Open Source Ecology Proposed Work for 2006-7

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Abstract: This part shows the work do be done in the period from April 2006 to April 2007. The majority of new developments revolves around the development of *novel social technology* and a *flexible hardware technology* which we are proposing herein. Technical developments include energy, vehicle, and farm equipment infrastructure. This is part of background developments of an integrated land-based enterprise community.

INDEX OF PART B

Proposed Work for April 2006-April 2007

I. Novel Social Technology

Our latest development lies in refining and modifying our organizational model for our *Land Stewardship Program*. This model involves the practical steps to the startup and replication of land-based enterprise learning communities.

The basic model has six components that we aim to implement after 18 months of development. It is an integrated package that includes the combined effort of OSE, future Fellows, and subscription customers to our program of year-round community supported agriculture. The six components are: (1), invitation of 12 initial Fellows for a 2 1/2 year commitment; (2), stewardship training of Fellows in the first 1 ½ years at our learning community; (3), finding 12 customers for a year-round subscription food program (community supported agriculture, or CSA); (4), OSE capitalization assistance for starting the CSA; (5), acquiring land with the subscription fee from the customers; and (6), continuing a well-organized effort of open source technology development for sustainable living.

We emphasize a novel procedure for the capitalization of replicable, land-based stewardship enterprise learning communities, including land acquisition. This assumes ergonomic organization, and the capitalization from three sources. These three sources are explained further:

(1) New Fellows pay an admission fee of $1000, such that $12k is collected for procuring the necessary building materials and hardware for agriculture, transportation, and building machinery. The methodology for attaining such functionality at this low cost follows principles of flexible fabrication, modular, open source technology Described in Section II. It yields a life-size, erector set-like construction, and is described in the next section. The devices that are part of the Land Stewardship Program will be produced via sweat equity of Fellows and open source technology knowhow from OSE.

(2) OSE, through its land-based facility, will provide the necessary genetic resources for CSA startup. Also, OSE will share any natural products, such as compressed earth blocks or lumber. Present genetic resources include hatching 250 chicks per month at a cost of $40, to be reduced to $0 within 6 months once our present chicks begin laying. Both figures assume voluntary labor. We have yet to build a fruit tree nursery and propagation facility; seed saving of essential crops; goat and dairy cow breeding; fish hatchery. We need to develop our repository of microbial cultures for fermentation, food processing (such as kefir cultures), biodynamic agriculture, and other useful processes. We are expanding our redworm population to generate organic leachate fertilizers for hydroponics.

(3) Subscription cost from CSA members pays for the actual land acquisition. The key here is that Fellows are able to utilize this income for land acquisition as opposed to capitalization and operational expenses. Capitalization was described in point (2), and operational costs are zero because all the food, housing, energy, transportation, and machinery expenses have been eliminated via integrated food self-sufficiency, self-built, natural housing, oil-based energy resources, and the flexible equipment pool for agriculture and transportation. Incidental other expenses will be paid by income from passive direct sales to customers within the surrounding community, including self-pick crops, and a self-serve on-farm store that provides nonperishable and frozen goods. Local markets may likewise be tapped. The location of the land acquisition acreage will be within 1.5 hours from a major metropolitan area, such that the clientèle of the CSA is primarily elite urbanites. The acreage will be on the edge of a small town, for immediate, small scale marketing in the surrounding area.

This program indicates stewardship-oriented land acquisition where Fellows obtain all required experience and build up the capital infrastructure as a result of their participation with OSE. The agreement between the Fellows and OSE is to share a common vision of open source technology development for sustainable living. The greatest challenge may be finding a suitable group of individuals that is willing to cooperate as such. We ask, therefore, for a 2.5 year commitment. We aim to create an environment so rich for personal growth and expansion of horizons that individuals are indeed attracted to our package. We focus on attracting those who are passionate about creating free enterprise alternatives to the corporate, military-industrial control of the provision of human needs.

II. Infrastructure Development Overview

Currently we are engaged in the firsthand learning aimed at realizing the successful CSA operation. To this end, we will be adding several major components to our infrastructure:

(1) hydraulic compressed earth block (CEB) machine development (prototype by May 1, '06)
(2) sprouting facilities (June 1, '06)
(3) grain and legume field cropping (May '06)
(4) PTO module and shredder for

mulching/ building soil (May '06)
(5)orchard tree irrigation system (May '06)
(6)milk cow operations (begun July '06)
(7)food processing kitchen (July '06)
(8)year-round greenhouse (Sep. '06)
(9)pottery kilns (Dec. '06)
(10)earthen baking oven (Dec. '06)
(11)aquaculture facilities (Dec. '06)
(12)fruit tree nursery (March '07)
(13) functional, hybrid personal transport vehicle and basic agricultural tractor (Oct. '06)

Many of these development rely on the development of point technologies that are the components of a robust, flexible, modular building system. This system applies to various structures and electro-mechanical devices. The methodology for this design method is described in Section III.

III.Flexible Fabrication,[1] Modular Open Source Technology

We are proposing a technology infrastructure for the built and mechanical environment that has the following characteristics:

1. Open source design
2. Design for disassembly (DfD)
3. Maximum modularity and interchangeability of parts
4. Flexible fabrication/manufacturing requiring least specialization and most operator skill
5. Maximal use of natural and local resources
6. Recycling and waste stream utilization

This system is made of generalized building blocks, where each building block may be used in various devices. The key to developing a multipurpose system with the highest range of functionality and lowest cost is to maximize interchangeability of its component building blocks. Structures and electromechanical devices may be reduced to a set of building blocks from which they are made. We have created icons to represent these building blocks, and adopted the particular building blocks to the specific goals of our appropriate technology infrastructure. These building blocks are shown in Figure 1.

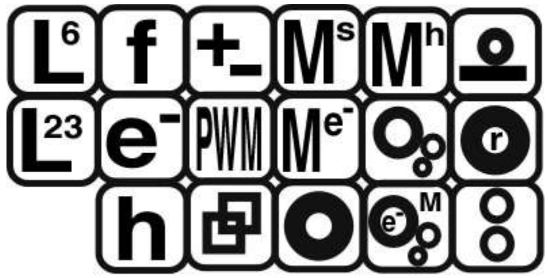


Figure 1. Icons corresponding to the building blocks of structures and electromechanical devices.

These building blocks are: (1) power generator, (2) electrical generator, (3) heat generator, (4) fuel, (5) erector set-like structure, (6) battery storage, (7) pulse-width modulator-based electric motor speed control, (8) electric motor, (9) steam engine, (10) hydraulic motor, (11) power transmission, (12) electric traction motor, (13) wheels, (14) linear actuator, (15) generalized rotor, and (16) pulley. Dedicated components, not represented by an icon, may be added to this core of modules.

This set of modules and their specific implementation was chosen based on simplicity of construction, easy availability of parts, and easy interconnectivity. Because interchangeability, access to parts, and transparent design are priorities, weight and compactness are not optimized.

It is important to note that with such a system of technology, a new economic pattern emerges. Here we introduce the concept of *dedicated cost as distinct from total cost.* Total cost of some device is obtained by summing up the cost of components. The dedicated cost is the cost of the machine after subtracting the cost of interchangeable modules. For example, a compressed earth block (CEB) machine consists of the compression chamber, hopper assembly, an engine, hydraulic pump, and accessories. The total cost is the sum of these components. The dedicated cost, on the other hand, consists only of the compression chamber and hopper assembly, as all of the other components may be designed as flexible modules that are also used in other devices. Since the number of other devices in which these modules may be used is unlimited, we discount their cost in the *dedicated cost* of the CEB machine. Thus, we may state that the dedicated cost of materials for a hydraulic CEB machine is $800 – steel for the hopper and compression chamber, and two hydraulic cylinders - while the total cost may be $4100.

Regarding the modular building system, we are presently testing its feasibility. Before describing each component, we should note the essence of such a system is a structurally modular building method like the erector set toy package. On top of this structural system may be superimposed a multi-kilowatt hybrid electric system where the power unit is a 1 cylinder diesel engine linked to an electrical generator. The electricity powers electrical motors for rotating and linear motion with mechanical advantage.

Practical examples of devices may be a hybrid electric vehicle, an agricultural tractor, a pottery kiln, a sawmill, or many others.

The particular icons of Fig.1 are as follows. The L6 and L23 icons are 1-cylinder Lister-like diesel engines, either stationary 6 horsepower (Figure 2) or mobile 23 horsepower (Figure 3).

One cylinder design is chosen for the greatest simplicity and longest lifetime. Diesel power is chosen because of its capacity to use waste vegetable oil or other liquid fats as fuel. There are also other options for diesel fuel. Fischer-Tropf fluid is a diesel fuel substitute derived from wood, and may be a part of a decentralized energy economy.

Figure 2. Representation of the L^6 icon, the Lister 6 hp, 1 cylinder, 350 kg diesel engine.

Figure 3. Representation of the L^{23} icons, the Lister-like 23 hp diesel power unit, a Yanmar TS230[2], 200kg engine.

The f icon stands for fuel. We intend to maximize our use of waste vegetable oil fuels in the immediate future due to its abundance. Here is a picture of us pre-filtering waste vegetable oil obtained from restaurants:

Figure 4. Filtering of waste vegetable oil for fuel.

The e- icon corresponds to electrical generators. An example is a 140 amp, 24 V generator head obtained from Surpluscenter[3]:

Figure 5. An example of the e- icon, a 140 amp 24 volt generator.

Three of the above generator heads match the power output of the L[23] diesel engine. This yields a voltage from 24-72 V, and electrical power of 10 kW. The importance of the electrical generator is that electricity is the most versatile form of energy. Electrical energy may be turned into heat, light, motion, logic, and other processes. Electric motors are efficient and lightweight: 85 lb for the 54 kW peak motor on our hybrid VW Bug conversion.

The h icon stands for heat generator. Once again we focus on waste vegetable oil. We are interested in self-powered burners with varying outputs for applications in home heating, cooking, bread baking, pottery kilns, melting of glass and metal, and modern steam engine electrical generation. One example of a burner is a forced-air type[4]:

Figure 6. Example of a forced air oil burner.

A second example is a commercial waste oil burner from INOV8[5]:

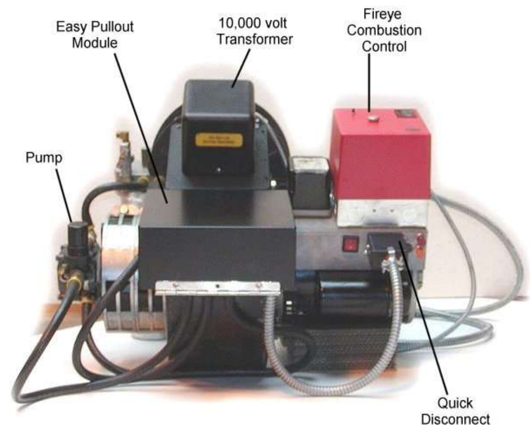
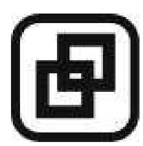


Figure 7. Commercial waste oil burner that uses 1.2 kW of electricity and produces 100 kW of heat.

Another example is a passive 3-tier vaporizer burner used to fire a pottery kiln:

Figure 8. Vaporizer oil burner.

The structure icon,



corresponds to a flexible structural system where attachment of one member to another is by means of readily-dismountable connectors. A good example is the x-y-z corner of wooden beams connected with bolts, such as described in the Box Beam Sourcebook[6]:

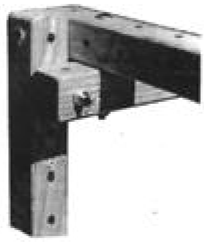


Figure 9. Bolting of three pre-drilled members for a solid connection.

This technique may be applied to metal, where ¼ inch structural box beam and 1 inch metal plate suffices for the bodies of vehicles, tractors, and heavy machinery. This is an example of a hydraulic motor assembly that utilizes grade 8 bolts, not welding, as part of a modular design for disassembly:

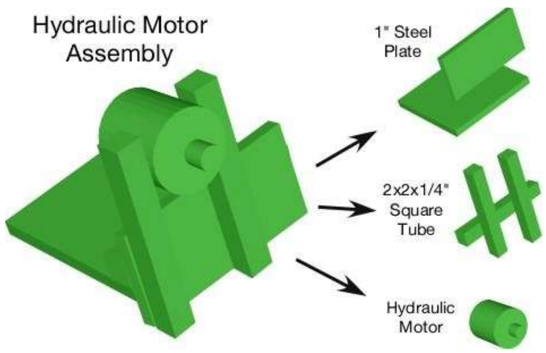


Figure 10. Example of an assembly of beams and plates that are bolted together.

The PWM icon corresponds to the Pulse Width Modulator (PWM) method of controlling electrical power. This applies to the smooth speed control of electric motors and power control of any other electrical devices, AC or DC. It works by turning the power on and off rapidly through a power-handling transistor. The duty cycle of this switching corresponds to the power output. A picture of a device that handles 1 kW of power is shown in Figure 11:

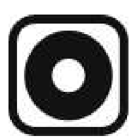
Figure 11. PWM speed controller for a 1 kW electric motor. A power-switching transistor is mounted on the heat sink.

The PWM controller is useful because it controls power smoothly and may be used with a control circuit that can run a motor in forward and reverse. Smooth control of power may displace gearing or transmission requirements in certain cases. For example, it becomes feasible to use a geared-down motor on each wheel of a tractor to obtain fully controllable 4-wheel drive with skid turning.

The +- icon corresponds to battery storage. We are presently considering a battery bank for our larger windmill consisting of 12 of these[7]:

Figure 12. Proposed batteries from Surpluscenter.

The wheel icon,



corresponds to the wheel without the rotor hub. We aim to replace the hub with ball bearings, shaft, and another way to fasten the wheel to the shaft, such that any wheel may be mounted on any shaft we choose. This has applications to doubling wheels for added traction, modifying wheels for added traction, to using wheels as blade tracks on a band sawmill, and others.

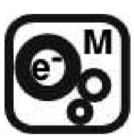
Separation of the wheel from the wheel hub allows for flexible fabrication of other rotors. The rotor icon,

may correspond to a rotor such as a windmill, a rototiller, or blade tracks on a band sawmill.

The transmission icon,

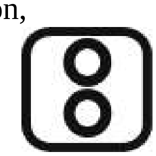
corresponds to bearings, shafts, and gear arrangements inside a structural lattice that speed up or slow down rotating motion. Presently, we are focusing on the chain and sprocket as an affordable, power-conserving route to mechanical advantage. It allows easy implementation of 50-fold gearing. Because this transmission is in a structural frame, it may be connected readily to motors and rotors. It may be used in low speed, high torque applications such as augers, well diggers, and traction wheel motors.

The traction wheel motor icon,



is a highly geared-down electric motor inside a structural lattice. Because it has its own structural frame or lattice, it may be attached readily to any structure. It may be connected by a wire to a PWM controller, and combined with a wheel, it may serve as the traction wheel of a utility tractor or any vehicle.

The pulley icon,



corresponds to a pulley with metal wire, which may be used as a device for obtaining mechanical advantage or for converting rotary motion to linear motion. For example, it may be used with an electric motor and transmission module to lift a front end loader on a tractor. We will explore whether pulley systems, combined with linear actuators, can replace hydraulics in a cost-effective fashion. Hydraulics require another whole package of technology, with pumps, hoses, fluid tank, motors, valves, and cylinders to generate linear and rotary motion.

The linear actuator icon, or

is a device that converts rotary motion to linear motion. At the simplest implementation, this could be the rack and pinion gear, as shown in Figure 13.

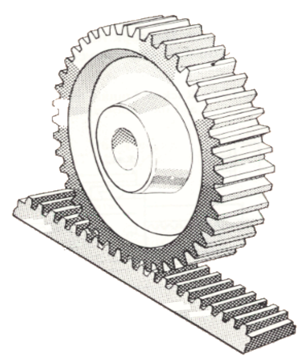


Figure 13. Rack and pinion gear.

The M^{e-} icon is the electric motor. The M^{h} icon is a hydraulic motor or pump:

Figure 14. A hydraulic motor..

The M^s icon corresponds to a steam engine. One modern steam engine that appears promising is the Green steam engine:[8]

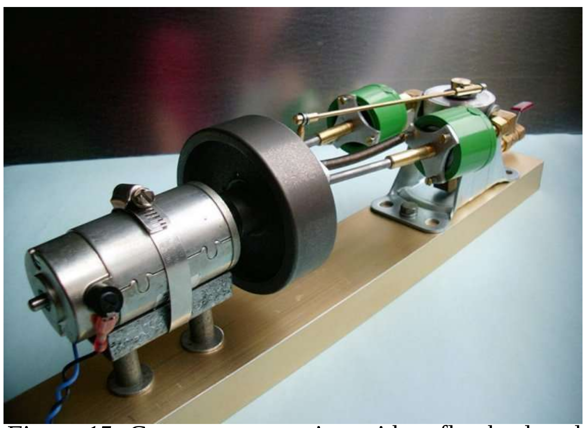


Figure 15. Green steam engine with a flywheel and small generator.

This type of engine, without steam generator, weighs only 5 pounds, and can put out 1 horsepower. The engine is scalable to 40 horsepower. This kind of engine may be a good candidate for a hybrid electric propulsion system.

Using the set of 17 icons, it is possible to use them as an aid in designing various devices. For example, the symbolic representation of our hybrid electric vehicle VW bug conversion is shown in Figure 16. The icon indicates that the vegetable oil-fueled hybrid has the 23 hp diesel engine, electric generator, battery storage, PWM controller for the electric motor, and a structural trailer upon which this is mounted. The body of the VW is not shown because it is a component dedicated only to the VW Bug hybrid electric vehicle.

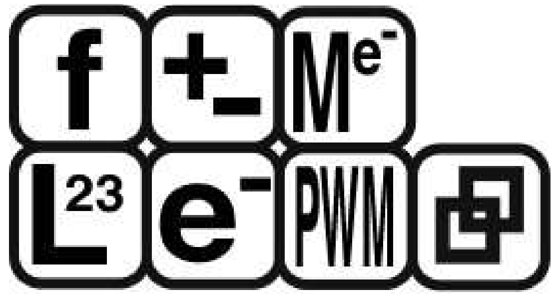


Figure 16. Symbolic representation for our VW Bug hybrid.

This icon represents a hybrid tractor with front end loader:

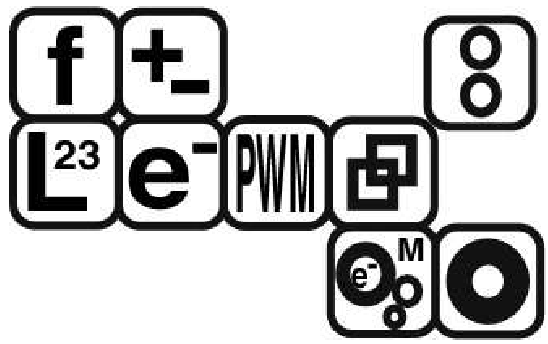


Figure 17. Icon for a tractor with front end loader.

This icon implies that the hybrid electric power source and battery storage is identical to the hybrid car. In the tractor case, there may be 4 individual traction wheels, in this case electric, each controlled by a PWM controller for 4-wheel drive and skid steering. The structure icon refers to the body of the tractor and loading bucket. The pulley indicates that it lifts the front bucket. It is not clear how all the components fit together, such as that another wheel motor module is required for the pulley. This icon may be expanded to show more detail, such as 4 wheel motors, 4 wheels, another wheel motor for the pulley, and another structure module for the bucket.

Figure 18 shows an icon for a windmill. The rotor icon corresponds to the windmill blades and the transmission to a 50-fold gearing up ratio. There is an electrical generator head and battery storage, all put together in a design-for-disassembly (DfD) structure.

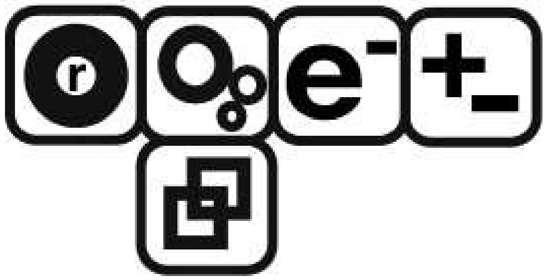


Figure 18. Symbolic representation of a windmill.

These are some examples of how the design method may be used to assist in the comprehension and design of various devices. We will invoke these icons in further discussion as needed. They are summarized in Figure 19.

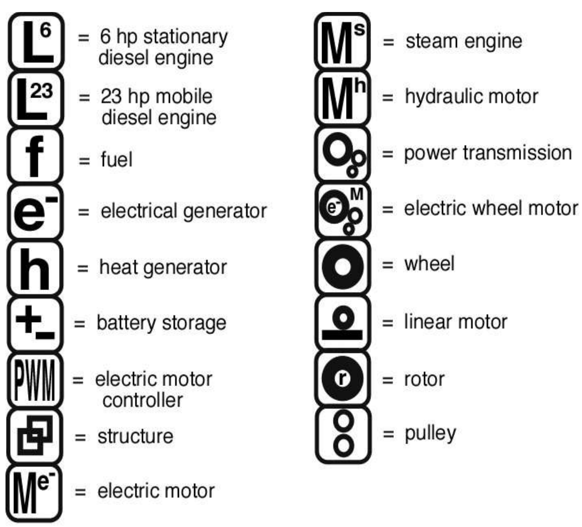


Figure 19. Review of icons for flexible, modular technology design.

IV. Infrastructure Developments

1.Water: We currently have semi-running water. We are installing an electric submersible pump to accommodate this issue, shown in Figure 20. We are also considering a manual well pump mechanized via a linear motion converter. We will test the suitability of a 55 gallon drum as a pressurized water tank substitute that costs less than six dollars.

After obtaining pressurized water, we will develop on-demand electrical water heating powered by the Lister engine. To do this, we will use 3/8 inch inner diameter copper tubing with heat tape made from nichrome wire inside a fiberglass sleeve insulator. The nichrome wire and insulator are shown in Figure 21.

Figure 20. Submersible pump.

Figure 21. Nichrome wire and insulator to be used in on-demand fluid heating applications.

We will recycle our water through worm beds to obtain leachate for hydroponics. We will begin tilapia aquaculture as another source of animal protein. We will install drip irrigation in our 200 fruit tree orchard. We will build a sauna after we master the compressed earth block machine for building. The entire water system will consist of the elements shown in Figure 22.

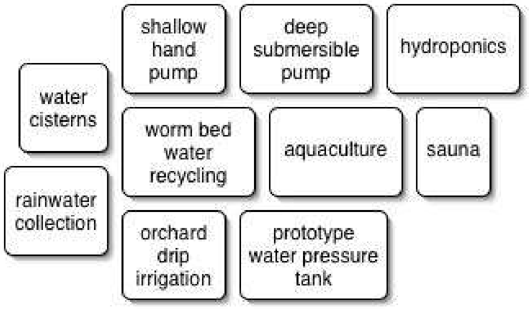


Figure 22. Proposed water system.

<u>2. Vegetable Oil and Suburban</u>: We are currently installing a temperature gauger in our heated fuel line to assure proper temperatures for running our Suburban on vegetable oil. This temperature gauge is shown in Figure 23:

Figure 23. Temperature gauge for vegetable oil monitoring.

Figure 24 shows the entire temperature gauge setup as it will be installed on the Suburban fuel line.

The filtering system will be upgraded to 3 settling tanks. Each tank is a 55 gallon drum with robust outlets made from modified ¾ inch bolts, shown in Figure 25. The filtered oil tank will be placed outside as a fueling station. The Suburban second fuel tank will be upgraded to a 20 gallon tank from a camper. Off-market valves, such as shown in Figure 26, from drip irrigation companies[9] will follow the outlets.

Figure 24. Temperature gauge setup taken from another copyrighted source.[10]

Figure 25. Modified bolt to serve as a settling tank outlet.

Figure 26. ½ inch ID ball valve, $1.65.

The diagram of the complete filtering system is shown in Figure 27. The new vegetable oil propulsion system for the Suburban is shown in Figure 28.

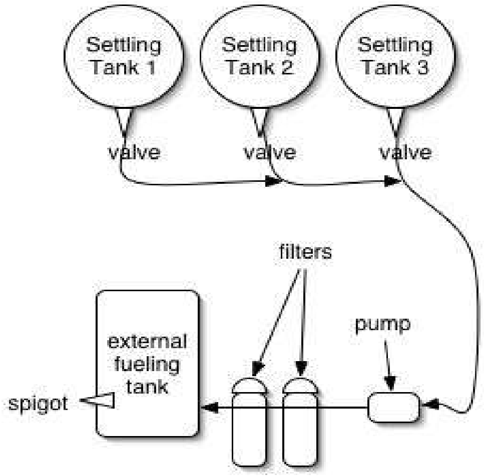


Figure 27. Upgraded filtering system.

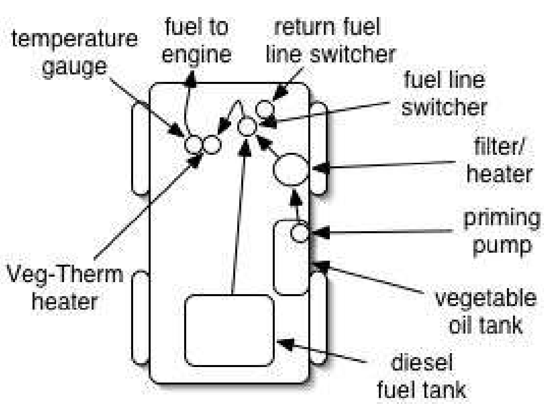


Figure 28. Diagram of Suburban vegetable oil conversion..

3. Compressed Earth Block Machine: The main priority in terms of the built environment is to upgrade existing emergency shelter construction to elegant design utilizing compressed earth block (CEB). The rationale is that this building method is capable of utilizing 100% onsite building resources to produce building blocks. These blocks are classified in building codes as structural masonry block, the same class of building material as structural stone block[11]. Structural masonry compressed earth blocks have higher compressive strength than rocks such as marble, schist, or granite. This is because CEB is made from pulverized, homogeneous clayey soil, and no fault lines are present. Also, no block curing is required.

Machines capable of producing 3-5 blocks/person/minute of 6x12x4 inch dimensional blocks cost in the range of $25k.[12] A machine which we think is one of the most advanced is shown in Figure 29.

Figure 29. Example of an automated CEB machine from Advanced Earthen Construction Technologies, Inc.[13]

This machines produces 5 bricks/minute. These bricks are ejected one after another onto a conveyor belt:

Figure 30. Finished compressed earth blocks deposited on a conveyor.[14]

We are aiming to fabricate a similar, hydraulic machine with manual controls, powered by an electric motor, that will produce 3 blocks per minute, at a dedicated cost of $800.

The CEB machine of interest involves a compression chamber and a hopper. The chamber and hopper each have a hydraulic cylinder, such that the cylinder on the hopper loads the compression chamber and pushes the completed block out of the way. This allows for rapid production rates, where the compression chamber is loaded automatically. Manual loading and ejecting of blocks are the major time expenses in compressed earth block machines. A simplified diagram of the principle, taken from a 1986 US patent,[15] is shown in Figure 30.

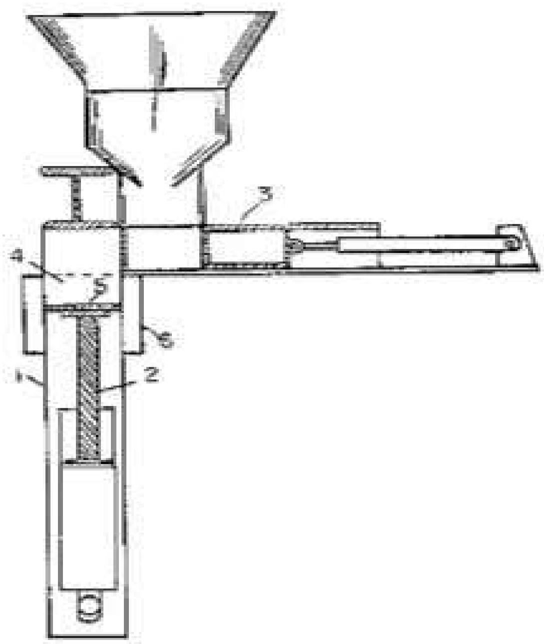


Figure 30. Diagram of an automated CEB machine taken from a 1986 patent.

Our design likewise includes two hydraulic cylinders, one for the compression chamber, and one for the hopper. For the CEB body, we are using design-for-disassembly (DfD) construction. In this design, metal plate and tubing are tapped and connected with ½" grade 8 bolts. We will use an electric motor to drive the hydraulic pump and cylinders, and the power source will be stored electricity from the Lister 6 hp oil engine.

The icon for our design is shown in Figure 31. This icon, read from left to right, contains 3 main sections. These parts are the Lister power unit, the utility tractor, and main body of the CEB machine.

Figure 31. Proposed design for the OSE compressed earth block machine.

The Lister 6 hp stationary engine as the primary power source. The fuel is recycled vegetable oil. The Lister will charge a battery bank either with our 40 amp dedicated 12v battery charger or a 75 amp automotive alternator. The battery bank will consist of 12 6 volt batteries for a system voltage of 72 volts.

The batteries are placed on a utility tractor with hydraulic drive. This tractor is powered by the same electric motor that we utilize in our hybrid VW electric vehicle conversion. The electric motor drives a hydraulic pump, shown in Figure 32, through a 2-fold gear reduction ratio to the pump. This pump provides power to two hydraulic motors, shown in Figure 33, that provide 4-wheel drive to the utility tractor via skid steering. This same pump provides the hydraulic power takeoff to the CEB. The utility tractor structure is made from 2 inch square tubing of ¼ inch thickness.

Figure 32. Hydraulic pump, 14 hp, for the CEB machine.

Figure 33. Hydraulic wheel motor for the utility tractor.

The main body of the CEB machine consists of the compression chamber structure with its main, 5 inch diameter hydraulic cylinder (58,900 lb pressure), and the hopper structure with its smaller cylinder. The main and secondary cylinders are shown in Figures 34. The ½ and 1 inch steel slabs for the compression chamber are shown in Figure 35.

Figure 34. Main (5x12") and secondary (2x14") cylinders for the CEB machine, $250 and $80.

Figure 35. Metal for the compression chamber of the CEB, $140 at 30 cents/lb.

The structure consists mainly of ½ and 1 inch plate and ¼ inch thick steel tubing. It in interesting to note that a basic workshop that includes a drill press and a metal cutoff saw is sufficient to produce the CEB machine, assuming pre-cut steel slabs are available. Our workshop is shown in Figure 36.

Figure 36. Workshop with metal cutoff saw ($79) and a floor drill press ($159).

Holes will be drilled and tapped using a ½ inch tap, shown in Figure 37.

Figure 37. ½ inch tap used for making structural bolt holes.

The heart of the OSE CEB machine is a compression chamber made of 1" steel, shown in Figure 38:

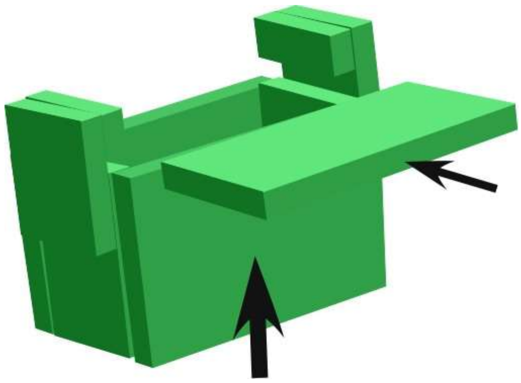


Figure 38. Compression chamber of the CEB machine.

The big arrow shows the direction of motion of the main compression cylinder. The compression presses against the reinforced, one inch top plate. This plate is moved directly over the compression box by the secondary cylinder, indicated by the smaller arrow. This top plate is held down after it slides under another piece of metal that serves as a latch. The top plate is part of the hopper assembly, which loads soil into the compression chamber after every ejection cycle of the machine.

The rest of the CEB consists of the surface upon which the hopper slides and onto which finished block are deposited. There is also a structural details of holding the compression cylinder in place and the hopper cylinder in place.

The main challenges are: (1) proper alignment of metal as it is bolted together, and (2), alignment of the main compression cylinder and plate assembly during compression.

The CEB equipment infrastructure includes the CEB machine, a rototiller, front end loader, and 5 gallon buckets. The rototiller and front end loader scrape the topsoil to expose clayey subsoil. The rototiller then grinds up the soil, and the loader deposits it in a pile for use. The pile is covered with a tarp to let moisture equilibrate. Buckets are used to load the hopper of the CEB machine.

Once the CEB equipment infrastructure is developed, the route will be opened for the second phase of the built environment. We will focus on CEB and earth sheltered/underground construction. A good example of an underground house is shown in Figure 38b.

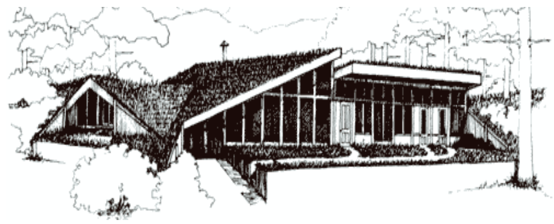


Figure 38b. Example of an aesthetic underground house[16] integrated into the landscape.

4. Heat and Power Generation Overview: Our main priority in our energy system is to provide ample heat generation and power generation to supply various agricultural and light industrial processes. Our priorities for this year are: (1), to deploy a robust oil burner for process heat, (2), a 20+ hp diesel power unit for electricity generation for mobile applications, (3), a multi-kilowatt windmill for base load power generation, (4), deploying a modern steam engine for electrical generation, and (5), upgrading the Lister engine electrical system.

Applications of the oil burner that we would like to pursue include steam engine electric power generation, (6), radiant home and greenhouse heating, (7) cooking range, (8), bread ovens, (9), a pottery kiln, and (10), a sauna. We will utilize the compressed earth blocks to build related structures in these projects.

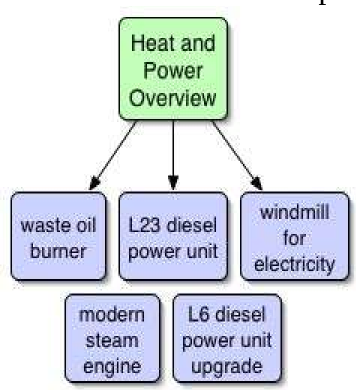


Figure 39. Overview of the heat and power program.

We will also utilize our electricity resources to produce on-demand electric water heaters for household water needs. Other on-demand electric heating applications may exist, such as melting of plastic resins for greenhouse glazing applications.

Along with power generation developments, we will develop power electronics for transmitting, modifying, and dispensing electrical power. We will develop various flexible, open source electrical controls. The main one is the pulse width modulation (PWM) combined with transistor switching. Applications that we are interested in are: (1) scalable DC and AC electric motor and power controllers; (2) DC -DC converters; (3) DC-AC inverters; (4) battery charge regulators; (5) grid intertie inverters. Our goal is to be able to link to the existing power grid to feed excess power back into it as we evolve into our role as energy farmers.

5. Lister 6 hp Oil Electrical System: We will make 5 upgrades to our Lister electrical generator. (1) We will install relays to automate the linkage between the 3 $kW_{electric}$ Lister and the 2 kW inverter in our 120V AC home power grid. We will install a relay system that turns the inverter off and starts feeding live power to the grid from the Lister whenever the Lister is started. When the Lister is turned off, the power grid will revert to the inverter. (2) We will extend this 120V grid to other locations at our facility as needed, such as the sprout house, water pump for the well, or remote battery charging. (3) We will enclose the Lister fully to muffle its sound output. (4) We will add a 75 amp alternator to the Lister for direct battery charging. (5) We will also connect the 240 volt output of the Lister to a transformer, so that we can get all the power out from a single, 120 volt outlet, instead of two outlets at half the power.

6. Waste Oil Furnace and Applications: We will either build our own self-powered oil burner or purchase a commercial unit. We are currently evaluating options and prices for systems. We are interested in a system that has a simple heat-up mechanism and which sustains its power output without electricity. We are interested in a robust system that could burn all types of waste oils. We may be interested in a unit that requires electricity, as in Fig. 7, if the electricity to sustain the burn can be generated from the burner itself.

We are interested in a burner system that can be used as an interchangeable module. We would like to attach this module or its multiples to various devices as needed. This diagram shows the possibilities that arise with our burner:

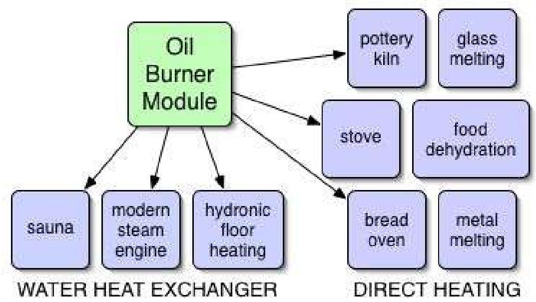


Figure 40. Suggested applications for a waste oil burner.

7. Windmill*:* We are pursing a vertical axis sailwing wind turbine for baseload power generation. Average wind speeds are 11 mph in Osborn, MO. We choose the vertical axis wind turbine (VAWT) design because it is the simplest to build from a mechanical standpoint. It can catch wind from any direction by design.. The basic design is shown in Figure 41.

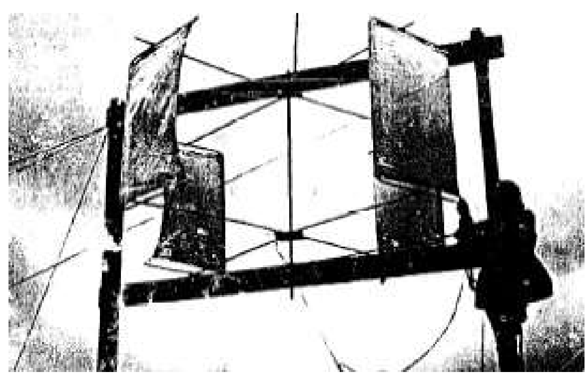


Figure 41. Vertical axis sailwing windmill example.

The sailwing is a superior blade design for the simplicity involved, as it changes shape with the wind.

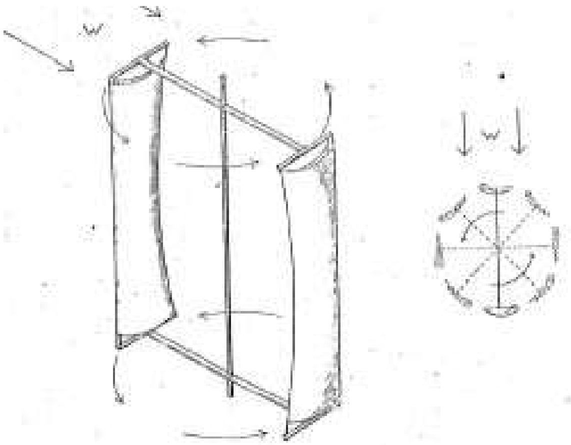


Figure 42. Diagram of sailwing interaction with the wind. Figure taken from the Appropriate Technology Sourcebook.[17]

We have parts for an 12 foot diameter version with 6 foot high sails. A 50-fold gear increase ratio is required. The parts, including a 300 amp, 24 volt generator head, voltage control rheostat, circuit breakers, chain, sprockets, pillow blocks, and collars are shown in Figure 43.

Figure 43. some of the parts for a 12 foot diameter sail windmill.

Developments to be worked out are integration into our battery bank. We are considering a mobile battery bank that we will use with the CEB machine.

The icon for the windmill is shown in Figure 44. The left hand side indicates the sailwing rotor and structure with 50-fold gearing increase, connected to an electrical

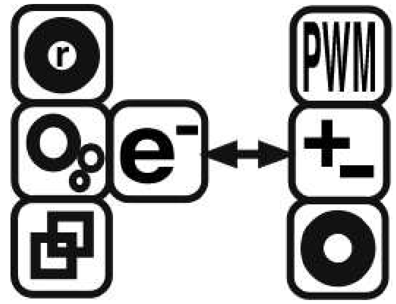


Figure 44. Windmill icon.

generator as in Fig. 43. The two-way arrow indicates connection to and feedback from the battery bank, where charge regulation is required due to the 9kW potential max output of the windmill. This control will be done in the immediate term with circuit breakers and a shunt relay. The battery bank may require switching from 24V to 72V, where the latter is the minimum operating voltage for our modular, Advanced DC electric motor that we showed in Fig. 18 of Part A. The PWM stands for a PWM-based inverter that will feed 120V AC back into our on-site grid from the 24V battery bank. This may be a major development in our power electronics infrastructure if we develop this inverter in-house.

The wheel indicates that the battery bank may be placed on a mobile trailer, such that power is either fed into our grid or into a battery bank that may be used in the near future with the CEB machine.

7. Modern Steam Electricity: The modern steam engine, as shown in Figure 15, may provide a viable, decentralized electrical generation option from cogeneration heat sources such as a wood stove or waste vegetable oil burner. This engine is scalable from 1 to 40 hp. In particular, battery charging could be a great application whenever the sun is not shining, the wind is not blowing, or if we run out of oil for the Lister engine.

We are particularly interested in a compact oil burner unit for mobile applications in steam electric hybrid vehicles.

The additional advantage of the steam engine is that distilled water is a byproduct. The schematic below[18] shows how to produce up to 24 gallons of distilled water per day and all the hot water for a household employing an ordinary household pressure cooker on a low simmering fire. The steam engine operates the system on 4 to 20 psi of steam.

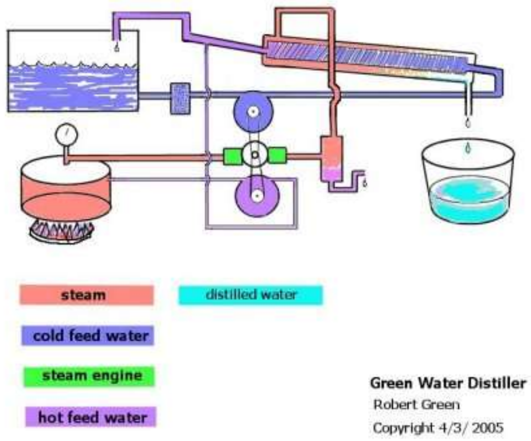


Figure 45. Schematic of the Green water distiller and water heater operating from a steam engine.

Thus, this steam engine may contribute to an interesting household ecology of winter heat and power cogeneration, water heating and recycling.

We have the plans for this engine. The inventor is willing to share his knowledge openly to help us deploy the device.

<u>9. On-demand Water Heater</u>: We have purchased nichrome wire and fiberglass sleeving, as shown in Fig. 21, to fabricate an electric on-demand water heater for household use. Other applications may include oil preheating in oil burner and engine applications.

The key is to test the proper length of wire and power input to operate this device in showers, sinks, and any other hot water applications. The basic diagram for a water heater is shown in Figure 46.

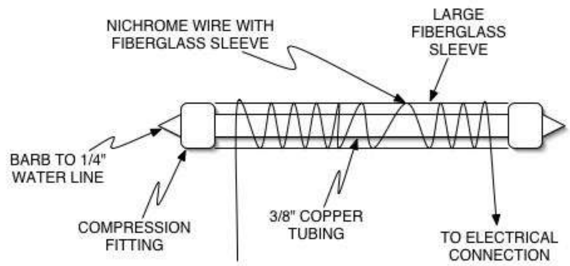


Figure 46. Basic diagram for an on-demand fluid heater.

Note that in addition to the nichrome wire and sleeve of Fig. 21., a larger diameter fiberglass sleeve is required to go around the copper tube itself, as indicated in Figure 46.

<u>10. Hydronic Floor Heating</u>: Using the heat exchanger as in Fig. 31 of Past Work, we have the capacity to heat 300 gallons of water by 10 degrees per hour of firing. This is sufficient for radiant floor heating. Our low-tech concept involves a water-sealed CEB floor and foundation. The floor may serve as the water conduit, if linear channels are made from water-sealed CEBs placed on the foundation. Water may be pumped in from one end of the room, and pumped out from the opposite end. The house floor, sealed with a water vapor barrier, may be put on top of these conduits. A diagram of this is:

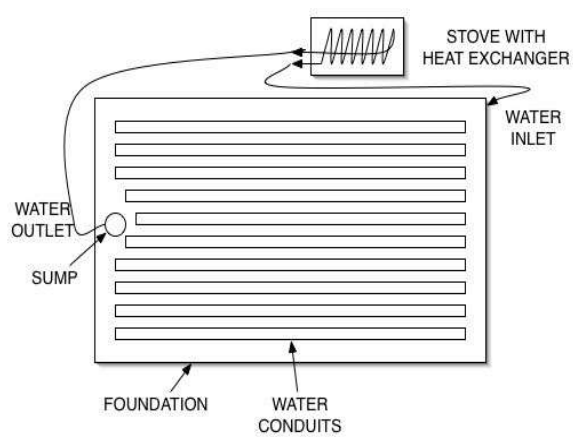


Figure 47. Radiant floor heating with water conduits made with CEB. The entire foundation may be made from CEBs as long as they are water-sealed.

The simplicity of this design is that it uses earth blocks instead of a large length of polyethylene tubing to provide the radiant heating conduit.

<u>11. Tractor and Vehicle Infrastructure</u>: We are presently working on our hybrid vehicle and tractor. The summary icon for this combined infrastructure is shown in Figure 48.

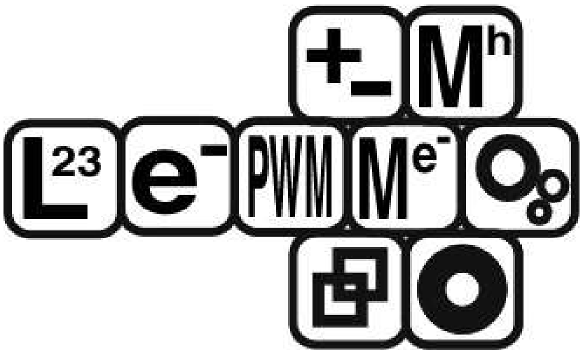


Figure 48. Icon for the vehicle and tractor infrastructure.

The key to this infrastructure is a powerful engine, noted as L^{23}. One possibility for L^{23} was shown in Fig. 3. The importance of a single cylinder engine lies in its simplicity.

The electrical generation part is another main feature of this development. We are presently planning to purchase 3 of the 24V, 140 amp, $100 generator heads[19] that will provide 10kW of continuous electrical power.

The linkage of the engine to the generators includes the features shown in Figure 49. The electrical power unit (EPU) will ride on a trailer that may be attached interchangeably to the VW Beetle or the tractor.

For initial testing, we will build a simple frame for the tractor and mount a battery bank of 12 6v batteries. We will be able to test the tractor and its linkage to the hydraulic system. We will leave the PWM motor control for later, while we test the electric motor and hydraulics at 72 volts with simple on-off switching to the hydraulic pump. The first application of this tractor will be as the power source for the CEB machine, as discussed in the related section above. The tractor will feature 4 wheel skid steer drive and hydraulic wheel motors. The middle section of Figure 31 above shows this tractor for the CEB machine. Initially, battery charging power will come from the L^6.

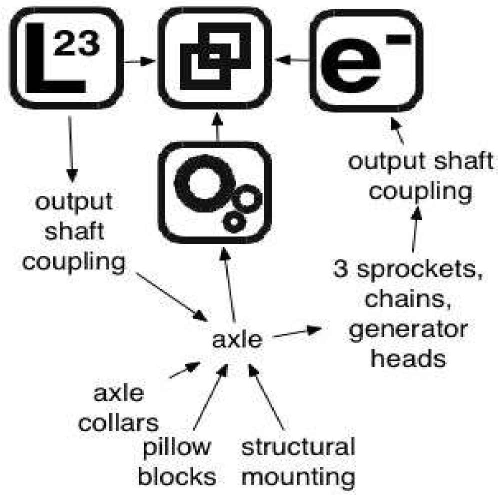


Figure 49. Composition of the electrical power unit.

The goals of the initial tractor/vehicle development is to demonstrate that the electrical power unit and electric motor may be used interchangeably between the car and the tractor. From that point, we will make additions to the tractor as if it were a life-size erector set.

Our first addition after the CEB machine will be a front end loader. This is a required part of our earth-moving infrastructure. If pulleys are sufficient to activate the loader, we will use them. Alternately, we will proceed to a hydraulic version with cylinders and quick-disconnect hydraulic hoses.

<u>12. Food Processing Kitchen and Sprout House</u>: Once the CEB machine is developed and the earth-moving infrastructure is in place, we will proceed to build our food processing kitchen and sprout house. Both will share an infrastructure including heated, running water, a freezer, refrigerator, stove, and oven. The kitchen will have a range of electrical appliances. These include mixers, flour grinders, blenders, juicers, food processors, and others.

The design of the sprout house includes good ventilation and ample water source and drain, water testing capacity, water filtering, heating and cooling, and access to sunlight.

13. Aquaculture and Engineered Wetland System: With our CEB equipment infrastructure in place, we can build troughs for aquaculture and engineered wetlands. We plan on raising tilapia in greenhouses, and developing our own tilapia breeding stock. Engineered wetlands, including worm beds, will be used to process organic waste. We would like to connect a water body under the chicken house roosts to produce a self-cleaning chicken coop. The engineered wetland will handle domestic effluents. Part of this system will be under greenhouse, and part will be outside. A component diagram is shown in Figure 50.

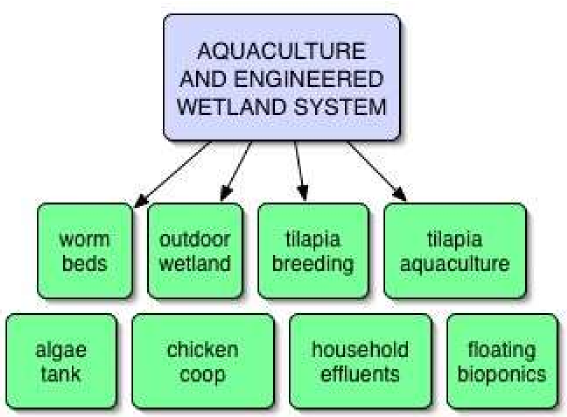


Figure 51. Diagram of the components for aquaculture and engineered wetlands.

14. Glazing Technology and SolaRoof Greenhouses: Greenhouse glazing technology needs further development to make it a more practical option for food growing. Affordable (8 cents/sq ft) UV-stabilized polyethylene film has a short lifetime of 4 years and it can be punctured. Polycarbonate, a lightweight, durable, 20-year, high tech glazing material, costs at least $1/sq ft. Glass greenhouse glazing is heavy and it breaks easily.

We will evaluate the feasibility of low-tech polycarbonate resin extrusion using commercial resins to produce UV-stabilized polycarbonate sheet. Given the $1/lb recycled resin costs and $2/lb costs for virgin polycarbonate,[20] this translates to 10 or 20 cent/sq ft material cost for 1/32 inch thick sheet.

We will experiment with extrusion of 1 foot wide sheets initially. A diagram for a simplified pneumatic extruder is shown in Figure 51.

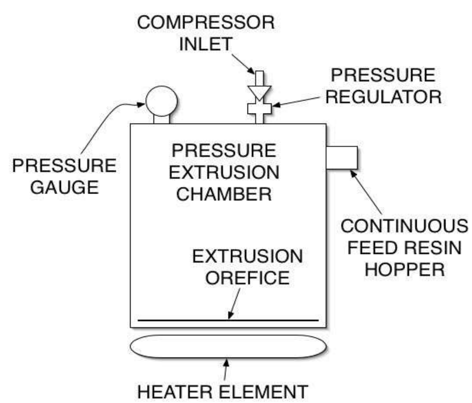


Figure 51. Diagram of an experimental polycarbonate extruder for making 1 foot wide sheets.

If this works, then we will have found a cost-effective route to building large-scale, long-lifetime greenhouse operations. This is a potentially great contribution to local food sufficiency.

Another unique greenhouse technology that would work well with single wall polycarbonate sheets is the SolaRoof[21] technology developed by Richard Nelson in the United Kingdom. This is an open source technology for insulating greenhouses in cold weather by filling a glazing cavity formed by two layers of glazing with soap bubbles. A cavity filling with bubble is shown in Figure 52, along with two examples of greenhouses using this technique.

Figure 52. SolaRoof glazing cavity filling with bubbles.

This technique may be implemented readily. This may be done by using a nozzle that sprays a 5% soap solution onto a window screen, where a strong fan blows through the screen to generate the bubbles. Practical aspects of this technique need to be experienced to determine the feasibility in our applications. The actual part of filling a cavity may be done in a day's time, using a 5 gallon bucket with window screen on it, a pump and nozzle with dishwasher detergent solution, and a shop-vac blower to provide the forced air flow.

1 Seminal work on the feasibility of flexible, high-skill manufacturing, as an alternative to unskilled mass production, is proposed in The Second Industrial Divide, by Michael J. Piore and Charles F. Sabel, from MIT.
2 http://www.yanmar.com/store/index.asp?DEPARTMENT_ID=54
3 http://surpluscenter.com/item.asp?UID=2006040916520241&item=6-987X&catname=
4 http://www.cybernet1.com/mcquaid/Waste%20Oil%20Burners.htm
5 http://inov8-intl.com/products.htm
6 http://www.thesustainablevillage.com/servlet/display/product/detail/29153
7 http://surpluscenter.com/item.asp?UID=2006041118375073&item=11-3054&catname=
8 http://www.greensteamengine.com/
9 http://www.dripirrigation.com/drip_irrigation.php?cPath=35_50
10 Copyrighted material taken from http://vegoilconversions.netfirms.com/Little%20Angel.pdf
11 http://pages.sbcglobal.net/fwehman/AECTOverview.html
12 http://pages.sbcglobal.net/fwehman/Impact2001.html
13 http://pages.sbcglobal.net/fwehman/
14 Photo taken from personal visit to AECT, Inc., in Texas.
15 http://freepatentsonline.com/4563144.pdf
16 http://www.undergroundhousing.com/
17 Taken from Vertical Axis Sail Windmill Plans, http://villageearth.org/atnetwork/atsourcebook/
18 Taken from copyrighted material at http://www.greensteamengine.com/
19 http://surpluscenter.com/
20 http://www.ides.com/resinprice/resinpricingreport.asp , http://www.plasticstechnology.com/dp/pt/resins.cfm , http://www.plasticsnews.com/subscriber/resin/price5.html
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