



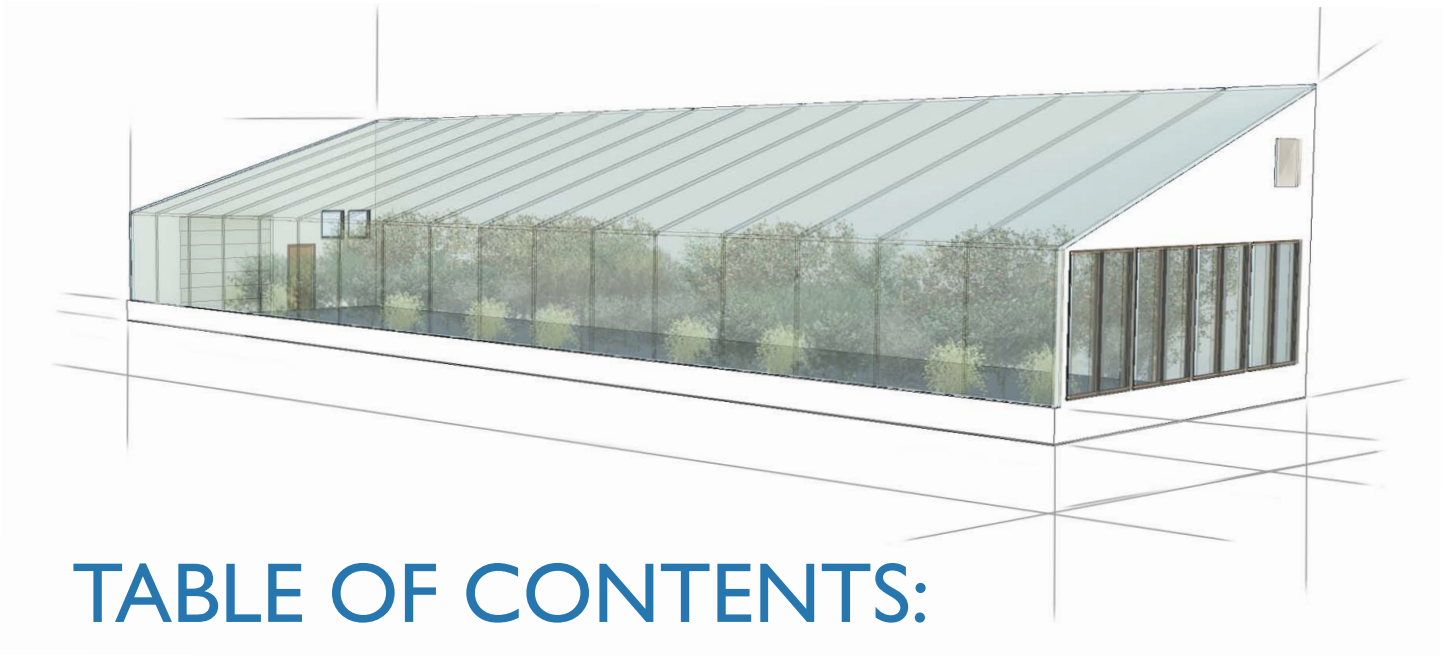
# DESIGN AN ENERGY-EFFICIENT AQUAPONICS GREENHOUSE

V2, April 2017



CERES GREENHOUSE SOLUTIONS  
CeresGreenhouse.com  
303-495-5006 | info@ceresgs.com



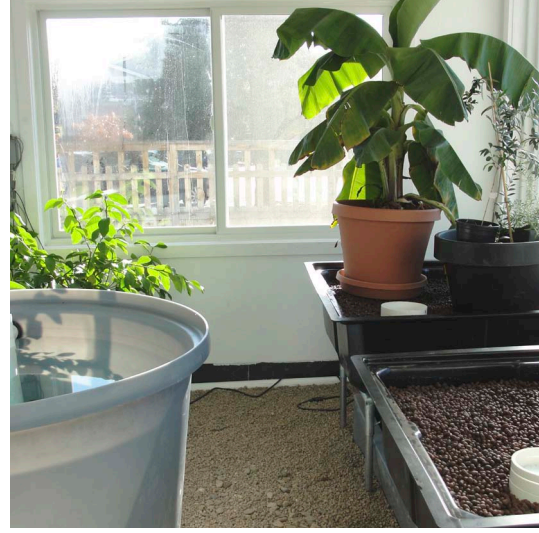


## TABLE OF CONTENTS:

04	About this Guide
06	Create An Efficient, Durable Greenhouse
09	Create A Floor Plan
10	Plan For Grow Beds
12	Plan For Fish Tanks
13	Decide On Flooring
14	Plan For Electrical
16	Planting Tips



303-495-5006 | [info@ceresgs.com](mailto:info@ceresgs.com)  
[CeresGreenhouse.com](http://CeresGreenhouse.com)



## ABOUT CERES

Ceres Greenhouse Solutions started with the idea of applying energy-efficient building design to greenhouses (notoriously inefficient structures). As a result, we build 'greener greenhouses' -- those that save energy, water and money; operate independently; and grow abundantly year-round. As energy-efficient, durable and customizable structures, we've found these greenhouses to be a natural fit with aquaponic growing methods. Over many years, we have continued to refine efficient greenhouse design for aquaponic growers, leading to this e-book.



## ABOUT THIS GUIDE

The purpose of this e-book is to provide a framework for growers to design a durable, cost-effective and abundant aquaponic greenhouse. The principles can be applied to greenhouses in any climate and size -- whether growing as a hobby or commercially. Importantly, however, these recommendations should be tailored for your specific climate and growing goals. This guide is intended to provide a general framework for planning an aquaponics greenhouse, which you should then customize for your specific situation.

If you need further advice on your aquaponics greenhouse, we offer hourly consulting, custom designs and engineering to assist you.

Finally, we would love to hear your feedback about this guide. What was helpful and what questions do you still have? Please help us improve our resources -- share your thoughts with us at [info@ceresgs.com](mailto:info@ceresgs.com)

*Photo top left and bottom left from Flourish Farms in Denver, CO. Bottom left Flourish Farms with ZipGrow Towers.*

## DON'T DO THIS

Why build an energy-efficient greenhouse? Standard greenhouses are extremely energy-intensive structures to operate year-round in most climates. This is because conventional greenhouses are normally constructed out of thin sheets of glass or plastic. Collectively called "glazing", these materials are extremely poor insulators. They let tons of heat in during the day -- causing the greenhouse to overheat -- and quickly lose this heat at night -- causing the greenhouse to over-cool or freeze. As a result, a typical greenhouse normally experiences huge temperature swings if uncontrolled. For example, the structure can easily go from freezing (32 F) to over 100 F within 24 hours on a sunny winter day. This intense temperature fluctuation will stress or kill plants. To accommodate, most growers must heat and cool the greenhouse, resulting in high energy costs and a dependence on fossil-fuels.

We should note that some growers have other strategies for growing year-round sustainably. Eliot Coleman, author of *The Winter Harvest Handbook*, is well-known for growing cold-tolerant crops like spinach through the winter without heating, on his farm in Maine. He does this by choosing hardy varieties and using additional layers of crop protection, like row covers, in the greenhouse. That is challenging in an aquaponics greenhouse, however, where both the fish and plants must be stable temperatures. In fact, fish tank heating is the top challenge for most aquaponic growers. Fish maintain their body temperature via water, which should not fluctuate by more than a few degrees. An energy-efficient greenhouse makes it far easier to control the water temperature, and grow healthy fish.

Finally, a energy-efficient greenhouse is usually more durable due to better materials. Most traditional greenhouses are not rated for high snow and wind loads, putting your investment at risk.

For those reasons, a durable and energy-efficient greenhouse tends to be far better equipped for aquaponic gardening. Energy-efficient greenhouses are able to grow more variety -- plants like bananas, avocados, figs, etc. -- using less energy and resources.



Above: A plastic kit greenhouse collapsed in a wind storm just a few weeks after it was put up. Standard greenhouses are usually not designed for the high snow or wind loads of many climates



# 1

## Create an Efficient, Durable Greenhouse

*Questions to ask: What do I want to grow and when? What minimum temperatures do I need?*

There are several ways to create an energy-efficient, year-round greenhouse. Most methods center on *passive solar greenhouse design*, a design philosophy which advises taking advantage of free solar energy, using some straightforward building principles outlined below.

### Passive Solar Greenhouse Design

**Orient the greenhouse towards the Sun.** In the Northern hemisphere, the majority of the glazing should face South to maximize exposure to light and solar energy.

**Insulate areas that don't collect a lot of light.** In most North American climates, most light comes from the South. The North wall of a greenhouse plays a minor role in light collection, and thus is better left insulated to reduce heat loss. We recommend insulating the North wall of the greenhouse similarly to the walls in your home. We typically use between R-10 to R-20 insulation. Some areas on the East and West sides of the greenhouse can be insulated as well, depending on your climate and light availability.

A solar greenhouse relies on natural elements for year-round heating and cooling. Designs can be as simple / economical or as creative as you would like., and can be applied to any size structure. See more examples of residential and commercial solar greenhouses on our Photos page at [ceresgs.com](http://ceresgs.com). Photos at right from Ceres Greenhouse Solutions.



**Insulate underground.** Insulating around the perimeter of the greenhouse allows the soil underground to stay warmer. This creates a “thermal bubble” under the greenhouse that acts as thermal mass and helps stabilize temperature swings.

**Maximize light and heat in the winter.** To grow year-round without dependence on lights or heaters, it is crucial to maximize sunlight in the greenhouse during the colder months. This is done by using proper glazing materials and angling the glazing for winter light collection...in general, using the glazing area strategically.

**Reduce light and heat in the summer.** Growing during the warmer months can mean challenges with overheating. Strategic shading, glazing placement and angles reduce unnecessary light and heat in the summer.

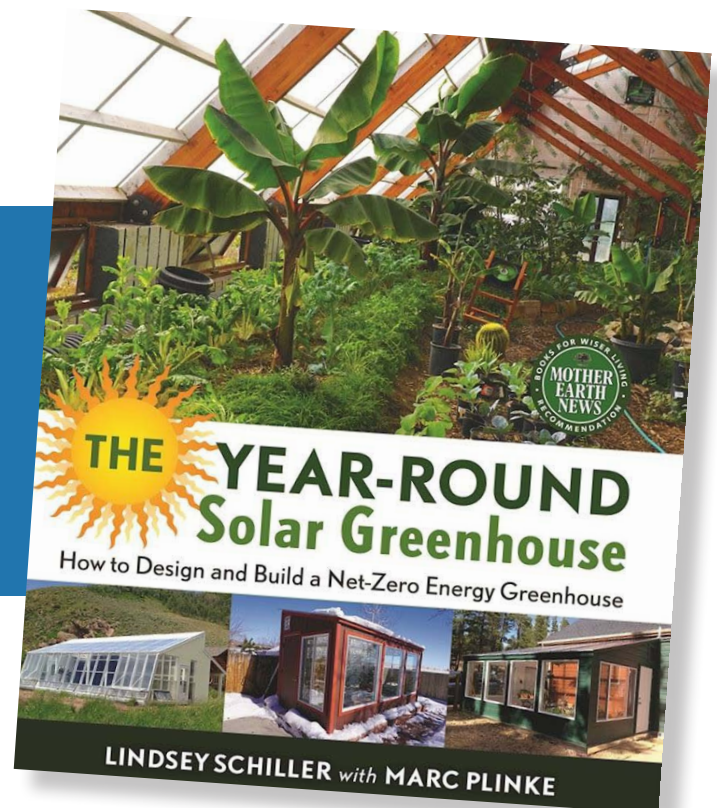
**Use Thermal Mass (or other thermal storage techniques).** Thermal mass refers to materials that store the excess heat in the greenhouse during the day, and slowly radiate it at night or when needed. This evens out temperature swings and creates a more controlled environment. Almost all solar greenhouses have some mechanism to store heat, broadly referred to as thermal storage. Methods for storing the passive solar heat vary widely and are discussed in-depth in *The Year-Round Solar Greenhouse*.

**Ensure sufficient ventilation** Natural ventilation ensures a healthy growing environment and controls overheating.

**Use materials intended for humid environments.** Humidity is a major consideration when selecting building materials.

## Further Reading

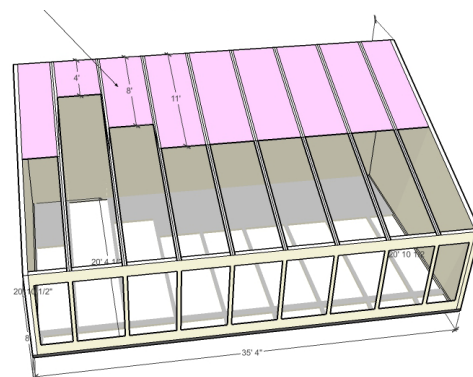
For more on the principles above, and building your own year-round greenhouse with passive solar design, we recommend our book, *The Year-Round Solar Greenhouse*, available at [ceresgs.com](http://ceresgs.com).



## Additional Tips for Warm Climate Greenhouses

### Shade part of your roof

For most of the year, sunlight coming in through the top section of the greenhouse roof will not directly hit the growing beds in a solar greenhouse. This is due to the angle of the sun (called the solar elevation), which varies by latitude. If this area does not directly illuminate plants, it is best covered with shade cloth or an insulating material, in order to reduce unnecessary heat gain in warm climates. A shaded area can be particularly useful if you have fish tanks and equipment on the North wall, which are best left in the shade.



### Shade tanks & leave them open

For those in hot and dry climates, you can take advantage of evaporative cooling from fish tanks. As air moves across the surface of the water, it will evaporate and absorb energy in the process. This only works well in dry climates. You must be cautious of over-humidifying the greenhouse, so proper ventilation is key. Evaporative coolers are another tactic to air condition a greenhouse in a hot and dry climate.

## Additional Tips for Cold Climate Greenhouses

### Insulate part of your roof

As mentioned above, a section of the roof does not contribute greatly to illuminating grow beds. Thus, for cold-climate greenhouses we recommend reducing heat loss through your roof by installing insulation at the top of the roof. The length of insulation will depend on your latitude (solar elevation angles) and floor plan.



### Insulate fish tanks and plumbing

You can reduce the cooling effect of evaporative cooling - as water evaporates from the surface of the tanks - by covering tanks in the winter. Jeremiah Robinson, who runs Frosty Fish Aquaponics in Madison WI, is a big proponent of this. He converts old freezers into fish tanks to create sealed, insulated tanks with air-tight lids. This requires using an aeration device to oxygenate the water, but saves a large amount of energy. He also recommends insulating any area where heated water will circulate, such as plumbing. Plumbing insulation is a simple, low-cost tactic to reduce water heating costs. More information at [frostyfish.com](http://frostyfish.com).

*Photo, top - effect of shading. Photo below - pipe insulation from Frosty Fish Aquaponic Systems.*



# 2

## Create a General Floor Plan

*Questions to ask: What do I want to grow? How much space do I need?*

Identifying the basic size and layout of your aquaponic system - and its arrangement in the greenhouse - is a critical step to your greenhouse design. You should know your goals and available resources. Budget is an obvious factor, so you may want to lay out a general floor plan, then get cost estimates, and revise if needed.

We recommend starting out planning space for your grow beds, and then using your bed area to determine the volume of fish tanks. The ratio of fish tank volume to bed space varies by aquaponic system. You should do further research for your specific set-up, however some basic general ratios can provide a starting point. For example, in her book *Aquaponic Gardening*, Sylvia Bernstein recommends residential growers begin with a media bed system, and use a starting ratio of 1:1 of grow bed volume to fish tank volume (assuming a stocking ratio of 1 lb. mature fish per 5-10 gallons of water). That means that fish tanks will a significant portion of the footprint of the greenhouse.

You may also want to consider space for:

### Water heaters

Heaters are usually electric, propane, or natural gas. Using renewable resources like solar hot water for is also possible (see case study, page 21, for an example).

### Space Heaters

There are a huge range of options for heating your greenhouse. The heat requirement (and thus equipment needed) depend on your climate, growing goals (minimum temperature requirements) and structure type. We explain in-depth many options for sustainable / renewable heating in *The Year-Round Solar Greenhouse*. Many growers integrate electric or propane heaters to maintain suitable air temperatures.

### Water Storage

Many growers find it helpful to store de-chlorinated water inside the greenhouse in order to top off fish tanks in the winter. Storing water outside while it de-chlorinates is not an option in areas with freezing winters. Adding additional water storage inside the greenhouse has the bonus of adding more thermal mass and passive climate control.

### Potting/Work Table

### Hang-out Area

Greenhouses can be for more than just growing. Consider integrating spaces for sitting, teaching or relaxing.



Photo from Ceres Greenhouse Solutions

# 3

## Plan for Grow Beds

*Questions to ask: What type of system will I be using?  
How much grow bed area do I need?*

This e-book does not cover the range of aquaponic growing systems - whether media beds, rafts, wicking beds, or vertical towers. Our goal is to show how to integrate an aquaponic system thoughtfully into your greenhouse design.

As a starting point, we recommend locating grow beds in the highest light areas of the greenhouse. If using a passive solar greenhouse design, and in the Northern hemisphere, this will be in the center and southern areas of the greenhouse. Accordingly, fish tanks and equipment should be located along the North wall, to reduce unnecessary sun exposure on tanks and equipment.

### Tip: Insulate Below Beds

For residential growers, we recommend determining your bed height before you build your greenhouse. Then, build an insulated knee wall below the height of your beds. Glazing below the beds does nothing for growth. It only exposes the beds and root systems to cold air at night and intense heat gain during the day. You want to keep your beds and root systems at a stable temperature. The best way to do this is to insulate around them. If building your own greenhouse or buying a custom design, we recommend identifying the height of your beds (usually hip height or 2-3' above ground). Then, design the greenhouse with a framed insulated knee wall up to the sill of the beds (shown in photo right). You can install rigid foam board insulation between studs or framing members of the wall.





## Growing Up

A 10' x 10' greenhouse has 100 sq. ft. of floor space, but 1,000 cubic feet of volume. That fact illuminates why many growers can take advantage of vertical growing to greatly increase their yields. In greenhouses with passive solar design, we normally recommend planting vertically along the North wall -- so as not to block light from other plants. There are several options for integrating vertical growing methods, whether home-made or purchased systems. They include:

**Growing towers** like Living Towers or ZipGrow planters from Bright Agrotech are good options if you are looking for a kit system.

**Wall planters** or **other small-scale systems** like Wooly Pocket, gSky planters or Live Wall systems can be sold as individual units for residential greenhouses. These are usually pricey, but are easy to install.

There is a huge array of **DIY systems** that residential growers may want to integrate. These can be made out of rain gutters, recycled plastic bottles, or your own creation. See Ceres' blog for more ideas and instructions on building your own planters, like the recycled soda bottle planters at right.

Photos top - Flourish Farms and ZipGrow towers. Photos left middle, bottom - soda bottle planters in a Ceres greenhouse



# 4

## Plan for Fish Tanks

*Questions to ask: Should I have tanks above ground or buried?*

As we noted earlier, try to keep fish tanks out of direct light. Direct light promotes algal growth and is stressful for fish. It is also generally much easier to heat tanks than to cool them. In addition, you can choose between burying your fish tanks and / or sump tanks partially underground, or having the tanks above ground. Some considerations...

**Underground** tanks have the advantage that you can build a platform over the tank and use it for growing space, or a work area. The soil also acts as natural insulation and thermal mass. But, be mindful of your soil temperatures. In most climates the soil will probably be colder than your ideal water temperature, and will suck heat away from the fish tank. To accommodate, we recommend insulating the perimeter of the greenhouse underground; actively heating the soil with a Ground to Air Heat Transfer (GAHT™) system; or insulating the tanks themselves. The disadvantage of underground tanks is that they are harder to empty and clean. You also must plan their location in early on, and be sure of it. Underground tanks are hard to adjust.



**Above-ground** tanks make it easier to drain and clean the tanks. They can also make it easier to monitor the fish. If using the greenhouse in a teaching or demonstration capacity, fish are a big attraction and you may want to build fiberglass view windows into the tanks.



Photo top right: Underground tanks at Growing Power, Milwaukee, Wisconsin. Photo bottom right: Fish viewing at Bigelow Brook



### Tip: Insulate your tanks

Insulate around your fish tanks to reduce heat loss and the water heat requirement. Bubble wrap or flexible insulation allows for easy installation. Larger aquaponic operations can even have a separated insulated room (i.e. a head house or equipment room) on the north side of the greenhouse for tanks.

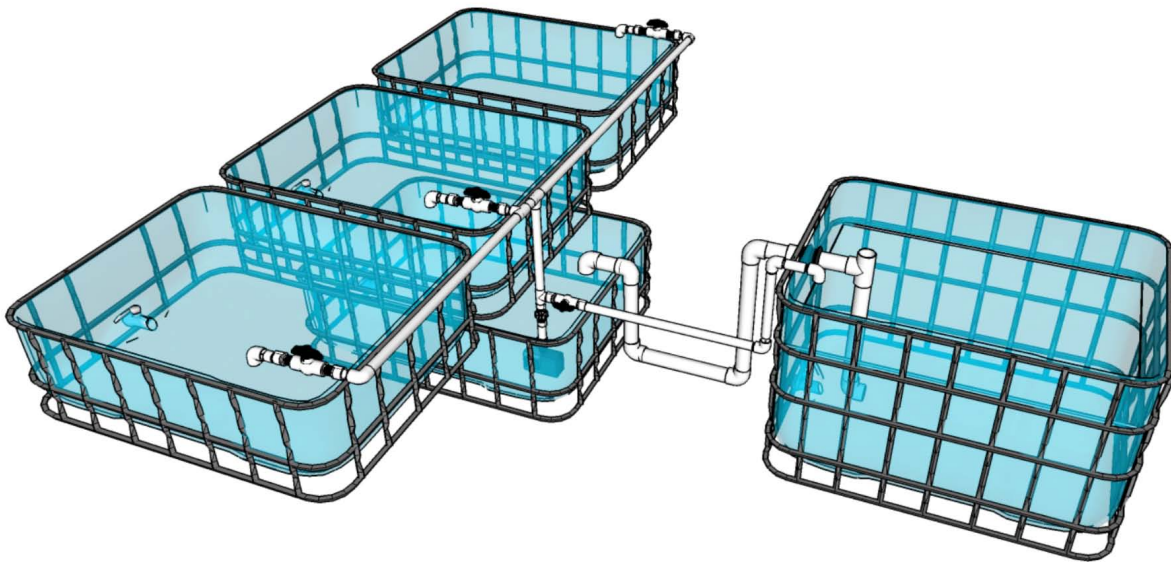
# 5

## Decide on Flooring

*Questions to ask: How can you create a stable and level floor?*

In addition to fish tanks, sump tanks can also be buried underground. In many cases sump tanks are logically located beneath the grow beds, so that water drains directly into them via gravity. (This is the typical set-up in the 'Constant Height, One-Pump,' or CHOP, system shown below).

If either sump or fish tanks will be buried, keep this in mind when choosing a flooring material. If using a concrete, for example, you must leave space open for the tank when pouring the pad.



### Flooring Options

Photo courtesy of The Aquaponic Source

**Concrete** is the most expensive option, but also probably the nicest long-term. It creates a permanent, level surface for all your systems. It is easy surface to clean and maintains a clean environment. The disadvantage with concrete floors is that if you want to bury your fish tanks, sump tanks or plumbing systems, you will not be able to easily alter your layout in the future, so you forgo some flexibility. A concrete pad should have a surface drain.

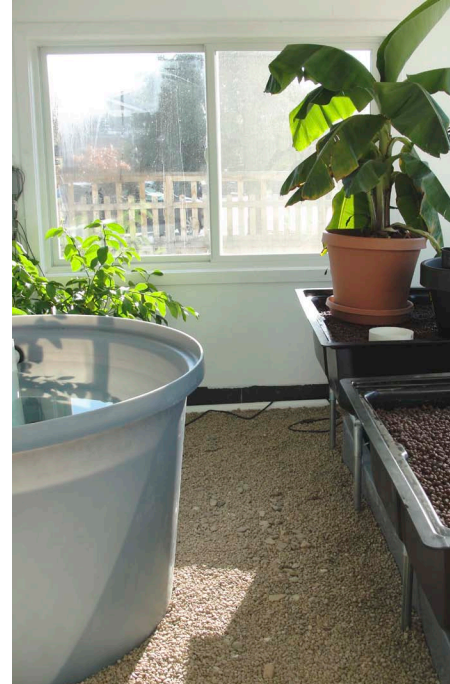
### Tip: Plan plumbing early

Many growers install the flooring and then the aquaponic systems. Going that route can leave you with plumbing that sits on top of the floor and becomes a tripping hazard. We recommend burying plumbing lines before installing the flooring. You can install a concrete plumbing trench for pipes. Alternatively, you raise your walkways to a level walking surface above the plumbing.



**Gravel, Pavers or Stone** are all good options for residential or small commercial greenhouses. They create a level surface and drain well if you have installed floor drains (recommended). They also allow for some flexibility if changing your design and floor plan...you can adjust or access buried plumbing if necessary. The downsides are that gravel can't be hosed down and does not allow for wheeling equipment or tanks around.

**Dirt** is *not* recommended. You are more prone to pests. Moreover, dirt under the weight of large sump tanks or water tanks will compact over time. If going this route, make sure to compact the floor before installing systems so that tanks and beds will stay level.



## 6 Plan for Electrical

*Questions to ask: What equipment will run and how often? How will I connect the greenhouse to electricity?*

Every aquaponics system, and every greenhouse is different and thus there is huge variation on heating and electrical requirements. To help you (and / or your electrician) plan for the electric system, you'll need to know the total power draw, or electric load of all the equipment in your greenhouse. The major energy users to consider are:

- Water pumps
- Water heater
- Aeration pumps
- Electric space heaters, if needed
- Grow lights, if needed

To determine the total power draw you will need to identify the energy usage of each device. This should be listed in the product specs, usually in Watts. You will also need to estimate how often the device will run. Combined, these metrics determine the total energy usage of the device. You will need to add this for each device in your greenhouse. Once you know your total energy draw, you can talk to an electrician about your electrical

plan and wiring the greenhouse (or proceed with it yourself if you have experience).

You need to make sure you have a reliable power supply, and some growers (particularly commercial operations) should consider back-up power available in case of an outage. We recommend Chapter 17 of *The Year-Round Solar Greenhouse* for more on the process of wiring your greenhouse.

Finally, all electric outlets should be above water levels, and should be protected with a Ground Fault Current Interrupter (GFCI) and waterproof covers.



# Going Off-Grid

When considering how to power your greenhouse, you have the same options as with any new electrical system (residential or commercial). Most growers connect to the grid. There is also the option of integrating solar panels. If considering adding solar panels (solar PV), your options are the same for homes: you can create a grid-tied system; a grid-tied system with battery back-up; or a stand-alone system (often called an off-grid system). If trying to go off-grid, we advise using an efficient or renewable source of heating, such as solar hot water, rocket mass heaters, or climate batteries / GAHT™ systems to reduce the total power demand of the greenhouse. Efficient systems will greatly lower the electric load of the greenhouse and make an off-grid solar PV system economically feasible. We delve into the options for solar PV much further in our book, *The Year-Round Solar Greenhouse*, and in articles on our blog at [ceresgs.com](http://ceresgs.com).

*Photo, right - Greenhouse at The Golden Hoof Farm*



## Where to Start?

Since many elements of planning a greenhouse are interconnected, sometimes it can be hard to know where to begin. If starting from scratch, here is a good game plan:

1. First you have to know what you want to get out of the greenhouse...generally, what do you want to grow and how much. How big does it need to be to produce what you would like?
2. This will determine your plant basic bed layout, which will in turn determine how many fish tanks you need. The result is your basic floor plan.
3. Then go to the structure. How do I create an environment that will make these plants happy? Tomatoes are different than kale. Cold hardy micro-greens have different temperature requirements than tropical fruit trees. If going for a large variety, aim to please the plants that need the warmest temperatures. You should have a general idea of how your greenhouse is going to perform, and how difficult or easy it will be to control. To get a better idea talk to other growers in your area, or talk to a Ceres project manager about an energy analysis of the structure.
4. Once you have a rough idea of how your greenhouse will perform, flesh out the components of your aquaponics system. If you anticipate your greenhouse will track air temps and you live in Montana, you will need a sizable water heater. If you are planning a well-insulated greenhouse that utilizes thermal mass, are in a moderate climate, you may only plan a small back-up water heater.
5. From here, you can finish out the system: electric requirements; water hook-ups; and additional accessories like lights and exhaust fans.

## 8 Planting Tips

When growing in an energy-efficient greenhouse, be mindful of plants shading each other. In solar greenhouses, tall plants on the South side of the greenhouse can shade those in the back. To avoid this, we recommend placing taller and vining crops like tomatoes along the North wall.

Solar greenhouses also experience micro-climates: zones of the space which have different climate conditions. One important micro-climate to be aware of is the area directly next the windows / glazed walls of the greenhouse. These zones generally experience much greater temperature swings, particularly the cold temperatures over night. Beds closest to the glazing / windows are a good area for hardy crops, while sensitive crops can be planted in the interior or along an insulated North wall.

Like many topics, growing in an aquaponic greenhouse warrants much more discussion than we can provide here. Books like *Aquaponic Gardening*, and *The Greenhouse Gardeners Companion* are helpful resources for refining your growing strategies.



are helpful resources for refining your growing strategies.

Photo courtesy of The Aquaponic Source.

## Need help?

Designing an aquaponics greenhouse can be a big endeavor. We're here to help you get it right, the first time. Get in touch with us for a free consultation or expert advice - [info@ceresgs.com](mailto:info@ceresgs.com). Folks at The Aquaponic Source can help you create an ecologically balanced design -- [info@theaquaponicsource.com](mailto:info@theaquaponicsource.com).



# 9

## Designs and Floor Plans

Examples of existing aquaponic greenhouses can help identify the best greenhouse design / layout for you, or illuminate the possibilities. Below are several year-round aquaponics greenhouses ranging from residential to small-scale commercial.



### 240 sq. ft. Aquaponics Greenhouse

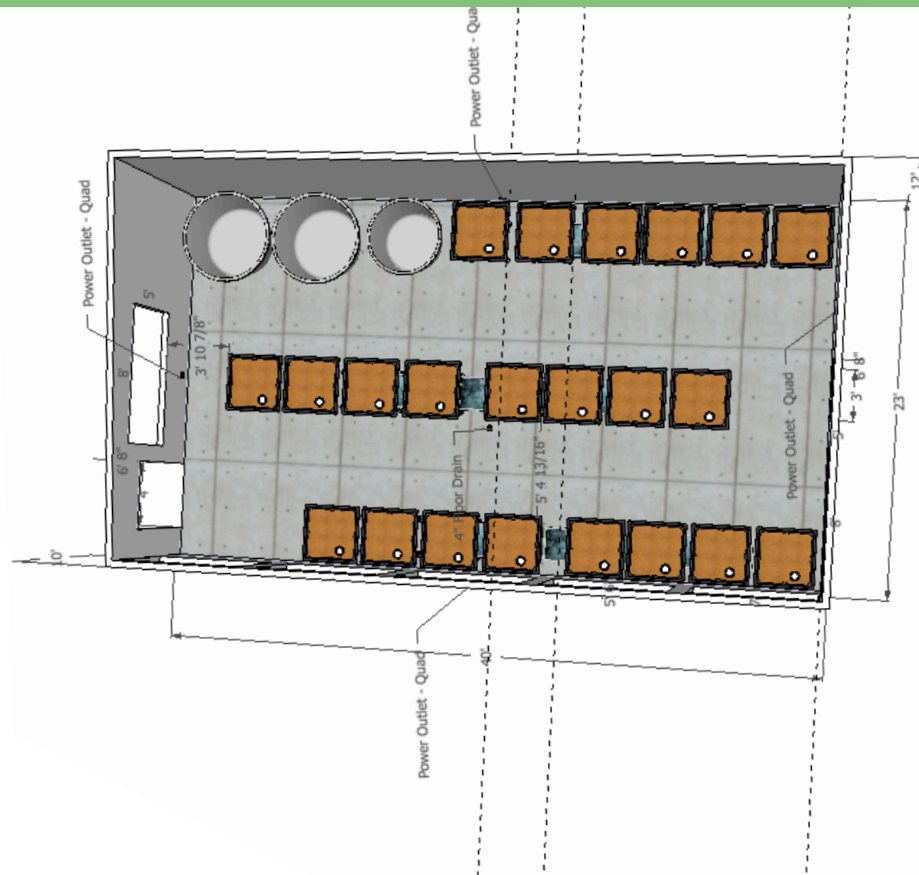
This 12' x 20' greenhouse was constructed from wood framing, triple-wall polycarbonate and glass view windows, following engineered plans from Ceres Greenhouse Solutions. The kit aquaponics system is the AquaBundance system from The Aquaponic Source.

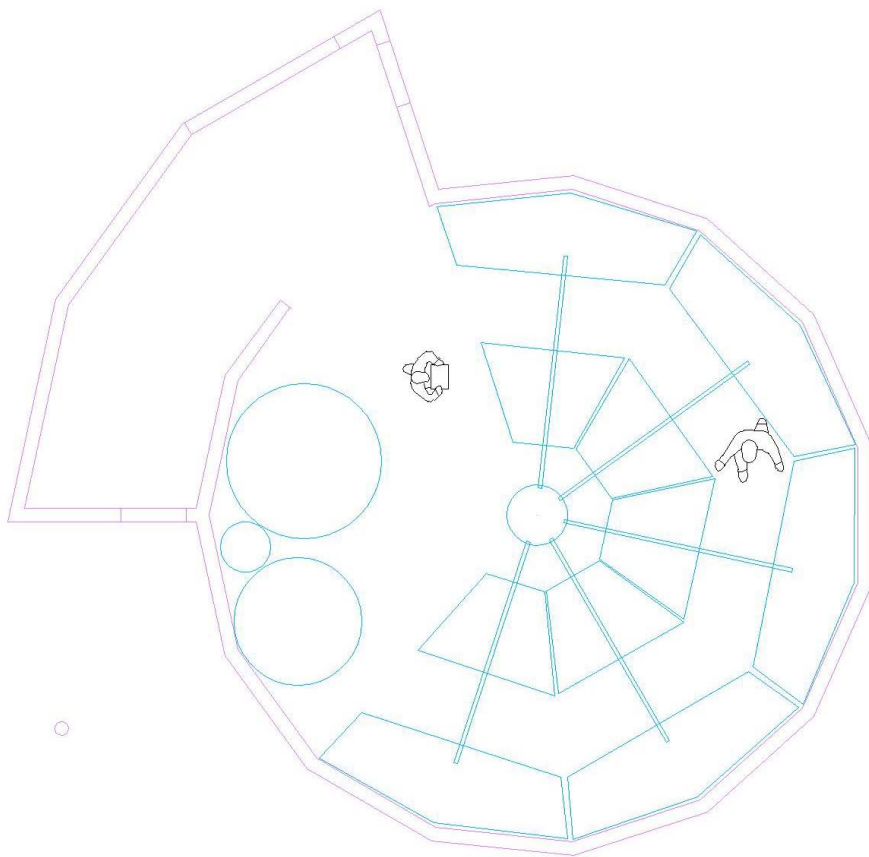




## Aquaponics Kit Greenhouse

This 924 sq. ft. greenhouse is constructed from Ceres' HighYield Greenhouse Kit. The greenhouse used twenty-two 4'x4' media grow beds, in addition to two fish tanks totaling about 1,000 gallons of water. It produces food for a family of four, who try to live as independently as possible.





## DIY Dome Greenhouse

Rob Torcellini of Bigelow Brook Farm built this dome greenhouse and aquaponic system on his farm in Connecticut.

The greenhouse has an insulated wall and custom working space on the North side. Rob put in a customized version of a Ground to Air Heat Transfer (GAHT™) system / climate battery to store energy in the soil and stabilize temperatures year-round. He also added a rocket mass heater to provide additional heating throughout the winter. You can watch several videos of Rob building the greenhouse, plumbing systems and aquaponic systems on Bigelow Brook Farm's youtube channel -

[www.youtube.com/user/web4deb](http://www.youtube.com/user/web4deb)

Above: Raised beds (blue) line the perimeter and center of the greenhouse. Plumbing connects the beds to a central sump tank, which is connect to fish tanks on the North side. The green lines show Rob's custom underground heat exchanger similar to a GAHT system / climate battery. Photos courtesy of Bigelow Brook Farm.



# Hillside Residential Greenhouse

This 288 sq. ft. greenhouse is nestled into a hillside of the owners home in the Colorado mountains. The greenhouse spans two levels, with three IBC tote fish tanks sitting in the center. The fish tanks (1,000 gallons in total) are insulated and connected in a series. They are heated with a rocket mass heater -- a high-efficiency wood-burning stove surrounded by thermal mass. The heater raises the temperature of the tanks several degrees Fahrenheit within three hours of running, says owner Bret White.

The greenhouse grows a few kinds of fish at a time (usually tilapia, perch, and wiper) as well as a wide assortment of plants, including goji berries, grapes, dwarf citrus trees.

The self-built greenhouse is wood-framed with twin-wall polycarbonate, following passive solar design. More information and pictures can be found at [groovygardenguy.wordpress.com](http://groovygardenguy.wordpress.com).



# School Aquaponic Greenhouse

When Harry Weekes became the Head of School at The Sage School in Sun Valley Idaho, he inherited an old and inefficient greenhouse that could not grow through the harsh Idaho winters. Using grant funding, he initiated a retrofit of the greenhouse, adding a large solar hot water system and installing an aquaponic system. The solar hot water heats both the aquaponic fish tanks, as well as the greenhouse, allowing the garden to grow independent of fossil-fuels year-round.

Currently, the school greenhouse provides a hands-on classroom to supplement math and science classes, a place where students learn about chemistry and biology as well as practical skills like gardening. It also serves as a production greenhouse -- some of the



*"We managed to keep the greenhouse above 40 degrees from November through March, and never turned on the heat. We grew lettuce, radishes, kale, arugula, and spinach. During our first crop of tomatoes last year, one woman stopped buy to see what kind of trees we were growing. Suffice to say, the system is up and functioning well.*



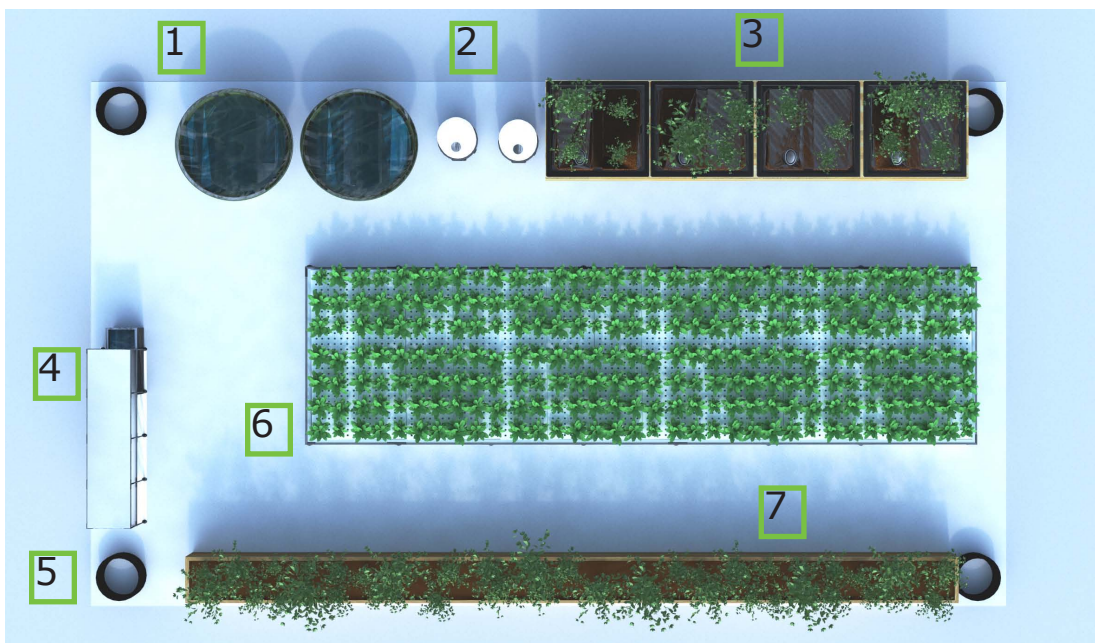
*In the last three to four months, we have sold over 200 pounds of produce, and made more than \$4,000 from our sales. We have found a way to reduce our energy costs, generate income, produce local food, and to reduce our environmental impact."*  
—Harry Weekes, Head of The Sage School



## Hybrid Aquaponic Growing

The layouts below feature two sizes of greenhouses with hybrid aquaponic designs, created by Colorado Aquaponics. The backyard greenhouse design includes:

- |   |  |
|---|--|
| 1. Two 300 Gallon Fish tanks                  | 4. Seedling nursery system               |
| 2. Water filtration system                    | 5. GAHT™ Heating & Cooling Pipes         |
| 3. Media beds for fruiting crops (64 sq. ft.) | 6. Deep water culture beds (256 sq. ft.) |
|   | 7. Wicking beds                          |



# Commercial Aquaponic Growing

Similar to the design on page 22, this commercial greenhouse integrates multiple aquaponic systems to increase variety and yields. Deep water culture beds can be used for high-volume production of leafy greens (estimated production is 40,000 heads of lettuce per year); media beds grow fruiting crops; and wicking beds can be used for root crops.

The greenhouse was designed by Colorado Aquaponics and Ceres Greenhouse Solutions in order to provide emerging aquaponic farmers with high yields, efficient growing, cost-effective operations and crop diversity.



Photo left - Hybrid greenhouse design by Ceres Greenhouse Solutions and Colorado Aquaponics. Photos below- Flourish Farms in Denver, Colorado



QUESTIONS?

**Greenhouse Design**

Ceres Greenhouse Solutions  
info@ceresgs.com / 303-495-5006

**Aquaponic Systems**

The Aquaponic Source  
info@theaquaponicsource.com / 855-285-4252

