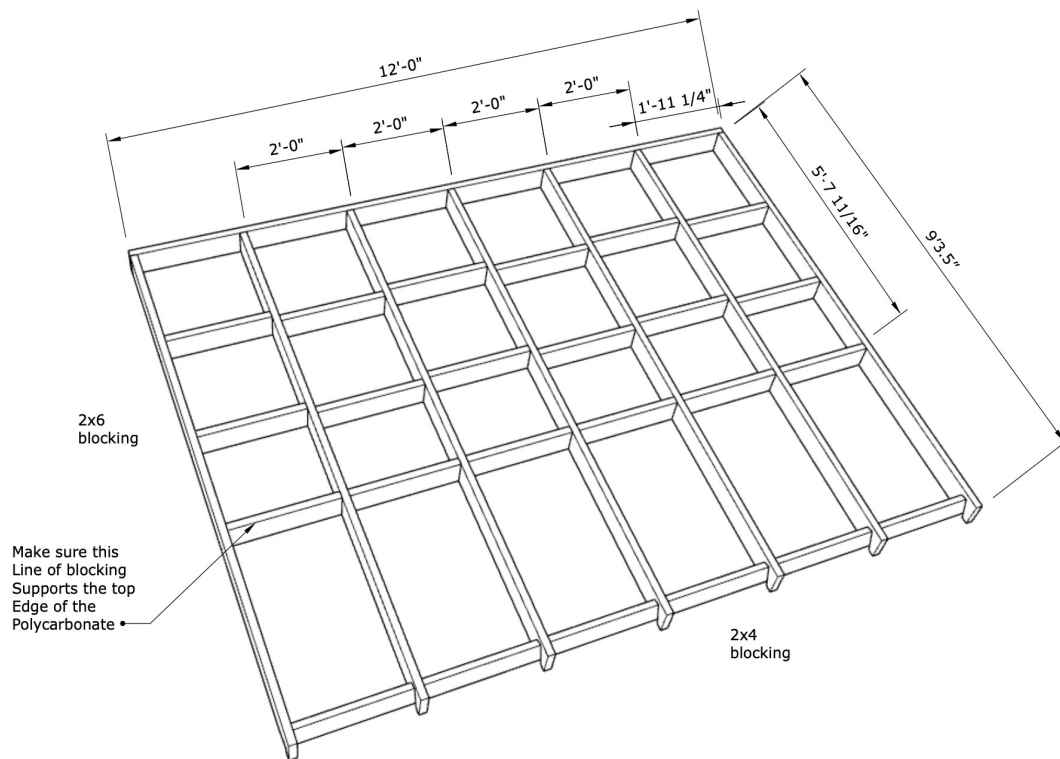
(2) 2x6 – 12' (144")

(7) 2x6 – 9' 1 3/4" (109 3/4")

Blocking, 2x6, as shown.

Notes:

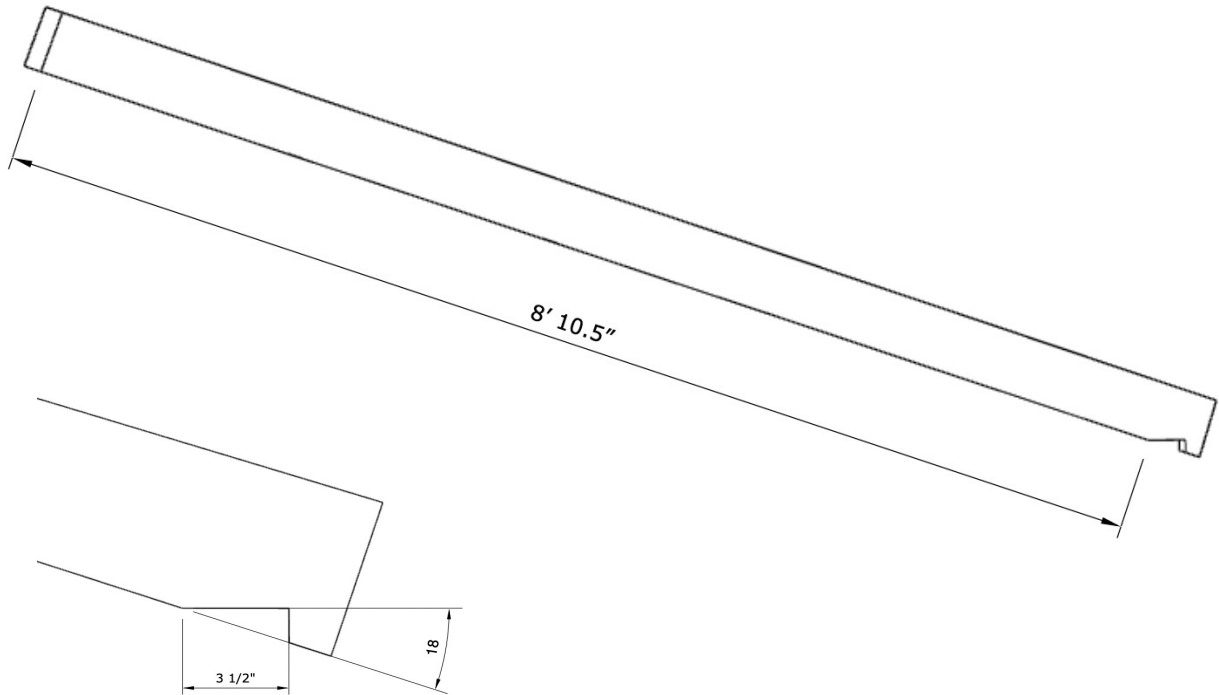
Secure with strong-tie brackets to greenhouse north and south walls.



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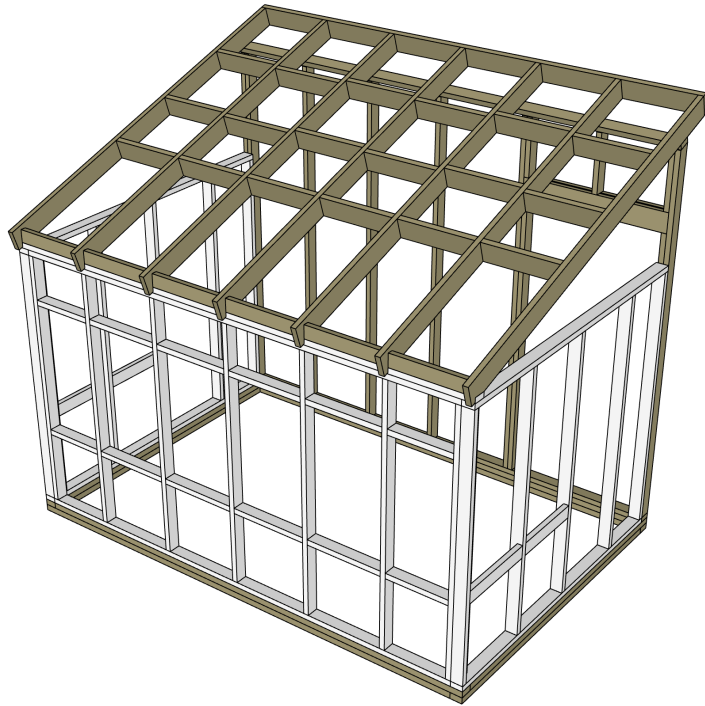
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Rafter end angle cut detail



Roof attached to framing

– full frame visual



Glazing

This diagram shows the greenhouse with three (3) sheets of 4x8 polycarbonate, cut so that a 5 foot section is placed on the front wall, and a 3 foot section on the roof.

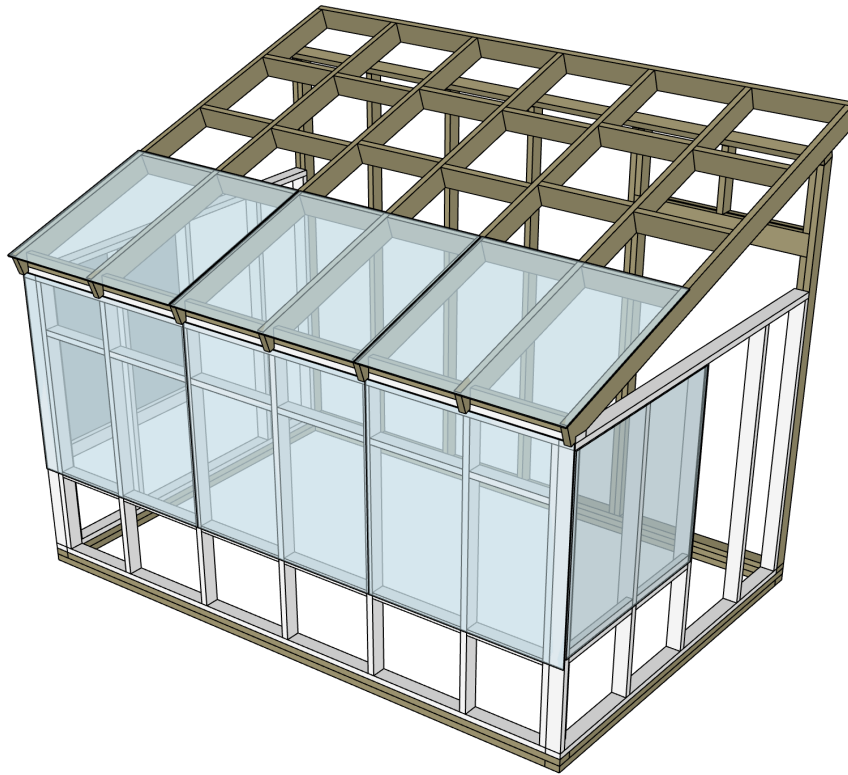
Three sheets will work, especially if the greenhouse is aligned to face south and east.

Four sheets: A fourth sheet can be added for better light.

Six sheets: Another option is to use six (6) sheets of polycarbonate, with three on the roof, and three trimmed for the front of the greenhouse. Additional ventilation will be required.

Suggestion: Do not add more than 8 sheets of glazing – max. 3 (4x8) on the roof.

Use recommended fastening specification included with glazing material.

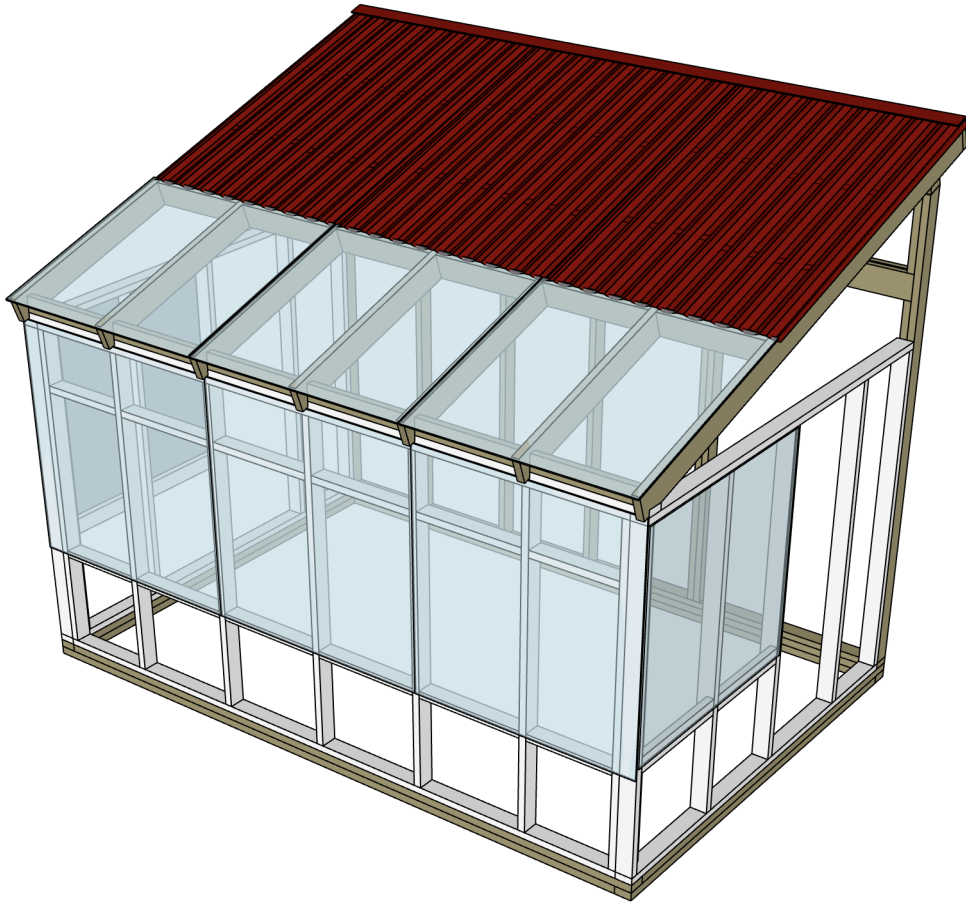


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Finishing the Roof

Finish the unglazed portion of the roof with 1/2" sheeting. Use roofing material of choice over the sheeting, making sure to overlap the glazing by a couple inches for water management.



Use recommended fastening schedule and technique for roofing material choice.

Installing Ventilation Window & Fan

Make a high ventilation panel with the temperature activated window opener. Have it opening facing down to protect from rain events (as shown in photo). The panel that opens does not need to be a window, it can simply be part of the exterior wall cut and hinged to open as a vent when hot.

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On the west wall, install the solar vent fan, such that it will be exposed to sun for the afternoon (3pm onwards) and vent hot afternoon air. If you don't wish to use the door as an air intake, you can install a low vent in the door, allowing the door to stay shut but still draw in the cool north-side air.

Monitor performance of the greenhouse to see if more ventilation is needed. Have a temperature monitor in the greenhouse to make sure peak temperature does not exceed 27-29C (~84F).

A note on exterior sheathing

The exterior sheathing of this greenhouse works really well with reclaimed pallet wood. If you are going to use hempcrete, you can still fill the walls from the inside, against the exterior boards, which were spaced to have small gaps between them. We have done this with our greenhouse, and it has worked well over the last 2 years. The hempcrete can breathe well through the interior surface.

It is also possible to do a standard sheathing exterior, using conventional methods. We have not experimented with hempcrete performance in this situation, but if you do this make sure the hempcrete has 3 weeks to dry fully – cast the hempcrete in place, and remove the board to allow good drying before fastening them back on.

Door

Do you have a door to reuse? Make sure to size and adjust the framing if so. You can also make a basic door if you don't have one handy. Reclaimed doors are easy to find, and youtube can help with the install.

Check out your local Reuse Centres for exterior doors, door knobs, etc.

Disclaimers

These are concept drawings, and do not imply engineering validation. For full permit approved drawings please consult your local building authority for requirements.

The square footage of this design (96 square feet) is usually falls outside permit requirements.

Use standard 3" framing nails and follow local building requirements.

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Hempcrete Basics

Adding hempcrete to your greenhouse is an excellent way to learn to use the material, and get an idea of what it can do. Hempcrete will lower heat stress by managing humidity – something it also does for humans in addition to being an excellent insulative material.

SAFETY WARNINGS:

Lime binder is extremely reactive and **MUST NOT TOUCH EYES or SKIN** or be inhaled. Use gloves, a breathing mask, and work in an outside space with good ventilation and no danger of dust blowing anywhere unintended.

This is a very simple quick start guide. For detailed hempcrete instructions consider purchasing our full guide.

A basic infill mix is a 1:1:1.5 **weight** ratio of hurd:binder:water. This is a typical medium density mix, used in walls. Using 5 gallon buckets and marking lines on them for the ratios is a great way to work with hempcrete to get a consistent mix.

- Hurd size: ideal would be an average size of 1/2-3/4”
- Lime: Type S Hydrated
- Water

Mix the hurd and lime together first, being very mindful of dust, and then slowly add water until the binder resembles the consistency of white school glue. Avoid over wetting, indicated by bubbling binder. You may not need all the water, and you may need a touch more. The mix will be like an oatmeal, able to hold a ball shape in your hand, but still break apart when poked with your thumb.

Pack into the prepared wall spaces. Use wooden forms screwed into the studs to provide a firm surface to pack the hempcrete against so that when you remove the forms there is a nice surface. Nails or screws can be screwed into the stud surfaces to secure the hempcrete, as it will shrink somewhat as it dries and may fall out of the space otherwise. Shrinkage is related to moisture, the wetter the mix the more it will shrink.

Forms can be moved up fairly quickly to continue packing. Leave a hand sized gap at the top and let the wall settle. Then form and pack it when ready – but pack it in sideways and tamp flat to match wall surface. This will reduce the settle/shrink gap at the top of the wall.

Hempcrete is an advanced material and system, friendly to the DIY with a good understanding of the material. To advance your understanding consider purchasing Essential Hempcrete Construction (Magwood) and joining our Facebook group: <https://www.facebook.com/groups/2094727400743633> (Goodvin Designs and 3DSpace Terraform – Alternative Material Design).

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