Sustainable Energy Aquaculture

An Experiment in Availability and Affordability

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Introduction:

- People are starving in today's world, not just in foreign countries like Africa, also in the middle east, in Europe, here in the USA, and even right here in the state of Arkansas,
- Over **two billion** people in our world today, do not have access to the main grid for power needs.
- Poor soil conditions and lack of access roads make agriculture extremely difficult, if not possible, in many of these areas.
- I wanted to find a way to counteract the problems that faces so many people and families in this world.
- The difficult task of trying to find a solution to this seemingly insurmountable problem was overwhelming at first.

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The Questions:

- What could be built that would provide a way for an average person just about anywhere in the world to be able to produce food, and also could be powered by renewable energy source(s)?
- Would the supplies needed to build and operate these systems be easily available to the average person?
- Would the average inexperienced person, handy with basic tools be able to construct a system that worked?
- What would be the medium with which the plants would grow in?
- What kinds of renewable energy would be able to handle a food growing operation?

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A Likely Solution

Nadine Straitt's green house under constructed in 2009.

Hydroponic Green House;

- Can be erected in virtually any climate
- Reliable, proven construction.
- Does not need soil for a growing medium
- The building process is easily taught and constructed with out complicated tools.

- Hydroponics can be used in a closed loop system that will use less water than regular agriculture
- Can create a working model to try out these ideas to see if they would work

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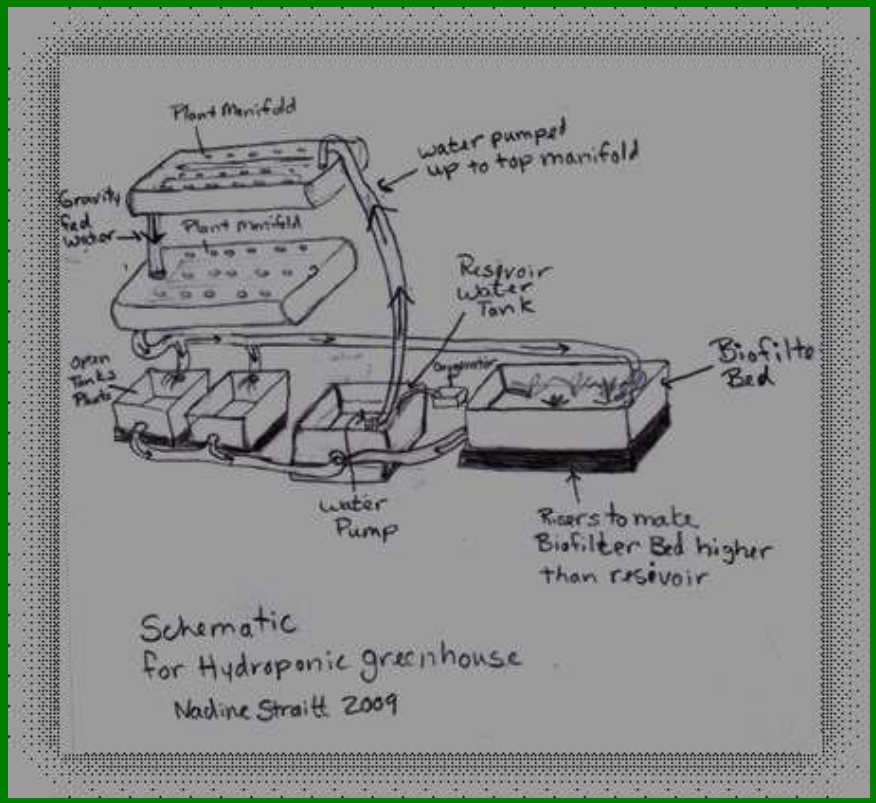
A Proposed Experiment:

- Identify what renewable energy sources would that would be best for the climate we live in.
- Identify what level of power could be expected from an affordably price array of renewable energy sources.
- Based on anticipated power generation capacity what type and size of agricultural facility could I build.



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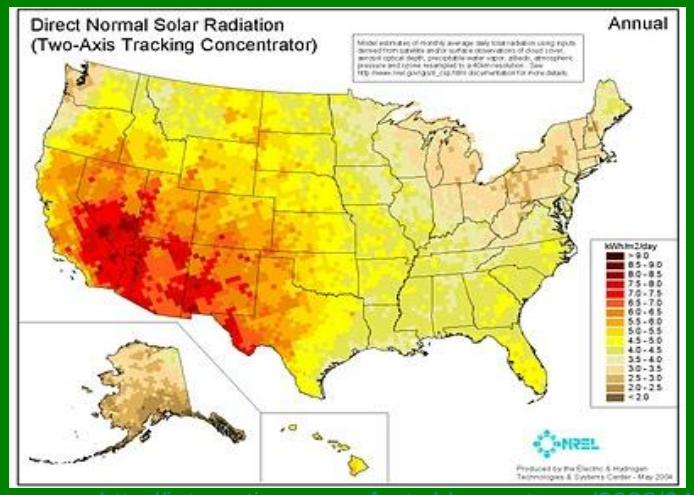
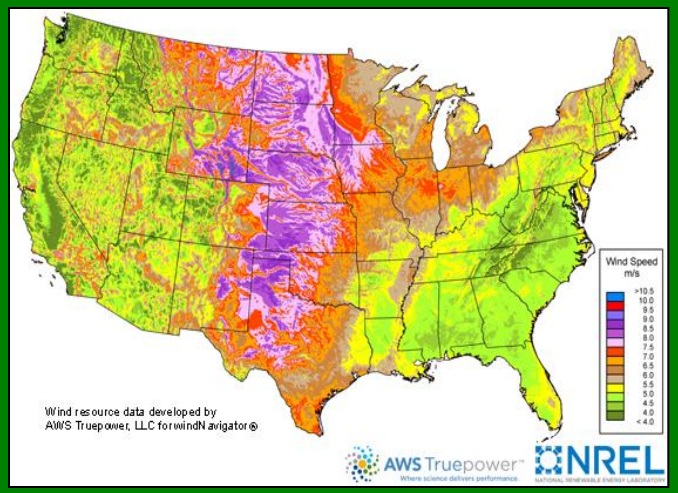
Energy Sources:

- Based on solar radiation maps and wind flow maps it was determined that a hybrid system of solar and wind power would be best for this region of Arkansas.





- http://interestingenergyfacts.blogspot.com/2008/04/us-solar-energy-map.html
- http://www.windpoweringamerica.gov/wind_maps.asp

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Materials needed:

- The materials needed to complete the hydroponic greenhouse are the following;
- A greenhouse or materials to build a green house,
- PVC pipes, unions and connectors 90° and 45° elbows
- photovoltaic panels, charge controller, inverter, brackets,
- one to two deep cycle marine batteries
- Water and oxygenator pump
- Storage tanks to hold water
- plastic hose, hose clamps,
- Styrofoam sheeting
- Planter cups

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Power Needed:

- Estimated power to operate the hydroponic greenhouse;
  - Water pump is 3.6 watts;
  - The oxygenator needs 2 watts,
  - And the grow light for at night needs 40 watts.
  - The grow light will only be on for a couple of hours starting at dusk
- Steady charge needed to run the greenhouse~36 watts

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Hydroponics - the growing of plants in a soilless medium.
Two systems are commonly used.

Nutrient Film Technique (NFT)

- growing seedlings on floating rafts in non-circulating water, such as, a trough of nutrient rich water.

Continuous-flow solution culture

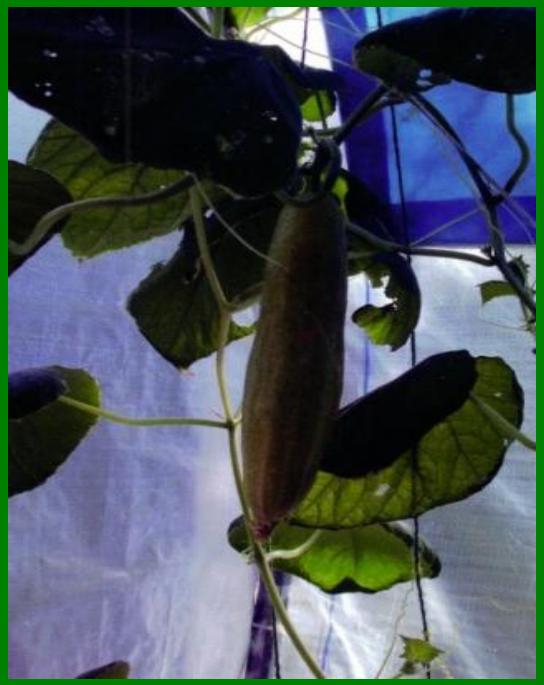
- circulating nutrient rich water past plants started in holes in pipes with their root system fully immersed in the water, or liquid hydroponics.

The use of Photovoltaic cells for power

- Installing 3 15-watt solar panels to power the Hydroponic Greenhouse.

Harvesting 2010

- First tomato harvested from the hydroponic green house.



- First cucumber harvested

The Learning Curve

Trial and Error is a *Great Teacher*

- Temperature
  - In Arkansas the temperature can reach 100*
  - Small spaces can be challenging to keep cool
  - My hydroponic greenhouse was 8 X 8 X 8
  - Trying to cool the greenhouse with a fan, and not exceed my power allotment while still giving the plants enough natural light
- Power Estimating
  - Determine your anticipated load
  - Have your load calculations verified by a collaborator
  - Then add another 100% of generation capacity
  - I need more power!

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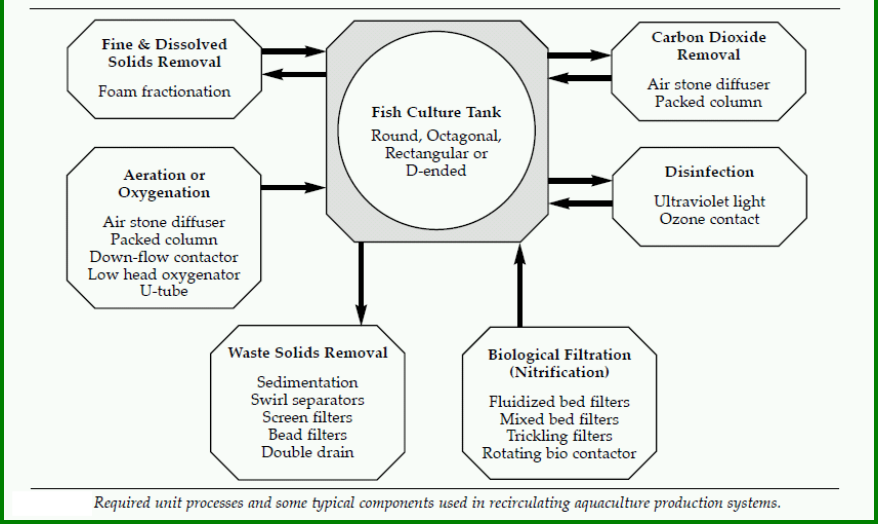
Future System Improvements:

- Aquaponics
- The use of natural nutrients from Fish effluent can be the food stock for a variety of easy to grow and highly profitable organic foods.
- Fish effluent (manure) has been found to contain enough ammonia, nitrate, nitrite, phosphorus, potassium, and other secondary and micronutrients to feed a variety of hydroponics plants.



Required unit processes and some typical components used in recirculating aquaculture production systems.

(Losordo, Masser, & Rakocy, 1998)

Conclusions

- Overall the model is a successful one
- Produced significant edible crops
- Resolved some hurdles of implementation of the technology
- More modeling is needed to complete a template for a sustainable design
- Total Costs for Phase I ~$1,000