



**E**NERGY  
**S**ELF  
**S**UFFICIENCY  
**N**EWSPLETTER

**October 2005**

**Off-Grid Living**

**Biofuels**

**Hydro**

**Solar**

**Wind**

**THE WIND BAG**  
**SUMMER ON ŠIPAN**  
**OFF-GRID CAMPING**  
**MAKING ETHANOL FOR FUEL**  
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**STARTING YOUR OWN FRUIT TREES**

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### From The Editor's Laptop

by Larry D. Barr, Editor

## It's Time To Get Serious

The landfall of Hurricane Katrina on the Gulf Coast of the United States was a demonstration of the utter inability of man's devisings to resist the fury of Mother Nature. The rebuilding process will be ongoing for months, if not years. But the effects on life in the US may last for years.

One of the immediate effects was the almost overnight increase in petroleum fuel prices. The arguments are raging and accusations are flying over whether the price increase is justified. Conspiracy theorists are coming from all points of the compass and the pro- and anti-government factions are at each other's throats. Let 'em have at it. That's not why we're here.

The purpose of this publication is to help you, our readers, learn about renewable energy sources and utilization. So, let's talk for a few minutes about what RE can do to mitigate the increase in fuel costs and, very possibly, future fuel availability.

I believe that this event may serve to increase interest and acceptance of RE technologies that, until now, have not garnered wide-spread use. I speak of Neighborhood Electric Vehicles (NEVs), diesel or biodiesel/electric hybrids and PV augmented electric vehicles. A friend in Ireland suggested a PV augmented hybrid with the internal combustion engine powered by ethanol. As he said, "It'll run on either sunshine or moonshine."

We must – and I don't mean "we" as mankind, I mean "we" as folks devoted to renewable energy – be open to the development and adoption of technologies that big business is ignoring. If you have an idea for something new, or a combination of a couple old things, I encourage you to give it a try. Go out back to your shop and prototype it. Don't have a shop? Find a couple of friends to work with you on the project, and make your dream a reality.

Whether your idea is a new type of drive system for a vehicle, a high mileage modification for an existing engine, or simply a way of cutting down consumption of energy in the home, this is the time to bring that idea to fruition. The great concepts of the future will not be developed by major corporations and giant think tanks. They will be brought to reality by dedicated

people who are solving a problem for themselves, and by extension, for mankind.. Those developments may be later adopted by the mainstream, but we are the nucleus, the sourcepoint, for new developments that are accessible to all.

I encourage you, I challenge you, to put your creative mind to work. Select a problem that irks you, and work on a solution. Together we, a dedicated group of renewable energy believers, can make a difference.

Continued on next page



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Rebel Wolf Energy Systems



### Command Center Update

In our August issue, I told you of my plans to convert my two-level desk to operate on either 120 VAC or 12 VDC. All the components I ordered have now arrived, and I'll be able to get underway in a couple of weeks, being fortunate that Hurricane Rita had collapsed before it reached us here in Stephenville.

Just to recap, the project will provide PV power from two [Uni-Solar US-64](#) panels to maintain a 100 AH AGM [PowerSonic](#) battery which will power all the devices on the desk. The 12 VDC power will be distributed to the end-use devices by a [West Mountain RigRunner 4012](#). In the event that the PV panels can't maintain a full charge to the battery, a 40 amp power supply from [Circuit Specialists](#) will take up the slack and will also charge the battery through a [West Mountain SuperPWRGate](#) transfer switch/charger. The West Mountain equipment and the [Anderson PowerPoles](#) I'll be using for the connections are available from [Powerwerx](#).

The desk holds a laptop computer, printer, 9" TV/DVD, USB HDD, speakers (w/sub), router, DSL modem and 2 meter ham radio. All except the router, speakers and the modem will operate on native 12 VDC. Those units will be powered by a 300 watt MSW inverter from [Marlin P. Jones and Associates](#) (turn the page to see a pic of it and all the other components I have now received).

It's time to get serious. It's time for all of us renewable energy 'fanatics' to cut our creativity loose. Jump right in there and do something to minimize the energy usage at your home. Devise a way to increase the fuel mileage you get, or come up with something entirely new to help wean us all away from fossil fuels. Whatever it is, get creative and help make a difference.

Peace,  
ldb

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**ESSN exceeds 23,500 downloads!**

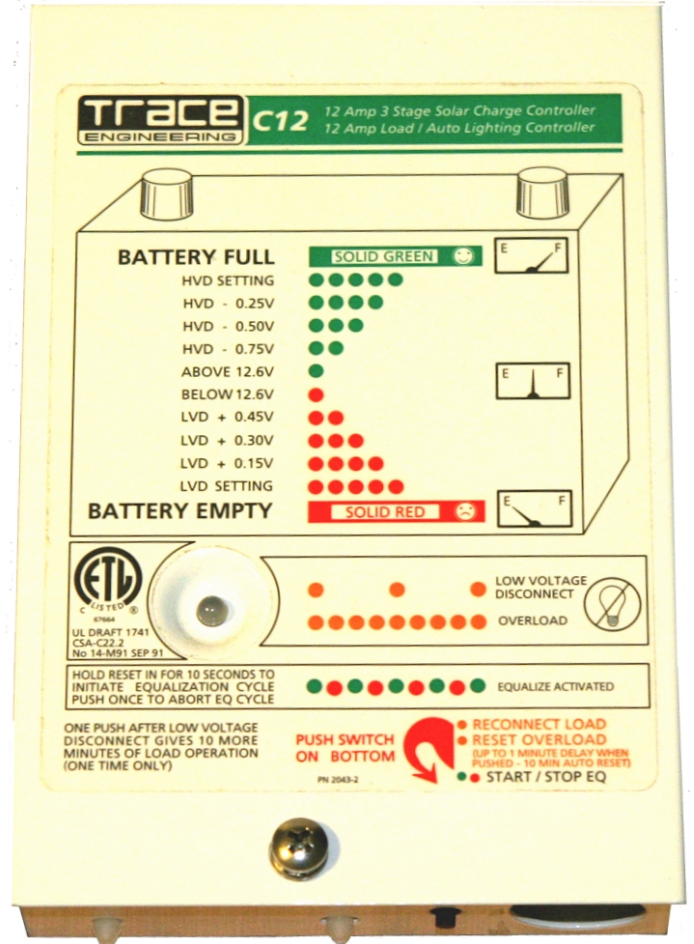
Monthly circulation of ESSN, measured by downloads of the PDF and HTML files, continues to rise and now stands at over 23,500!!! As the word of our existence spreads, and our content increases, we will continue to share our experiences (and yours) in off-grid living and energy self-sufficiency with folks around the world. Thanks for your interest and your support. ldb



40 amp @ 13.8 VDC power supply from [Circuit Specialists](#). This unit will not only power the desk under AC operation, but will also maintain the battery in a fully charged state via the [West Mountain SuperPWRGate](#). Atop the power supply is the small 300 watt MSW inverter from [MPJA](#) that will power the AC devices on the desk.



Shown in the left rear is the [West Mountain SuperPWRGate](#) unit that functions as both a transfer switch between the power supply and the battery and also is a 3-stage (bulk, absorption, float) battery charger. The [West Mountain RigRunner 4012](#) DC distribution panel is shown in the right rear of the photo. The RigRunner provides a fused outlet for each device up to a total load current of 40 amps. In the foreground are 25 pairs of [Anderson PowerPole](#) 30 amp connectors and four Velcro™ cable organizers. The connectors and cable ties are included with the 4012S “starter kit” from [Powerwerx](#), as is 25 feet of #12 AWG red/black zip cord.



[Trace C12](#) PV charge controller from [Backwoods Solar](#) for the pair of [Uni-Solar US-64](#) amorphous solar modules ([Affordable Solar](#)) (not shown) that will charge the battery under good solar conditions.



[Yaesu FT-2800M](#) 2 Meter amateur radio transceiver from [Universal Radio](#) that will alternate between desk duty and mobile service. Max current draw of the transceiver when transmitting at 65 watts output power is 15 amps. I'll use the minimum transmit power necessary both to conserve energy and to comply with FCC regs.

[Power-Sonic PS-121000](#) 100 amp-hour sealed AGM type battery from [Mouser](#) which will power the desk during power outages and when the battery can be maintained by the PV panels.



Well, I now have all the components I need to start the Command Center project. Looks like it's time for me to get to work. The construction saga and on-going pictures will be in future issues of ESSN. Peace, ldb

# OFF-GRID CAMPING

By Steve Spence

Last week, we finally embarked on a much needed vacation. It's been a few years, but we packed up the tents and supplies, and headed into the woods. Many folks think of camping in terms of motor homes, trailers, electric and water hook-ups, and some even have cable tv. That's not our scene.

Now, that's not to say we didn't take a long a bit of technology with us. We hauled in water, and generated a bit of electric for the cooler and lights. We do like to keep meat and drinks refrigerated, so we brought along a subset of our renewable energy system, consisting of a Peltier equipped 40 quart Coleman cooler, a 115AH deep cycle battery, a 750 watt inverter, and a 40 amp charger (vehicle powered) to recharge the battery occasionally. This kept the cooler in the low 40's most of the time.

We also took along our Camp Chef propane stove, but did most of our cooking in a Dutch oven over a wood fire. The wood was scrap wood courtesy of a local log and lumber company. We cooked a variety of items in the Dutch oven, including pineapple upside-down cake (need to work on that one), Chili (best ever), spaghetti, plus boiling water for washing dishes. I brought my green tea bags and coffee bags for that morning pick-me-up.



The three boys (my two plus a friend) shared a tent, the Wife and I had ours a ways away from theirs. We don't appreciate late night pillow fights like we did when we were younger.

The kids enjoyed fishing and swimming in the river, and hiking the Appalachian Trail, including a hike up the local 1167 ft mountain. I used to hike Mt. Marcy a lot as a teen, but that was 20 years and 60 lbs. ago. I made it, but it hurt ;-)

The weather was mild, no rain, and day temps hit the mid 70's, night temps in the mid 50's, and fairly bug free. With numerous games of Chicken Foot (dominoes), Scrabble, etc., it was a good time together as a family.



Steve hard at work preparing for the next edition of ESSN

# BIOGAS POWER FOR FAMILIES

By Hemant Thite

### What's this all about?

As Al Rutan has shown in previous articles in ESSN, biogas is an extremely important part of off-grid living. A biogas plant is basically an anaerobic digester, having millions of micro-organisms digesting organic matter and generating biogas. You rarely get so many workers toiling for you in return for just food!

A biogas plant can be used to digest agricultural residues, animal manures, kitchen-waste and sewage. Biogas is very popular in developing countries as a source of fuel for cooking. These are small units, and generate just a few cubic meters of biogas every day, providing enough cooking gas for a whole family. Portable generators, or 'gensets', can also be run entirely on biogas, providing from 400-5000 watts electrical power, enabling families to utilise this energy for many other applications in the home. At the other end of the scale, big farms with large numbers of cattle, as in Europe and USA, install biogas plants to neatly convert the large quantity of animal manure produced into biogas that can be usefully used for both power generation and heating.

Biogas consists of 65% methane and 35% carbon dioxide, with traces of water vapour, hydrogen sulphide and ammonia. It's flammable, with about 70% the calorific value of natural gas, but is corrosive, so proper care should be taken while handling it.

### Gensets



Portable generator set – a 'genset'

A portable genset can be used for power generation. Portable gensets are available from 400watts –5000watts. These are Internal Combustion (IC), Spark Ignition (SI), Gasoline engines in range 1.4 –8HP. These gensets are available in AC/DC, 50Hz/60Hz and 110V/230V options. A genset running on propane gas or natural gas is used for running on biogas.

### What size genset do you need?

Take a look at your current electricity bills. Find out the daily power consumption. If you are consuming 20KWhr per day, then you need a 5KW genset running for 4 hours or a 2KW genset running for 10hrs. A battery pack will be needed to store power. Talk to your local genset supplier.

### Choosing your biogas plant

Biogas plants come in two main designs, the fixed dome and the floating drum. Also, depending on feeding patterns, they are either batch-fed or continuously fed. Batch fed biogas plants are fed once every few months, and continuous plants are fed on a more frequent basis, like once a day, twice a week, etc. Biogas plants running on animal manures are invariably the continuous type as it is impossible to store such manures for any length of time.



A continuous biogas plant

Gensets consume about 0.5-0.9m<sup>3</sup> of biogas to generate each KWhr. So, if you have a 2KW genset, it will consume about 1.2m<sup>3</sup> biogas each hour. So, if you run it for 10 hours then you will need 12m<sup>3</sup> of biogas – the amount of gas generated by the fresh manure of about 20 cows.

In places where the temperature drops below 5°C (40°F) in winter, then about 20% of the gas generated will be needed for heating the digester and maintaining the digesting material at about 35°C (95°F-100°F).

Continued on next page



Guidelines for selecting a site for biogas plant and designs should be available at local renewable energy agencies. Add a few m<sup>3</sup> of extra capacity for getting cooking gas and gas for heating water.

### Costs

Biogas plants will cost between \$150-200/m<sup>3</sup> depending on their size and material of construction. Government grants and loans are available in most places for construction. The genset will cost between \$700-1500. Other components you will need are monitoring equipment, like a gas meter, pressure meter, flowmeter, KWhr meter, current meter, and a voltage meter. A pH meter and thermometer will also be required to monitor the digestion in biogas plant.

### Operations

The portable genset should always be started on gasoline, and then run for a minute on gasoline before switching over to biogas. Once it has warmed up, the engine will run entirely on biogas. The gas consumption of gasoline engines is about 60% that of diesel dual-fuel engines, so you get more power out of biogas using gasoline engines. The genset should be switched to gasoline mode while shutting down as this helps in flushing the engine of biogas.

### Applications

The 400watts-5000watts power range is ideally suited to individual homes for supplying primary or backup power. Power can be generated in sub-urban areas, farms, remote villages, small hamlets, etc. The power is enough for lighting, running kitchen appliances and entertainment systems. When the genset consumes few m<sup>3</sup> of biogas, every one should try to install small biogas plants and generate their own power.

I am installing two similar systems in India. Both have 6m<sup>3</sup> biogas plants and a 2KW genset generating 12KWhr/day. The genset will run for 6hrs everyday. Biogas will be generated from deoiled cake of Jatropha and Pongamia.

Biogas is an important renewable energy source as it is predictable, site-independent and provides enough power for consumption. Alternative energy systems can be simple, cost-effective and sufficient. Let biogas take us one step closer to self-sufficiency.

### About The Author: Hemant Thite



Sustainability has always attracted me, and before working on energy I was a organic farming consultant. Biogas attracted me for its simplicity and predictability. I have degree in Physics, and have conducted various experiments on biogas generation from grains and deoiled cakes. Currently I am focussed on small scale power generation, designing and installing biogas energy systems through my firm Calorees.

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Visit: [www.biogas2energy.blogspot.com](http://www.biogas2energy.blogspot.com)

# SOLAR ENERGY PRODUCTION

A technical overview of the equipment used in a solar electric system

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To select a solar electric system for your home or RV, you should know what the major parts are called, what each one is for, and how they work together. We hope that this quick overview show how this can be done.

### THE PROCESS

Sun shining on solar modules produces **DIRECT CURRENT** electricity, or DC, the only kind of power stored in batteries. Often this is 12 volt DC, the standard used in cars and RVs. Larger systems may be designed for 24 volt DC, or sometimes 48 volt DC. This just means combining the same solar modules in pairs for 24 volt, or groups of four to get 48 volt. Windmills and micro-hydro generators in this catalog also produce DC for charging batteries.

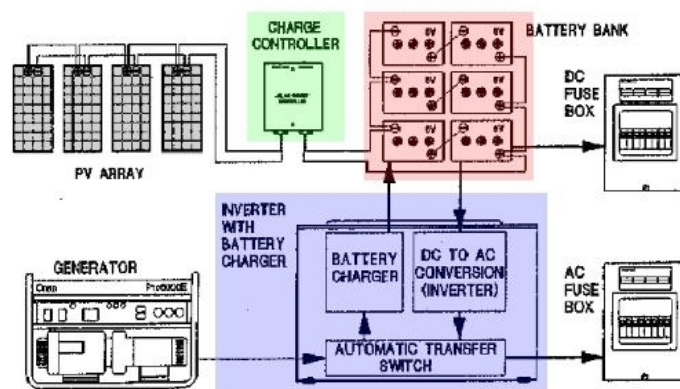
This DC power is stored in **DEEP CYCLE LEAD-ACID BATTERIES**, which give back the electricity as needed, even when no power is being produced. Like a bank account, power put into batteries over a period of time can be taken out more quickly if a lot is needed. Like a bank account you cannot take out more than you put in, or the account will be depleted. Moreover, lead-acid batteries need to be frequently 100% fully charged to remain in good condition. They should never be drawn completely down to empty. Because of these needs, to get the most years from your batteries requires some supervision by the owner.

The **INVERTER** is a major component that converts the 12, 24, or 48 volt DC current from the battery into 120 volt AC current, the same as utility power for standard household lights, outlets, and appliances. Most solar homes use primarily 120 volt AC produced by the inverter. A few DC circuits are usually added where using DC can save a lot of energy. Sometimes a small solar electric RV, boat, or cabin may have no inverter, and use only DC wiring and appliances.

If there are a number of consecutive days without sunshine, the owner, being aware of the weather, checks his batteries. If the charge level is low, an engine driven generator may be started to recharge the batteries in order to keep the whole system working. A **battery charger** plugs into 120 volt AC

from the generator producing low voltage DC to charge the battery. The generator is shut down after the batteries have been recharged. This process is automated in some power systems. (Battery chargers in Recreational Vehicles are called *converters*).

### THE HARDWARE



Drawing courtesy of [Solar Electric Independent Home Book](#)

### SOLAR MODULES

These are installed in groups of one to 12 modules on a **solar mount**, which in turn attaches to a building, to the roof of an RV, or atop a metal post in the yard. Together this is called a **solar array**. Each solar module is wired to the other modules in that array by sunlight tolerant **solar interconnect wiring**. Several arrays may be wired to a **solar combiner box** where they are all connected to heavier underground wires taking the power to the battery and equipment room.

A solar electric module works like a car battery charger... Except instead of plugging it into the wall, you put it out in the sun.

Continued on next page

**PHOTO-VOLTAIC** or solar cells convert sunlight directly to electricity within wafer thin cells. Light “particles” called photons actually bounce electrons across a barrier, creating an electrical current. About 36 cells are built into a 4 to 12 square foot solar module. Cells are sealed within a tough resin between a tempered glass front and plastic or foil backing, then framed in aluminum rail. There are many sizes and brands of modules, at similar prices, specifications, and claims. New brands come each year, many as good as, but none better than, the proven reliable brands listed in the next pages. Considering cost and length of module lifetime and warranty, we stock the longest tested and most respected brands.



**DIRECT SUNSHINE** with no shadows is absolutely necessary for full power. Partial power is produced on overcast days, but any shadows falling directly on a solar module will reduce power, regardless of what some advertisements claim.

**DURABILITY:** First used 40 years ago for space satellites, modules of that vintage still operate unless the glass has been broken or water has entered the seals. Life expectancy of solar modules is over 30 years. Most photovoltaic modules come with a 20 to 25 year warranty on power output and may last a lifetime.

**THE AMOUNT OF POWER** a solar array produces depends on the number of modules you use and the number of daily sunshine hours in your climate. Overcast days with only half normal brightness give half of normal power. Some climates allow much more power in summer than winter. Solar modules can easily be added to your array to increase power as your needs grow. Modules are rated by volts, watts, and amps. The AMP rating is the best indicator of the charging you get and is what you will see on your meter during ideal sun conditions.

**A CHARGE CONTROLLER**, sometimes called a **charge regulator**, is a small wall mounted unit receiving the power from solar, wind, or micro-hydro generators, and controlling the flow of power to the battery. To prevent battery damage from overcharging, the charge control automatically cuts back or stops the charge when batteries become full. A charge control may have manual control switches and may have meters or lights to show the status of the charging process.



**BATTERIES** receive and store DC electrical energy, and can instantly supply large surges of stored electricity as needed to start or run heavy power appliances that the solar panels or hydro electric generator alone could not power. This large power capability can be a fire hazard just like utility company power, so fuses and circuit breakers on every circuit connected to a battery are essential. Battery size is chosen for both surge power requirements and for the amount of reserve power needed. Typically, 2 to 12 square feet of batteries weighing 200 to 1000 pounds are enclosed in a battery box with a vent pipe to outside. This component contains both acid and a great deal of stored energy, therefore requires care and knowledge to safely install.



**The INVERTER** is the major electronic component of a power system. It converts DC power stored in batteries to 120 volt AC, standard household power. Short, heavy cables with a large fuse or circuit breaker carry battery power to the inverter. After conversion to AC, power from the inverter connects into the circuit breaker box of the house in place of utility lines. The house breaker box routes power to lights, appliances, and outlets of the house. Inverters for home power come in ratings from 50 to 5500 watts.



Continued on next page

A **STANDBY INVERTER/CHARGER** is an inverter that also has a **battery charger** and **transfer relay** built in. When the input terminals of a standby inverter/charger receive power from an outside source of AC (a generator or utility power) the inverter stops producing AC power from the batteries, and instead passes generator or utility AC power straight through to the house. At the same time it uses the generator or utility power to recharge the batteries. Some standby inverters even auto-start the generator when batteries need charging. A separate battery charger can be used instead of (or in addition to) a standby inverter/charger.

An **ENGINE GENERATOR** producing 120 volt AC power is usually part of the system. This is a second source of AC power and a backup for charging the battery when there is a shortfall in solar or wind power, a temporary need for additional power for construction or visitors, or in case of breakdown of other equipment. Just starting the generator begins the standby inverter charging process. The best generators start by push-button from the house.



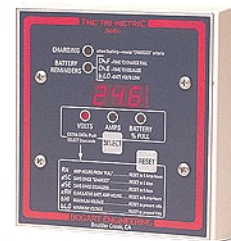
A generator is located outside, usually in its own shed at least 30 feet away to avoid noise. For reasons of health and safety, it cannot go in a basement. 120 volt AC power from the generator goes through a circuit breaker, then is wired into the power room to run battery charger/s as well as supply the AC power to the house whenever the generator runs. Since the battery charger and AC transfer relay is usually part of a standby inverter, the generator power usually connects only to the AC INPUT terminals of the inverter, not to the house breaker box.

A few special lower cost generators are made to produce only battery charging DC voltage instead of AC. These send DC power directly to the battery.

**FUSES or CIRCUIT BREAKERS** are necessary in all DC wiring between the batteries and other power system components described, but are not shown in the drawing. This prevents fires and equipment damage in event of a malfunction. Breakers might each be a separate component, or might be built into a powercenter. In contrast, the AC breaker box for household wiring is part of the house wiring, not usually included with power generating equipment.



**METERS**, like the gas and temperature gauges in a car, are necessary to show everything is working. Solar charge indicating meters are often built in the charge control to confirm the charging process instantly. Other meters show how much power is being consumed, and confirm how much power is available. These battery system monitors can be located in the power room, or at a convenient spot in the home for easier checking.



A **POWERCENTER** is a combination product including system meters, DC circuit breakers, and wiring connections for batteries, inverter, solar and other charging sources. Powercenters are easier to install and to pass building codes than selecting, buying, and installing all those parts separately. The power room is simplified, with just a few main components: **powercenter with charge control** attached, an **inverter with standby-charger**, and the **battery box** on the floor. Some powercenters, like the Outback PS-2, are shipped as a completely assembled power system.

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Steve and Elizabeth Willey started BACKWOODS SOLAR ELECTRIC SYSTEMS as a home based business in 1978, after successfully pioneering the use of photovoltaics for their own mountain home, two miles from utility lines. As of June 11th, 2004, Steve and Elizabeth have retired but their current employees continue to operate the business for a new owner who intends to maintain the Backwoods Solar that our customers know! As one of the major mail order renewable energy businesses, Backwoods Solar Electric once operated from a remote mountain-top property. Both home and business were 100% powered by the time tested equipment described in their catalog: 85% by the sun, with wind and back-up generator covering the balance in snowy winter months. As of mid-August 2004, Backwoods moved out of Steve and Elizabeth's home and relocated to a facility just a couple miles down the road.

You are invited to visit them at their web site  
<http://www.backwoodssolar.com/>



## SUMMER ON ŠIPAN

Suzanne Ubick

### SEPTEMBER – ON MY OWN AND FANCY FREE

I got the family house to myself on August 30. This gave me the chance to experiment with matching off-grid living techniques with on-grid realities. So I switched off the water boilers – the big one in the bathroom and the small one in the kitchen, and the automatic washing machine.



Another experiment I tried was to take a dark brown enamel pot, line it with aluminium foil, place a smaller enamel pot inside it, cover that with a dark metal lid, and then cover the bigger pot with a glass lid. Somewhat to my disbelief, it worked. It really truly worked. And I'd given it a toughie:

Left running on grid:

- The upright fridge/freezer.
- My laptop and camera charger.
- Lights. I avoided using the overhead lights; there are some weird floor lamps here which seem to have some kind of LED bulb. I had one between my bed and my desk, serving both. On the dining table, I had a desk lamp with the same kind of bulb. And in the kitchen, there's a fluorescent tube mounted above the worktop.

Looking to the future, when I have a tiny house of my own, all of these items could run directly off 12V DC.

- The cookstove was connected to the mains electricity and to its off-grid gas bottle.
- Hidrofors: the electric pump supplying water from the rainfed cistern to the various points of use. I've used solar-powered 12V DC pumps before, so I know this can be done off-grid.

I cooked my main meals in my solar oven. It doesn't get hot enough for breads, and it takes four hours to boil water. So I made Turkish coffee and boiled water for tea on one of the gas rings of the stove. Meats, vegetables, and rice are properly cooked, and very tasty when done in the solar oven. One needs very little or no liquid, so all the flavours stay in the dish. I fried my breakfast eggs in the solar oven, and they too were delicious, with a velvety texture that has to be experienced to be understood. All of this, of course, meant that I needed very little bottled gas.



whole wheat grains, covered with tap temperature water. I put this outside at noon, and when I checked it at 6pm, those grains were soft and tender.



I did my laundry on a daily basis, using either small buckets or two baby baths on a table outside. Usually it was just undies and a teshirt. Every couple of days there was a pair of shorts and a nightshirt. Once a week: bedding and my towels, both swimming and bath, staggered so there wouldn't be a staggering amount on any one day. I used cold water and a bar of plain laundry soap, being sensitive to multiple chemicals. The clothes were clean and smelled wonderful after drying in the sun. I didn't iron anything. Hanging laundry soaking wet erases most wrinkles. Vigorous shaking after taking them off the line takes care of the rest. I thoroughly enjoyed the laundering process too. I worked in the shade, listening to the birds, tickled by the breeze, watching my green-gloved hands knead through the laundry. Two one-gallon buckets of water was all that it took on an everyday basis, and that water went directly into the garden. Even on a sheets day, the whole process took only half an hour, and six buckets of water. Nothing's filthy, after all, and bar soap is much easier to rinse out than the laundry detergents I've encountered. The most arduous part of the job was carrying buckets of water from the bathroom.



Continued on next page

My tiny house will have taps outside, supplying a large shallow porcelain laboratory sink.

I heated water for dishes in a black beer can sitting inside a plastic coke bottle (water pasteurizer). It gets hot enough to scald an unwary finger. This was plain old luxury; seeing I cooked in the solar oven; there was very little grease to contend with, and cold water would do the job just fine. But there we are, a little luxury doesn't hurt, and I felt very clever whenever I glugged that pint of very hot water into my bright yellow bowl!



Also in the spirit of practicing for tiny house living, I moved my bed into the living room where it served also as my couch and daybed. I needed very few clothes here; three pairs of shorts, five teeshirts, undies and flipflops were adequate. So I rolled the garments like crepes and put them in two shelves of a vegetable rack, with my meds – contact lens supplies and suchlike – in another, the top one. This was tucked in at the bed end of the long narrow table I used as a desk. At the other end, I had a wheeled plastic table on which I stored my various papers and reference books. Besides these necessities, the room contains a large dresser that holds crockery, a dining table, three chairs, and the table with the TV and radio on it.

Leading off from this is the kitchen and next to this is the bathroom. Between these three rooms, I had more than enough space, some 424 square feet. I could definitely manage with less, were it configured differently.

I managed to keep the house at a pleasant temperature by opening and closing doors, windows and shutters. At night, I threw the windows and shutters wide – and coated myself with mosquito repellent. During the day, windows stayed open, and I closed the shutters as the Earth rotated windows into the direct rays of the sun. The back door stayed open all day as it faces north, and long into the night. The area I was living in is the new part of the house, with thin cement block stuccoed walls. So I cheated: I opened the door into the old part of the house, where the stone walls are two feet thick. This was a well of cool air which pushed the warmer air out of the new part of the house. The temperature in the kitchen, which faces west, stayed between 24 and 26 degrees C throughout the 24 hours.

Refrigeration was a big thing. On a daily basis, milk, butter, cheese, and eggs needed to be kept cool. Seeing that I had to

keep the freezer going for the meat, it was easiest to pop my perishables into the fridge and made fuller use of the electricity. Still, I had to try!

Lacking clay flowerpots, I took part of the plastic vegetable rack. I lined it with two thick terry dishcloths soaked in cool water and only lightly squeezed. On this I placed the butter, in its foil wrap, eggs in



one of the plastic egg holders from the fridge, cheese, and the milk. I put the milk into an enamel mug, and covered that with another damp cloth. Then I covered the whole thing with a wet clean dishtowel. The veggie rack went into a plastic tray to catch any drips. I put the whole thing on top of the fridge to foil Ishtar, the scrawny black cat who took possession of me during my sojourn. It wasn't the ideal position, as it didn't get the good breeze from the window, but it was better than having Ishtar's claws and teeth in everything all the time. The butter was spreadable, but didn't melt. Likewise the cheese was soft, but not oily. The milk was okay, cool, not cold. The eggs stayed fresh; they come in tens, and I used two a day. However, I was always a little uneasy about the milk, and I'll have to have a small Sundanzer freezer for my tiny house. There is no substitute, and even I can eat only so much salted meat. My in-laws left me piles of delicious smoked meats, but I discovered that I do have limits. I could freeze bottles of water in a Sundanzer, and use them in a small ice chest for my milk, cheese, butter and eggs.



My Sister-in-Law had planted a vegetable garden which hit its peak in late August. Suddenly there was literally a bucketful of tomatoes every third day, and a bowlful of peppers.

I could not bear to let this go to waste – and everybody else has bounteous gardens too, so I literally couldn't even give the veggies away.



Continued on next page

I chopped a bucketful of tomatoes into a roasting pan and arranged it within the solar oven to catch the sun. I'd found a damaged mirror in the store room, which I cleaned and angled to reflect as much sun as possible down into the tomatoes.



I took my two sheets of damaged glass from the old medicine cabinet and balanced them around the pan. The photograph makes it all clear, including the hi-tech weights on the glass! And then I simply left it alone, stirring when I remembered throughout the day. The house

stayed cool, and so did I. When the pulp was thick enough to bottle, I brought it to a galloping boil on the gas stove, added a half cup of apple vinegar to ensure that the acidity level would be high enough, and poured it into the sterilized mayonnaise jars – preheated in the solar oven. Before putting on the lids, I poured an inch of olive oil over the pulp as an additional safeguard, to exclude air.

Peppers were sliced into eighths and sundried, together with the paste tomatoes. Some went into a jam jar and were covered with olive oil, others were simply stored in plastic ziplock bags.



I'll be in San Francisco for several months, so this will be a good test of the keeping qualities of my preserves.

Thinking forward to the little house, the only issue still to be tackled is that of quick heat for making coffee, and for cooking indoors when the weather does not cooperate. Before leaving San Francisco, I bought this cute little alcohol stove made from a soda can, and tested it out. It works, and uses amazingly little fuel. The Dear Husband and I make a few gallons of wine every year, and after pressing the grapeskins we store them up in a vat, where they continue to ferment slowly. In late December or early January, when the weather's cold and additional heat is welcome in the house, we distil the ethanol out of some of these skins. Thing is, we're not drinkers! My Father-in-Law takes some of it and adds herbs and raisins, but a pint of this lasts us over a year. It's Mediterranean tradition to make rakija after the wine, and then use the grapeskins for compost – waste not, want not!

We keep the ritual alive, as well as the Afrikaner custom of using some of the early fermenting wine to make sweet buns which are dried into rusks (mosbolletjies).

However, I wouldn't at all mind using the alcohol as fuel. Given that alcohol distils off at low temperatures (78°C/173°F), I could set up a solar still, which would cut out the energy input cost. The only reason we store the skins so long is because we're going to need additional heat at the turn of the year. Living here though, the skins could go from the wine vat into the still, in October when the sun is still sufficiently intense to do the job. Right? And as alcohol does not freeze at water-freezing temperatures and I've already decided on a Sundanzer freezer, bottles of hooch could go into the freezer for a couple of hours and the pure fuel poured off.

There's baking to be thought of; bread-making is one of my favourite activities. I made a different design of solar oven, which is supposed to get much hotter. I'll test that. But again for rainy or dark days, I will need a back-up. I'm thinking of using a Coleman camp oven heated by a couple of rakija stovelets, or maybe even a two burner boat stove – these come in alcohol-fuelled variants. I love the idea of being able to fold up the oven and put it away when not needed, and am particularly in love with the idea of being able to wash it in the sink instead of going through the usual Hansel and Gretel performance. A portable oven could be used with a Midge stove, or over a barbecue unit.

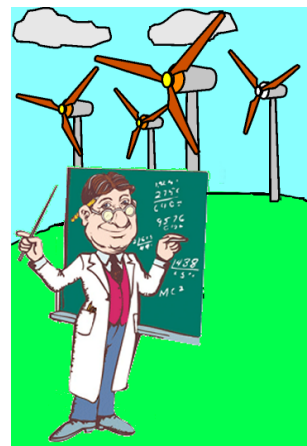
It's really wrenching to leave Šipán, but I have the challenge now of finding ways to lessen my grid dependence in San Francisco. And I will be returning to my Adriatic island relatively soon, to build a little house that will be energy self-sufficient.

Suzanne Ubick



# THE WIND BAG

Dan Fink



Now that my 3-part series on wind turbines is done, I'm taking the time to answer some renewable energy questions that arrive via email. You can send your questions to [windbag@rebelwolf.com](mailto:windbag@rebelwolf.com). Please don't worry if your question sounds too basic or too 'dumb.' 'Dumb' questions are often the best ones for explaining wind turbine physics, and remember the old adage: "There are no dumb questions – only dumb answers!"

Hello Mr. Windbag:

I am describing in shortly, if you think it is workable I will let you know every details.

In our country (Bangladesh) there are 450,000 person who are engaged in RICKSHA DRIVING (a three wheel human driven 2 person cart) and earning their living cost.

In the capital Dhaka city there are 250,000 of this Ricksha. Our Govt trying to reduce the quantity for many years as it becomes a major problem for our traffic system but failed as there is no alternative job for them.

A ricksha driver drives avg. 12 Hr / day , driving 60 km and carry avg 200 Kg ( 2 person + Self weight + cart ). Their avg income less than 2 US\$/day.

Our vision is to involved them to create human electricity by small size low RPM turbine in the 3KW range . Please let us know your valued comments in this regards.

Best Regards,  
J.Alam



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Hello Mr. Alam:

Your question is a good one, and gives me an opportunity to explain some wind turbine theory too. Specifically, how wind turbine alternators and generators must be matched to the size of the rotor and therefore incoming power.

The short answer is, your idea would certainly work, but there's no way one human could generate 3 kW by pedaling. However, 6-10 humans pedaling together could do so.

How does this relate to wind turbines? A big part of the 'black magic' of designing a wind turbine is matching the wind power input to the power output by how the generator is sized designed. A human trying to pedal a 3kW alternator would be similar to putting 5 foot blades on on a 3kW wind turbine alternator that's designed for 16 foot blades. The blades stall, because they don't have enough power input from the wind to move fast enough to make that amount of power. In the case of human power, the human would 'stall' and collapse from exhaustion after a minute or two of pedaling.

This can be demonstrated in the shop with the alternator from a wind turbine mounted on the workbench. We use this example all the time for folks that visit our wind turbine research shop so they can feel the load 'hands-on.'

[The alternator for our homebrew 17 foot turbine](#) spins very freely when the power output wires are not connected to anything. Voltage is being produced in this case, but voltage is only part of the equation—there also needs to be a current flow for 'work' to be done. There is SOME 'work' being done by the human, but it all goes into simply overcoming the extra friction losses in the system. The alternator is very easy to spin by hand. Now, short the alternator output wires – the alternator crashes to a stop with a resounding 'clang' and big spark. This is a common emergency shutdown system for wind turbines, and watching it

Continued on next page



Now, a good question from Alma, from the Backwoods Home Magazine discussion forums: <http://www.backwoodshome.com/> (no relation to Mr Alam who sent in the last letter!)

in action is a very convincing demonstration for the advice of “don’t shut down your turbine at high speed.” If the alternator is connected instead to an battery, the resistance is higher than the dead short from an emergency shutdown. While it doesn’t clang to a stop when connected, it slows down and stops within a couple seconds. The force input needed to keep it spinning is directly related to the power output.

Professional bicyclists measure their power output in Watts with on-board computers. The leader of the pack in the Tour de France is often putting out 500 watts for short periods of time, while the cyclists behind have to make a bit less due to reduced wind resistance. At the 1983 IHPV (International Human Powered Vehicle) Scientific Symposium, Douglas Malewicki presented a paper that graphs the time to exhaustion vs. power output capability of normal, healthy humans and top-notch athletes. According to his paper, a normal healthy human could consistently make 120 Watts for about 5 hours. A first-class athlete could do about 300 W for 5 hours.

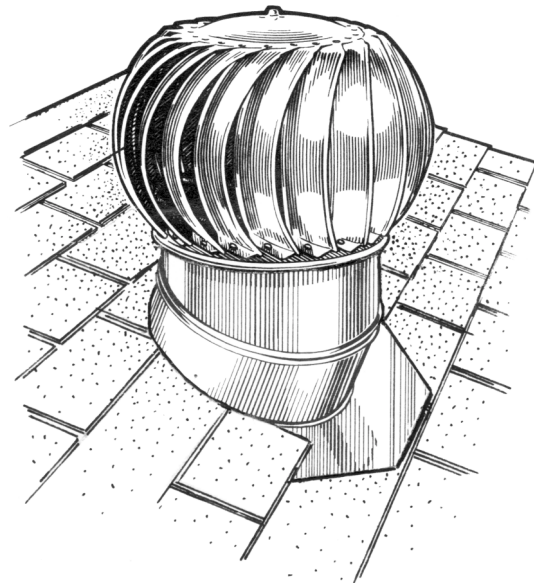
I very much doubt that there are many pudgy, overweight ricksha drivers in Bangladesh, and from your power output figures they are very close to world-class athletes in their physical stamina. But 300 watts is not a whole lot of power, certainly not enough to make it worthwhile to feed the grid with. However, could you have 10-20 ricksha drivers pedaling together? Then 3000 watts is a possibility, and the output could be fed to the grid via a grid-tied inverter, though the idea might be better for a more remote community with limited power production capability.

This has been done – see issue #47 of [Home Power Magazine](#) for information and photos of a multi-human pedal-powered generator running a PA system at a renewable energy fair.

Good luck with your project!  
The Windbag

What about those rotary vent things on top of the house that go round and round all day? We are in a position that we get a lot of wind. I don’t see why any number of systems can’t be moving at the same time and the energy combined and stored for small use.

Alma



Hi Alma. Your question gives me a good chance to explain why just because something is spinning doesn’t mean that you can make power from it.

In the previous question, I mentioned about how Watts are a pretty good way to measure the force needed to spin something. [In the July 2005 issue of ESSN](#) I also talked about efficiency, and how no generator can be 100% efficient, due to friction and electrical losses. And because of the Betz limit, no wind turbine can extract more than 59.26 percent of the energy available in the wind. So, the basic concept here is that to make (let’s say) 100 watts of electricity from a generator, you need to spin it with MORE THAN 100 watts of force.

Let’s see what would happen if you connected a small generator to your spinning roof vent. If the generator was attached, but the wires not hooked up, you’d be adding a bit of friction to the system. It would take slightly higher winds than before to spin your roof vent.

There is now measurable voltage on the + and – leads of your generator, but no actual ‘work’ is being done, because the wires are not connected to a load. But now, connect a battery you want to charge to the generator. The roof vent will stop spinning immediately, unless the wind is VERY strong. Spin the roof vent by hand, and you’ll feel extra physical resistance from your generator, because by connecting the generator you are asking it to perform ‘work,’ and the power coming in must be provided by you, or the wind.

Now take a look at our drawing of a standard roof vent turbine, courtesy of roof vent manufacturer [Lomanco](#). In the [July 2005 issue of the ESSN](#) I also talked about swept area, and the blue highlighted area shows the effective swept area of the roof vent turbine. The rest of the turbine is not helping power production, so the red highlighted part is actually working AGAINST your power production. For simplicity, I’m ignoring that factor in the math, and it will hurt turbine performance even further.

**Danger – Math ahead!** By the high-tech measuring technique of placing my scale ruler on my computer monitor, I roughly calculate the effective swept area of this 12 inch diameter roof vent to be about 32 square inches, or .0207 square meters. We’ll use a coefficient of power (Cp) of 30 percent, which is highly optimistic for a blade design of this type in a wind speed of 15 mph (6.71 meters per second).

**The Math!!!**

**If:**

- Cp = % efficiency of entire system
- Air density (rho) = 1.23 kg/cubic meter at sea level
- Swept area is in square meters
- Wind velocity is in meters per second

**Then:**

Expected power output (in Watts) =

$$Cp * \frac{1}{2} * \text{air density} * \text{swept area} * \text{wind velocity}^3$$

**So, inserting our values:**

$$\begin{aligned} \text{Power output} &= 0.30 * 0.5 * 1.23 * 0.0207 * 6.71^3 \\ &= 1.15 \text{ Watts output in a 15 mph wind.} \end{aligned}$$

So, you might be able to make the roof vent work as a generator— but you’ll never get any more power than 1.15 Watts out of it—that’s about what a trickle charger for AA batteries would make. Add that 1.15 Watts of extra drag onto the roof vent, and it will stop spinning immediately, defeating the purpose of the vent in the first place. It’s there to get a little bit of air moving out of your attic, and the extra drag from trying to perform more work by generating power will stop it—and you might end up with a soggy attic! If you can stop something from spinning with your pinky, there’s not much power available for harvest there.

The Windbag

From a High School student, sent to me via [Otherpower.com](#).

Dear Mr. Windbag: I have an electric model train (author’s note: or car, or airplane, or boat) that runs off batteries and I thought that if I mounted a small wind turbine on top of it, the power coming in would help charge the batteries, so I’d get more battery life. Would this work?

Sorry, it won’t work. As the train speeds up and the mounted turbine starts making power, the extra drag on the train would increase too – and the extra power to overcome the extra drag would have to come out of the train’s batteries.

No generator or alternator can get near 100% efficiency – 100% means that the same amount of power being put into the system is being output at the other end. And, thanks to Betz (see the [July 2005 issue of the ESSN](#)) the absolute maximum power conversion efficiency from a wind turbine would be 59.26%. Friction and electrical losses compound the problem more. An efficiency of 35% would be an excellent turbine design, and keep in mind that the train would have to get going quite fast for the turbine to even start making power.

So let’s say you fly a tiny wind turbine on your train. The faster the train goes, the more power is produced, and the more physical drag is put onto your battery powered train—it has to work that much harder just to keep up its speed. Now take the power output of the wind turbine – at most Cp=35% . To simplify the math, let’s say the train has to push with 10 Watts extra power to go the same speed as normal. But the turbine can only put 3.5 Watts back in, and 10-3.5=6.5. That’s 6.5 watts extra power being used. Your train batteries will be drained MORE quickly, not less.

It is different when the energy comes from a free source like the wind. But when your ‘wind’ has to be generated via electric power, you are in a losing situation. It seems like a model plane in a dive (or an electric train going downhill) could have some extra power available for your turbine – but the energy to climb that hill or get to that altitude in the first place has already come out of batteries, and at most only 35% percent of it will be recovered via wind. It’s still a net loss that will drain your batteries faster, not slower.

Send your questions for the WindBag to [windbag@rebelwolf.com](mailto:windbag@rebelwolf.com) and they will be answered in ESSN as time and space permit.

Thanks.  
The Windbag

# EVEN MORE ON METHANE

Fourth in a series by Al Rutan,  
the Methane Man

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Temperature is critical to the success of any methane operation if it is to be considered an energy system. If the primary concern is waste management and not energy production, then a net energy loss is not a major consideration. If the intent is to produce energy, a net energy gain from the process is everything.

### Body Heat

Methane activity, in one of its natural situations, is found in the digestive tract of warm blooded animals, people included. For people, the normal body temperature is 98.6° F. In a chicken or pig it is 103° F. So right at 100° F is the ideal working temperature for the methane process. To maintain this temperature outside an animal is a problem if the ambient temperature is cool or cold.

### Sewage Plants Energy Producers

There were several methane farm operations launched in the upper midwest with much bravado and publicity. All of them are now out of business. On the other hand, sewage plants of medium size still commonly use the process to treat toilet waste and destroy pathogens, but in each instance they consume much more energy during the cold part of the year than they produce. The toilet water flowing into each sewage plant is ordinarily cold. It would be exceedingly difficult for sewage plants to be anything but energy users rather than producers at any time except in the hottest part of the summer.

Universities' verdicts at the end of the methane studies were always the same: "It's possible, but it isn't practical. It takes more energy to run the system than the system can provide." In harnessing methane as an energy system, it is important to conserve heat in the process of producing gas. A few years ago a new sewage plant was built at St. Cloud, Minnesota to the tune of 17 million dollars. I asked the engineer, "Did you insulate the tank?" He said, "Oh yes. The old one used to actually freeze on the north side during the winter." My next question was, "Did you run the insulation into the ground?" His reply, "No. The ground never gets cold." My reply was, "That's right, but it never gets warm either." This sewage plant burned \$750,000 a year in fuel oil to keep the digester at 100° F. It costs big bucks to flush the toilet in St. Cloud.

### Capturing Warmth

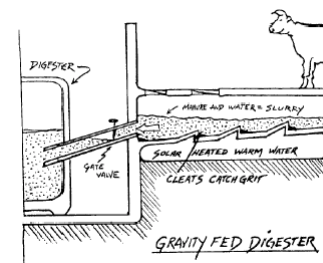
Heat has to be considered as something that is very slippery. Conserving heat requires understanding insulation. We are fortunate that there are many types of insulation available now that simply did not exist a few decades back. On the other hand, there's a general lack of understanding of insulating properties of common building materials such as wood, metal, and concrete. I recommend *Movable Insulation*, published by the Rodale Press in 1980.

Anyone familiar with insulation knows that if it gets wet, it is no longer insulation. Some "closed cell" insulating materials such as urethane, styrofoam, and polyethylene foam are more impervious to moisture than cellulose or fiberglass insulation. Even closed cell materials can break down if moisture under pressure is present.

Styrofoam is used on the outside of the foundations to provide a frost barrier for basements. Soil pressure and moisture can cause the styrofoam to be less than "bone dry" and thereby lose much of its insulating ability.

### Situating the Tank

My personal preference is that the methane tank be as effectively insulated as possible. Insulation should be below the flow line of the material entering the tank, but should not be buried in the dirt, regardless of the insulation. The temperature of the ground several feet below the surface stays quite constant at 50° F – 55° F. To the methane tank, the earth is a "heat sink", a cool mass always ready to absorb its heat. The best way to fight this heat



sink is to insulate the tank and build it above the ground. Another good reason for a free-standing tank is access to the grit trap at the bottom. A free-standing tank should be covered with six to eight inches of high quality insulation. Various people have asked if a buried tank would work. I can't say that it won't, but I've never seen any that work in a cold climate, and I have seen several that don't.

Continued on next page

### Restoring Warmth

When feces leaves the body, the waste is at exactly the right temperature for working within the methane digester. Whatever heat is lost in the interval between leaving the animal and entering the digester has to be restored. If the heat needed is significant, there needs to be a heat source available with an abundance of “free” energy, such as solar or wind.

### Relation to Fermentation

The methane process is a type of fermentation. Most folks have baked bread or made homebrew beer or wine at one time or another. For instance, after a yeast dough is kneaded, it is put in a warm place free of draft and allowed to rise. A draft could produce cooling. The yeast organisms feed upon the mixture’s sugar. This produces carbon dioxide bubbles, which cause the dough to rise. There is a similar activity within the methane tank. The methane organisms feed upon simple sugars, alcohols, and peptides produced by acid forming bacteria. Methane gas, CH<sub>4</sub>, is the result.

I’ve been asked if the digestion process within the tank doesn’t produce some heat, such as the heat produced in a compost pile. It probably does. Because the metabolic activity is so diluted and spread out within the tank, the heat available is minimal in comparison to the target temperature.

### Awareness is Essential

You’ll need to know how hot the tank is, day to day, season to season. To eliminate the guesswork, install sensors both inside the tank and outside the tank. Record temperature both inside and outside the tank over a period of time. Then you will know how efficiently the tank is retaining heat, at what rate the temperature drops when no heat is added, and how much energy is needed to raise the temperature. If this is done, then a reliable calculation can be made of how much gas is needed to maintain working temperature if “free” heat is not available.

Producing methane gas is relatively easy. The conservation of heat more than any other factor determines whether a methane system will “fly” or not. Of all the systems I’ve seen that failed, the principal reason is improper handling of heat.

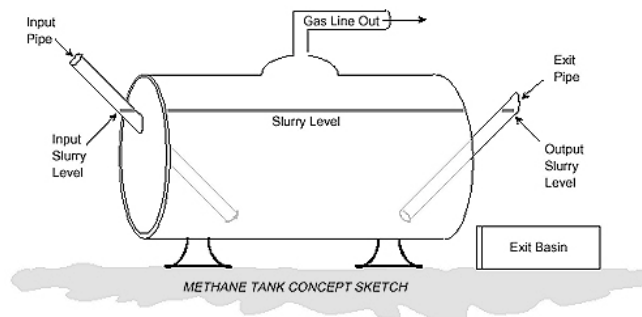
### Care and Feeding of your Methane Digester

Having thought about temperature, we can turn our attention to feedstock. I work with a mixture of manure and vegetation. Sometimes the question is asked: can’t one use just vegetation to produce methane? It can be done because Mother Nature does. Swamp gas burning over a marsh is just that. Because the methane bacteria are part of the “flora and fauna” of the digestive tract, every time there is a fresh deposit, there is fresh input of the microbiological organisms needed.

### How Much Gas Can I Get?

There’s a wide range of mixes of material you feed a methane digester. It’s similar to what happens when we eat. Some of the material enters our system to maintain it and some of it passes on as waste. When manure is considered, all of it, minus the water, is designated as “total solids”, and the part that is digestible to the bacteria is labeled “volatile solids”. The numbers of what is and what isn’t available for gas production have been gathered repeatedly over the years. Each account is quick to qualify any statement by saying that there is any number of variables when dealing with animals regarding what they are eating and how they are housed. One of the clearest reference sources is a newsletter printed in 1973 by the New Alchemy Institute in California. Their figures correspond to what I’ve experienced.

The numbers run like this: a cow drops an average of 52 lbs. of feces a day, of which about 10 pounds are solids, the rest being water. Of the 10 pounds of solids, 80% or 8 lbs. are volatile—can be turned into gas. A horse produces an average of 36 pounds of feces a day, of which 5.5 lbs. are volatile solids. A pig produces 7.5 lbs. per day of which 0.4 pounds are volatile solids. A human produces 0.5 pounds of feces a day of which 0.13 pounds is volatile solid. Chickens produce 0.3 pounds a day which 0.06 pounds is a volatile solid.



All of this is good information, but it still doesn’t tell us how much gas we can reasonably expect. If you ask an “expert” in the field, you’ll get an answer something like, “It all depends...” All manure contains a degree of nitrogen, but because nitrogen exists in so many chemical forms in nature—ammonia (NH<sub>3</sub>), nitrates (NO<sub>3</sub>), proteins, etc.—it’s difficult to test the total amount of nitrogen in a given material.

### Why Consider Nitrogen?

The process wants one part nitrogen to every 30 parts of carbon. Manure is nitrogen rich, averaging about 15 parts carbon for each part nitrogen, so all the studies show that gas production is substantially increased by including some carbon material along with the manure. The nitrogen proportion may be even higher in animal waste if urine is included with the feces because urination is the principle way an animal rids itself of excess nitrogen.

Continued on next page

To illustrate, straight chicken manure will produce only five cubic feet of gas for each pound of manure, but chicken manure mixed with paper pulp will produce eight cubic feet of gas for each pound of manure used. My experience was an outstanding ten cubic feet of gas for each pound of chicken manure when the manure contained some ground feed that had been spilled.

Cow manure will produce only 1.5 cubic feet of gas per pound, but cow manure mixed with grass clippings will produce 4.5 cubic feet of gas per pound of manure.

### The Nature of Biogas

Assume that we have a gas producing system and it's making gas nicely and filling the gas holder. What do we actually have? It's important to understand that it isn't all methane. A proportion of it is carbon dioxide, produced by the acid forming bacteria, which doesn't burn. This fact isn't immediately evident because if one ignites the end of a hose coming from the gas holder, there is a blue flame.

The fact that is important to know is: if we had pure methane we would have a hotter flame—about 1000 BTU (British Thermal Unit) for each cubic foot of gas. With the dilution of carbon dioxide, we have roughly 600 BTU for each cubic foot of gas.

The composition of the gas in our gas holder will be:

- CH<sub>4</sub> methane: 54 – 70%
- CO<sub>2</sub> carbon dioxide: 27 – 45%
- N<sub>2</sub> nitrogen: 0.5 – 3%
- H<sub>2</sub> hydrogen: 1 – 10%
- CO carbon monoxide: 0.1%
- O<sub>2</sub> oxygen: 0.1%
- H<sub>2</sub>S hydrogen sulfide: trace

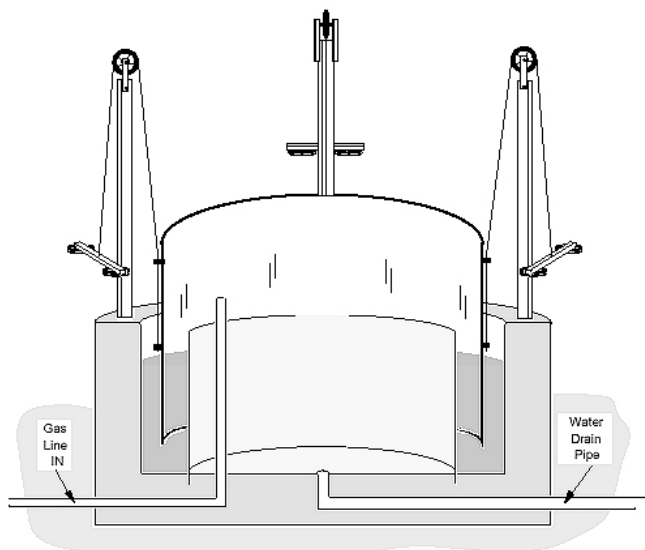
Wouldn't it be nice if we could separate out the methane and dump the carbon dioxide. Interestingly enough, Mother Nature has made it very easy to do just that because these gases all have different specific gravity weights.

### How to Get Pure Methane

The specific gravity of methane is about 0.55 in relation to the weight of air, so it rises, as does hydrogen. Carbon dioxide on the other hand is twice the weight of air. Within a vertical gas container, if the gases are allowed to settle, they will naturally separate themselves, the flammable gases rise to the top. This fact suggests that a good design should have a petcock at the bottom of a vertical gas holder. Use it to bleed off the accumulated carbon dioxide. In the right setting, this isn't environmentally harmful, because the trees and growing things around the yard will welcome a fresh sniff of carbon dioxide.



Al Rutan



Elysium

# STARTING YOUR OWN FRUIT TREES

By Thomas Ogren

I flat out love growing fruit trees and have been crazy about them all my life— or at least, as much of my life as I can remember. Actually, the very first thing I can clearly recall involved fruit trees.

I was about three, possibly four years old. It was a warm, lazy spring weekend and my older sisters were gone somewhere with my mom, but my dad was home, working in the garage. I wasn't allowed to cross the street by myself, but down the block, across the street, was a beautiful pineapple guava tree growing in the middle of some grouchy old man's lawn (Paste-up note: this grouchy old man in New Zealand calls them Feijoas!). The tree had a huge crop of large, green, totally delicious fruit, but the owner wouldn't let any of us kids pick guavas from his tree, much less climb it. He claimed that we would break the branches. He would however let us have fruit that fell on the ground, but these guavas were generally too soft and mushy.

That day I walked down the street by all by myself, seeing no adults or even any other kids around. I looked at that tree and dashed across the street. The old man was nowhere around and I climbed up his guava tree and started stuffing big, fat guavas in all my pockets. I picked as many as my pockets could hold and climbing back down I did indeed break a few small branches.

Looking both ways (of course!) I ran back across the street with my loot. Back at home I found my dad still in the garage and I showed him my stash, expecting him to yell at me for crossing the street. But dad never did make the connection and thus my first episode of crime was all in all, a total success.

Some fifty years later I now have five guava trees growing in my own yard, all grown from seed. I also have many other fruit trees, all of them homegrown ones.



## Fruit From Cuttings

Some fruit is so easy to propagate I always wonder why everyone doesn't try it. Grapes, figs, mulberries, and pomegranates are all easy to grow from directly stuck cuttings. I cut off a piece of dormant wood, 12-18 inches long, and I bury almost all of it in the ground where I want it to grow. I leave at least one good bud above ground. Sometimes to insure a better take, I'll stick five or six such cuttings

in the same spot. If they all grow, then the next winter I dig up the extra ones and give them to friends. I use cutting wood that grew last year and find that wood that is about pencil thickness or somewhat thicker roots the best.

I recently accidentally discovered a way to get plum wood to root for me. I used a long whip of plum branch (dormant wood) as a stake in a one-gallon pot of some fancy gold heart ivy. To my surprise the plum wood rooted and started to grow the next spring. I now do this on purpose, using plum wood that is from last year's vigorous growth. I select plum whips 2 to 3 foot long, with no branching on them, and stick each one all the way down into the center of a gallon pot of some well-rooted perennial flowers or herbs. A surprising number of these plums grow, and since they are "on their own root," they don't need to be budded or grafted. Try it.



Continued on next page

### From Seed

I have a spot in my backyard next to my compost heap, and here I toss any and all old pits from plums, apricots, peaches, and nectarines. I toss apple and pear seeds in here too. At the end of the summer I shake an inch or so of old compost over the area and see what grows. Since I do this every year, I always have a ready supply of seedlings each year.



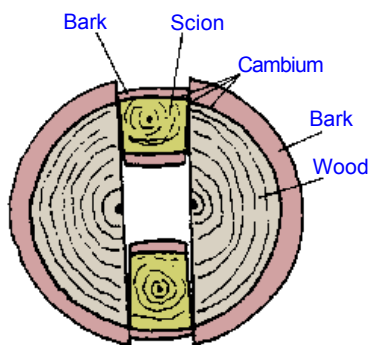
In the winter months, or in the very early spring months if you live in a zone 4-7 area, dig up some of these year-old seedlings, bare root, and pot them up one to each one gallon pot. I use a 50-50 mix of potting soil and garden dirt.



I then water the pots, set the potted seedling on a table, clip off most of the top, leaving 4-6 inches of trunk above ground, and then cleft graft the seedling. Cleft grafting is, I think, the easiest method and it works well with apricot, peach, plum, nectarine, quince, apples and pears. I use a thin bladed knife and tap it (tapping the back of the knife blade with a small hammer or a piece of wood) directly into the center of the cut seedling, going down only about one inch. I cut scion

wood (whatever you want to convert your seedling to) that is from last year's growth. I like to use scion wood that has a

diameter that is slightly smaller than the diameter of the seedling I'm going to graft it to. The grafts, or scions, should be about 3 to 4 inches long and each should have several good, dormant buds. The scions can be cut to shape with a sharp pocketknife. Try to get your scions cut smoothly, with a gradual taper.



The scions are then tapped into place in the split seedling (the rootstock), making sure that the cambiums of both scion and rootstock match on at least one side. The cambium is the thin green layer of wood that is just inside the outer bark. To keep your work from drying out, cover the entire finished graft with a thick coating of grafting tar or grafting wax. I also put a dab of the tar or wax directly on the exposed cut tip of the scion. Be careful as you do this, not to knock the scion out of contact with the rootstock cambium.

Now, unless a kid, bird, or a cat bangs into this graft and knocks the scion askew, if you did it right, come spring time the scion will sprout and grow. Voila! You've got a grafted fruit tree.

You can graft peach onto almond, apricot, plum, peach or nectarine rootstock, and visa versa. For sandy soils peach or nectarine make the best rootstocks, but for heavy clay soils, plum is by far the best. Apples can be grafted on apple seedlings as can pears. Pear can also be grafted on apple stock. If so inclined, scion wood from quince can also be grafted onto apple or pear. An apple or pear grafted onto a quince rootstock will be a dwarfed tree. If your soil is clay, a pear rootstock grows best. If sandy or loamy, apple is preferred.



I grow these new fruit trees on in the gallon pots for a year, making sure to cut off any sucker wood that arises from below the graft. Keep them well fertilized and watered and they will often grow 3-5 feet in one summer's time. The next year either plant them or give them away to friends.

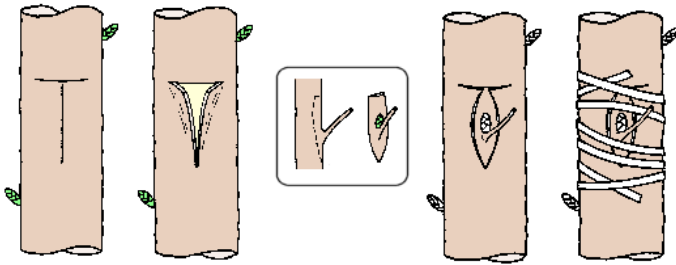
If you have a potted fruit tree seedling where the graft fails to take, simply cut off the unsuccessful grafted part. You can re-graft it the next dormant season. If you have year old seedlings left in the ground that you won't get around to digging and grafting, consider chopping them off just above the ground in the late fall. The next spring these seedlings will grow up with multiple trunks. The next winter dig your second-year seedlings with multiple trunks, thin them back to the strongest 2 or 3 stems, and then cleft graft each of the stems to something different. I have made many three-in-one trees this way, part plum, part apricot, and part nectarine.

Continued on next page

These make extra nice presents. You can of course just as easily graft each branch to a different cultivar of the same species, such as three different kinds of plum on the same rootstock. A tree like this is often very fruitful, since it will cross-pollinate itself.

### Budding

Just a little here on budding. In zones 3-8 most budding is done in May, June or early July. The easiest method is shield budding.



A T cut is made on the rootstock stem, cutting through the outer bark and the cambium, down to the hardwood. Next you cut a thin, shield-shaped slice of wood (from scion wood of the cultivar you wish to bud), containing one dormant bud. This shield will be about 3/4th of an inch long. This bud is then inserted in the T cut under the bark of the seedling rootstock. I use thin, clear plastic tie tape to wrap the bud up tightly. I will sometimes cut a tiny slice in the middle of the tape and wrap the tape over the tip of the bud itself, which should just peak out of the sliced portion of the tape. The tape serves to keep the bud in close contact with the rootstock and also to keep the bud graft from drying out.

Keep an eye on the budded stem for several weeks and by then if the bud and the shield are still plump and green, consider it a take. Cut off the rest of the stem half an inch above the new bud graft, and this will force the new bud.

Budding is not quite as easy to do as grafting, at least not at first. It has several advantages though. You can bud when the weather is nice and if the bud doesn't take, you can try it all over again in a different spot. Budding is easiest on thicker rootstocks.

I find that for me I have the best luck budding roses, apples, pears and apricots. Plums can be a little trickier. Cherries, by the way, are considerably more difficult to graft and bud than are the other stone fruits.

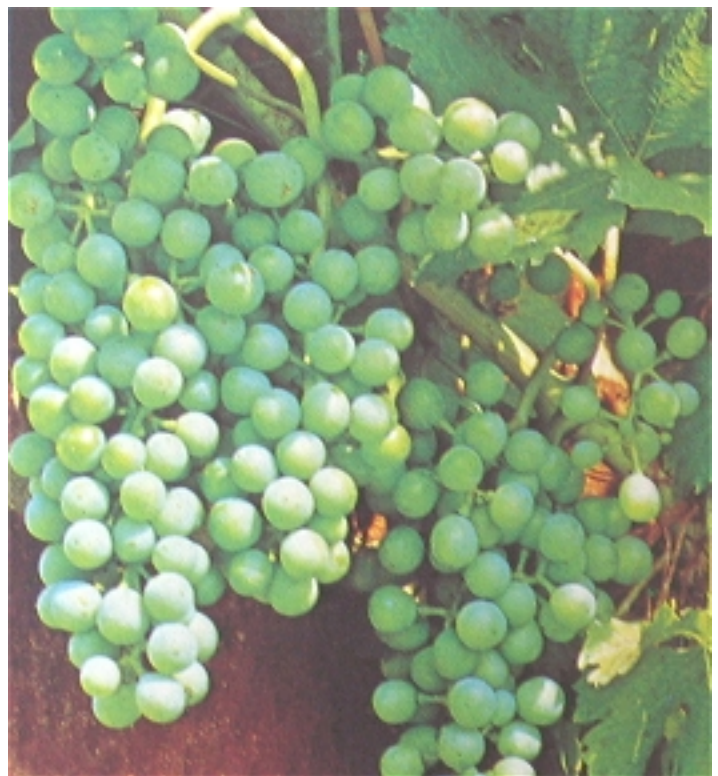


If you are lucky enough to know an old gardener who knows how to graft, ask him or her to show you how to cut your scions. A little practice always helps as does a sharp knife.

There are many books with drawings of cleft grafts and these too can be used as guides. It may sound a tad snobby, but once you can graft your own fruit trees, you join a rather select group. Almost all gardeners know what grafting is, but not that many actually know how to do it right.

One last thought: cleft grafting is also easy to do on existing dormant fruit trees. There is no reason you can't graft some different varieties on each of your trees. I have an apple tree with about a dozen kinds of apples on it and a pear tree that has five kinds of pear, plus quince and apple growing on it. I also have almonds growing on one branch of a plum tree, four kinds of plums on another tree, and both plum and nectarine on the apricot tree in my front yard. I have five kinds of roses budded on the climbing rose that grows on my front porch. I guess my plants are all mixed up, but then, what can you expect from an old guava thief?

**Thomas Ogren**





## MAKING ETHANOL FOR FUEL DISTILLATION EQUIPMENT

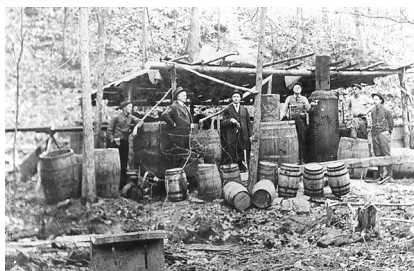
By Mike Nixon

Those of you who have nothing better to do than follow my boring articles will know that it's now time to think about what sort of equipment you need in order to distil the ferment that you have prepared. You may also have taken steps to get yourself registered as an approved ethanol distiller, although if you haven't done so yet, don't worry. You are perfectly entitled under every law I've heard of to own a still – you just can't use it to distil ethanol if you are unregistered! Please don't imagine that you will be able to duck under the radar horizon and distil ethanol for fuel without such a licence, for the quantities that make this a practical proposition will be too big to easily hide.

Right, my legal duties discharged, let's get down to designs.

### A pot still

The simplest type of still is called a "pot still". This is just a boiler with a spout on top through which the generated vapor can flow on its way directly to some sort of condenser.



You've probably all seen pictures of the pot stills used during the American prohibition days, often flanked by scruffy unshaven guys with a mean look in their eyes – a bit like me in fact!

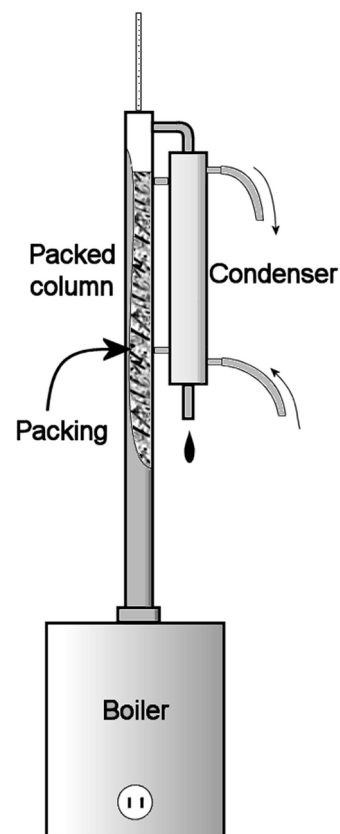
That's all you need know about pot stills, for as far as making ethanol for fuel they are a waste of time. You may recall that the ethanol you need for an engine designed to use it as fuel must have less than 15% water, and if intended for blending with gasoline or diesel then only a fraction of a percent water can be tolerated. A pot still will achieve neither of these targets. It won't come even close!

So what you need is some sort of still that will get rid of as much water as possible, and for that you need what is called a "reflux" or "fractionating" column.

### The Reflux Column

A "reflux" column is simply a long, vertical pipe which has been packed with porous material that lets vapor through, but which also provides a large surface onto which condensing vapor can settle and be held when it condenses. I'll describe what sort of material you need a little later, but first would like to say why such material is needed – and for that I need to go back and quickly describe the basic principle of separation of liquids by distillation.

Now that took two whole chapters in the book that my colleague Mike McCaw and I wrote (The Compleat Distiller), but can be summarized for our purposes here in just three short paragraphs.



Reflux Still

If you take a mixture of liquids – for example water with ethanol and a whole bunch of other alcohols and liquid substances – then the composition of the vapor you get from that mixture when you boil it will be quite different to the composition of the mixture it came from. The reason lies in the fact that the vast majority of pure liquids (not mixed with anything else) have distinct boiling points. Water boils at 100°C (212°F) under standard atmospheric pressure (we don't need to get into what this is in all the different units that are used – just think of a 'nice day'). In contrast, pure ethanol boils at 78.3°C (173°F). A mixture of water and ethanol will boil somewhere in between, depending on the mix.

Now if you boil such a mixture, say one part by volume of ethanol to 9 parts water (10% alcohol by volume = 10%abv), then the vapor you first get off will have much more ethanol in it than that original mix. It could be up to around 70-80%abv. Now some may be nodding their heads wisely and saying that's obvious because ethanol, having a lower boiling point, will boil off first. Sorry, O Wise Ones – that's absolute rubbish! Both ethanol and water will boil off at the same time, but in different proportions. Want to know why? Buy the dratted book!

The end result of boiling is therefore to produce a vapor in which the proportions of the most volatile substances (lowest boiling points) are greater than they were in the original mix. Condense that vapor and boil it again, and the same thing happens – the proportions change yet again in favor of the most volatile substances. Keep doing that with water and ethanol and you will end up with a liquid that is mostly ethanol. In short, you have separated the ethanol out of the original mix by means of distillation.

And this is where that packing material comes in. Pass a hot vapor through that material and it will condense and settle on the packing when it gets to a higher, cooler part of the column. As more vapor condenses, it releases the heat that it took to produce it in the boiler, and this heat is passed immediately to the previously condensed liquid and causes it to boil. Result – vapor with an even higher proportion of ethanol! This repeats over and over again as you go up the column, and the condensed liquid and the vapor that's boiled off gets richer and richer in ethanol. By the time you reach the top, most of the water left behind on the packing will have built up and formed large droplets that move back down in the opposite direction – finally ending up in the boiler again. Because it's moving back against the general movement of vapor rising in the column, this condensed liquid is called reflux (that which moves backwards), and a tube packed with such material is called a "reflux column".

**Reflux Columns – the Good and the Ugly**

It should be fairly obvious by now that the longer the column, and the more packing it contains, the better the column should work. That's true up to a point, but that same reasoning can lead to some ugly results. The first of these is that it can lead to the need to knock a hole in the ceiling if the column is to be tall enough to yield a high strength product.

The other is that if you don't pick the right sort of packing, then you can end up with nothing! You get either "flooding" or "avalanching".



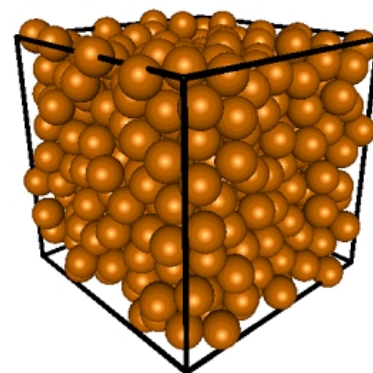
Flooding occurs when so much liquid reflux is on its way down that it takes up most of the room in the column and vapor can't get through. You end up with a solid plug of liquid that causes the pressure in the boiler to build up until something gives way. If you're lucky, then then you can invite your neighbors round to admire your own mini version of Old Faithful. If it's been a bad hair day, then you will get a pressure explosion!

Avalanching usually precedes flooding, and it occurs when liquid that has been held on the packing starts to join forces with other droplets to form a river of liquid down a preferred path in the packing, and the bigger the river, the faster it will move and the more liquid it will pick up on its way. The end result is that all that liquid you relied on to be held in place to be re-boiled and produce richer vapor will be hell-bent on avalanching back down to the boiler. Net result at the product end – zilch!

**Packing and Vapor Speed**

Flooding and avalanching can be avoided if you choose a packing material that has the right surface to volume occupied ratio, and if you keep the vapor speed to defined limits.

The surface to volume ratio (SVR) of packing is simply the amount of surface area that packing offers compared to the total volume it occupies. Spheres, like marbles, have the lowest ratio of all shapes, which is why bubbles are spherical when undisturbed. Now it may seem easy to calculate the SVR as  $4 \cdot \pi \cdot R^2$  divided by  $\frac{4}{3} \cdot \pi \cdot R^3$ , to give  $3/R$ , but that would be wrong! If you fill a container with marbles all the same size, then they settle down into a pattern known by eggheads as "random close packing". Given enough shaking, the ratio of the volume of the marbles to the volume they occupy will be about 0.64. However, Johannes Kepler (1571-1630) calculated that a packing density of  $\pi/18^{0.5} = 0.74$  could be achieved. This has been proved by experiment in the space shuttle and, as a demonstration of how difficult the math can be, it wasn't until 2000 that [Sal Torquato](#), a professor at Princeton University, proved that Kepler was right – and that there's a lot of skill in a game of marbles! Anyway, on a more practical front, marbles 1cm in diameter and packed "normally" will have a SVR of 3.6, rising to 7.2 when the diameter shrinks to 0.5cm. Compare that to metal mesh which can have a ratio of up to 40!



Continued on next page

As for vapor speed, experiment has shown that the maximum speed through a column before adding packing should be no more than 20 inches/sec. The packing takes up space, so the speed will rise beyond that, but empty-column speed is a good, practical design parameter to use together with the SVR of the packing. The reason? Simple: if the vapor shoots through too quickly then there's no time for it to condense. If it's too slow, then you can reach a point where nothing gets to the top. The ideal empty tube speed turns out to be around 10 to 15 inches/second, and that speed is controlled by the power you put into the boiler.

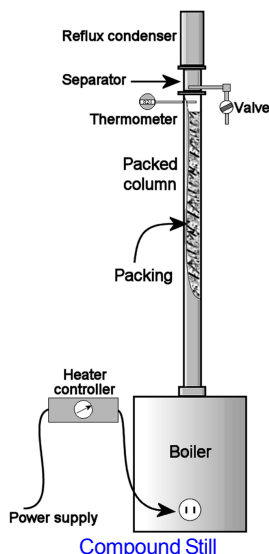
### Beyond the Reflux Column

A well packed reflux column, about yard long and 2 inches in diameter (oh, alright – one meter and 5cm), fed from a 1.5 kW boiler containing a 10-12%abv ferment or “wash”, will give a product that contains around 85%abv. Now that's fine if you are satisfied with the bottom limit of strength when running an ethanol fuelled engine. The nice thing too is that you don't have to worry about any other volatiles staying in, unlike those whose aim is to make potable ethanol. However, if you want to blend with gasoline or diesel then it's just not good enough.

What you need is a “forced reflux” or “Compound” still.

### Compound Stills

Just suppose you put a condenser on top of the reflux column and return the vapor that reaches the top back to the column as condensed liquid, or reflux. What happens is that you are forcing the vapor to go through another cycle of condensation and boiling, so the ethanol strength goes up. But you are doing this continuously, for what you've set up at the top of the column is a closed cycle! After a short while, and hundreds of cycles of that closed loop, it's not surprising that you will end up with vapor at the top of the column that's as rich in ethanol as you can get – around 95-96%abv. You cannot get any further than that under normal atmospheric pressure as ethanol and water have a nasty little trick of forming an Azeotrope – a mixture that is stable at a particular concentration of ethanol. However, you are well on your way now to drawing off a product that is, say, 95%abv ethanol, and that will work just fine in an ethanol burning engine, and needs only a little drying to get close enough to anhydrous ethanol which can be used



Compound Still

for blending with gasoline or diesel, or for making biodiesel (see last month's ethanol article, and Steve Spence's articles on biodiesel).

In practice, this simple addition to an ordinary reflux column will assure delivery of high strength ethanol, albeit at a slower rate than a simple reflux still. Why slower? Well, if you reduce the amount of forced reflux at the top to less than 90% of all that's condensed there, the strength goes down as the number of recycling operations is drastically reduced. You are therefore limited to drawing off at only 10% of the speed you would take from a plain reflux still. However, the advantages are considerable – you not only get the strongest ethanol possible, but you can also limit the length of the column! Easier than cutting that hole in the ceiling!



Fuel still under development

Now what I've described in these articles is what's behind making ethanol for fuel, and it's only a start. Our Noble Editor refuses point blank to letting me fill the whole of each issue of ESSN with this Worthy Subject, so sadly I must point you elsewhere if you want to progress beyond a simple batch system that you can make yourself, to a continuously operating still that churns out ethanol fuel for as long as you feed it. You may agree with me that this shows a petty small-mindedness on the part of the aforesaid Noble Editor, but I can assure you that he has many endearing qualities that more than make up for that (G). You may also wonder how I can get away with remarks like that – to which I blithely reply that it's one of the perks of being the guy who does the paste-up to get ESSN on the stands. It makes for a strong union of one!

If your interest has been sparked, then drop me a line, for my colleague Mike McCaw and I are right in the middle of developing a new design of continuous flow fuel still that is aimed specifically at the growing number of people who are interested in being energy self sufficient!

Mike Nixon  
[mikenixon@amphora-society.com](mailto:mikenixon@amphora-society.com)

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Hey folks, do you have experiences you'd like to share with other ESSN readers. Many of you have energy self sufficiency related experiences or information that you'd like to share with ESSN readers. If you're comfortable writing, please submit your article to [essn@rebelwolf.com](mailto:essn@rebelwolf.com).

On the other hand, if you'd rather not do your own writing, this forum is the place where you can get together with folks who'd like to do some writing with you: <http://www.green-trust.org/forum/viewtopic.php?p=1050>. So, if you're one of those folks who wants to work on a collaborative article, just post here that your available and check out the posts from the folks who are looking for you.

I'm hoping to see a lot of fresh content for ESSN come from this forum. We'll be waiting for your posts. All of you!

Peace,  
ldb

### THE AMPHORA SOCIETY



Mike Nixon, together with his close friend and colleague Mike McCaw, founded The Amphora Society several years ago. One of the first things they did was to write a book about distillation that is now widely acknowledged as the clearest book that has ever been written on the subject – so much so that it is now used as a text by many schools and colleges around the world.

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A full description of this book, complete with details of the contents of each chapter, may be found at

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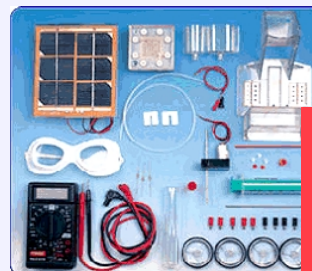
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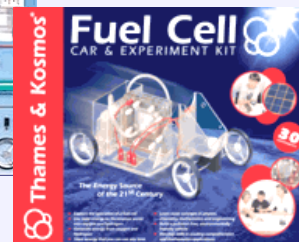
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