

EVERYONE EVERYWHERE can be empowered to independently purify unsafe water into distilled, safe water to drink using locally available materials and energy sources. Everyone Everywhere Purifiers are fully scale able from individuals to households to entire cities.

ANY COMBINATION OF ANY SOURCES OF HEAT (Herein “heat” is used as synonymous with “thermal energy”.) can be used to power Everyone Everywhere Purifiers: solar power; waste heat from stoves, engines, furnaces, etc.; burned fuels; geothermal heat; heat from compost piles, etc. etc. etc.

MOST PRACTICAL heat source is exhaust heat from an engine, furnace, stove, kiln, etc. Simply use the Everyone Everywhere Purifier like an exhaust hose extension.

VERY PRACTICAL heat source is biomass such as straw, wood, dung, empty corn cobs, seeds, dry leaves, cloth, paper, alcohol, bees wax, etc etc etc.

LESS PRACTICAL is fossil fuels such as oil, methane, propane, paraffin wax.

LEAST PRACTICAL heat source is Solar Energy. While a Everyone Everywhere Purifier will work fine with solar power alone, it can only work with as much power as the Sun will provide. Even at the equator, on a cloudless day, a 1 square meter Everyone Everywhere Purifier at 100% efficiency could only purify 15 liters per day.

Formula: (solar constant at Equator * evaporation area * 12 hours/day * 3600sec/hour * average sine of 1° through 90° ie rising and setting sun) / enthalpy of water = maximum liters/day

Calculation: (0.00137 mJ/sec/m² * 1 m² * 12 hours/day * 3,600 sec/hour * 0.642159 average sin) / 2.454 mJ/liter = maximum 15 l/day purified.

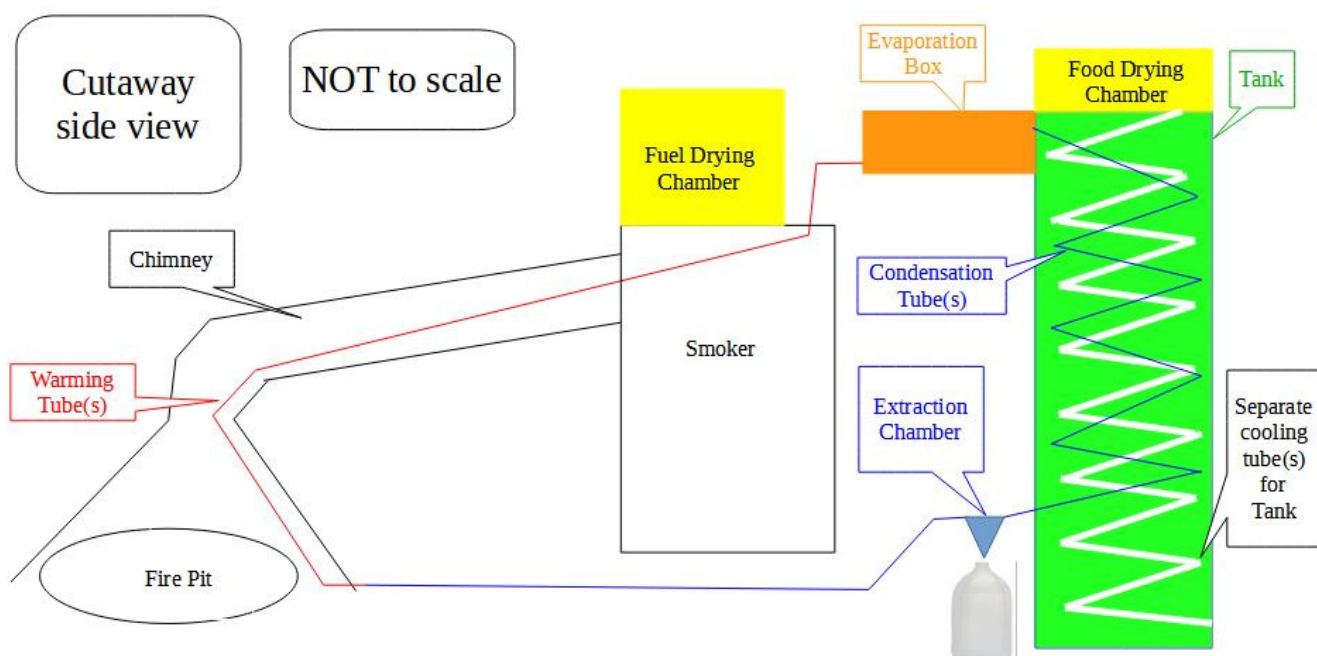
Burning biomass is much more practical and just as sustainable. Biomass is, after all, concentrated solar power. The Sun will shine. Plants will grow. Then plants will rot, putting methane into the atmosphere **UNLESS** we harvest plants and capture their methane production.

HOW THEY WORK: the guiding principle is the universal one for distillation, ie evaporate and re-condense water. However, Everyone Everywhere Purifiers do not distill water by directly heating a big pot of unsafe water and cooling the steam. Instead, captured air is repeatedly heated, allowed to collect evaporated water, cooled to release the water, then heated again to restart the cycle. Capillary action/wicking is used to partially purify and spread out water for the air to absorb.

ADVANTAGES of EVERYONE EVERYWHERE PURIFIERS

1. Everyone Everywhere could build a working purifier from scraps on a garbage pile
2. Publishing this writing should make the idea not patent able.
3. Uses any combination of heat sources
4. Scale able from single person to city
5. Can use locally available materials (beware of temperature maximums)
6. Installable on boats and vehicles
7. Quick, low cost process to undo fouling by salt residue etc
8. Can be operated by non-engineers
9. Simple, affordable, reliable
10. Do NOT need moving parts
11. Do NOT need chemicals
12. Do NOT need filters
13. Do NOT need electronics

This example was designed for a household that already had a fire pit and a smoker.



My purpose in publishing this paper is to make this idea not patent able.

Thus everyone everywhere can design and build their own versions.

My research has been done primarily on the internet, so checking my research and checking my math are both worthwhile. Everything I have written here is to the best of my knowledge and belief.

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1st Step-Planning

SUB-SYSTEMS

Working Air: circulates repeatedly from Warming Tube to Evaporation Box to Condensing Tube to Extraction Chamber to Cooling Tube to Warming Tube (start over)

Distilled Water: drips from Condensing Tube to Collection Chamber and out.

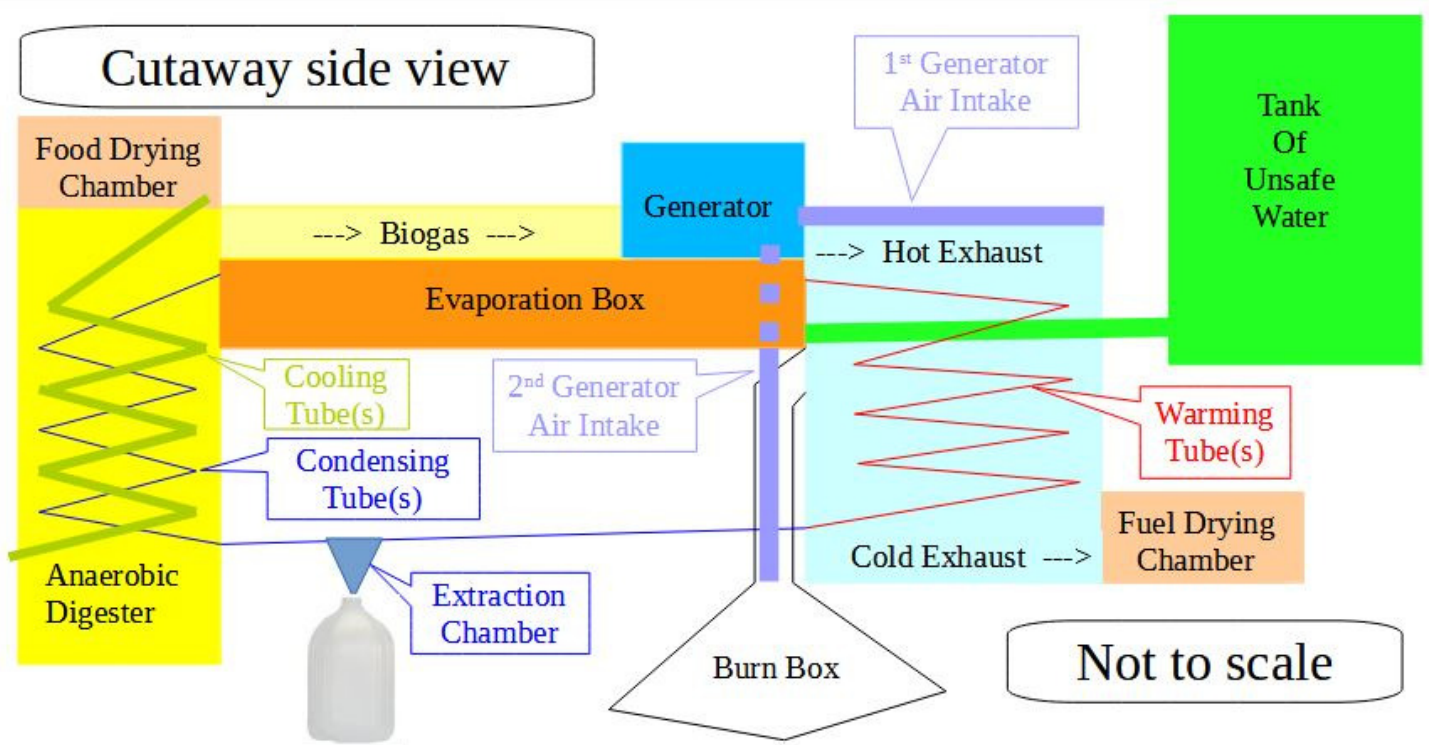
Unsafe water: flows from Tank to Evaporation Box

Smoke: rises from Burn Box to Chimney Chamber where it drifts down as it cools.

Cooling Air: is ambient air that rises through Cooling Tube(s) to Food Drying Chamber.

Drying Chambers: use excess heat to dry their contents.

SUGGESTED DESIGN (Detailed in following pages)



NOTES

- The sizes and arrangements of the components do NOT have to follow the drawings. As long as warming air is allowed to rise and cooling air is allowed to fall, the specific design is flexible.
- Within the limits of maximum temperature tolerances, any water tight materials can be used.
- No insulation is shown in this design, however, insulation will increase efficiency.
- The included design uses exhaust from the generator and/or smoke from a fire for power. However, any flow of hot air can be used.

OPERATING TEMPERATURE

Auto exhaust is typically 200°C (400°F).

Diesel exhaust is typically 280°C (540°F).

2.5 kW generator exhaust is typically 315°C (600°F).

With this same design, higher operating temperatures will power faster purification volumes.

Operating Temperature Production Rates (approximate)

Operating Temp °C	liters per day	Operating Temp °C	liters per day
100	66	500	418
200	154	600	506
300	242	700	594
400	330	800	704

FLAME TEMPERATURES

Wood Type	Flame Temperature	Wood Type	Flame Temperature
Beech	950°C/1742°F	Radiata pine	349°C/660.2°F
Birch	816°C/1500.8°F	Redwood	364°C/687.2°F
Douglas fir	350°C/662°F	Spruce	620°C/1148°F
Oak	900°C/1652°F	Victorian ash	311°C/591.8°F
Pine	500°C/930°F	Western Red Cedar	354°C/669.2°F

Notice: per kilogram, different types of wood will give the same heat, 3600 Kcal/kg

Fuel Type	Flame Temperature	Fuel Type	Flame Temperature
Biogas (50% methane)	975 °C	hydrogen	2210 °C
corn cobs	1100 °C	natural gas (methane)	1950 °C
cow dung (dried)	640 °C	propane	1980 °C
ethanol	1920 °C	straw	250 °C
gasoline	2138 °C		

As long as the Wicks are saturated with water, their temperature cannot rise over the boiling point of water. However, other parts could be ruined and if the Wicks go dry, substantial damage could be done to the Wicks and Evaporation Box. In fact, some room should be left between the chosen Operating Temperature and the melting temperatures of the materials used.

Metals

660°C (1220°F) is the maximum for aluminum

1375 – 1530°C (2500-2785°F) are the maximums for various stainless steels

Wicking material options

200°C (392°F) is the maximum for cotton

268°C (514°F) is the maximum for nylon

800°C (1,472°F) is the maximum for stainless steel wool

2nd Step-Anaerobic Digester

1. Thermophilic (digestion) temperature range: 50 to 57 °C
2. Leftovers are liquid effluent and semi solid digestate.
3. Biogas generator manufacturer
 1. <https://duryeatechnologies.com/mode-biogas-chp-engine-generator-set/>

Cutaway side view

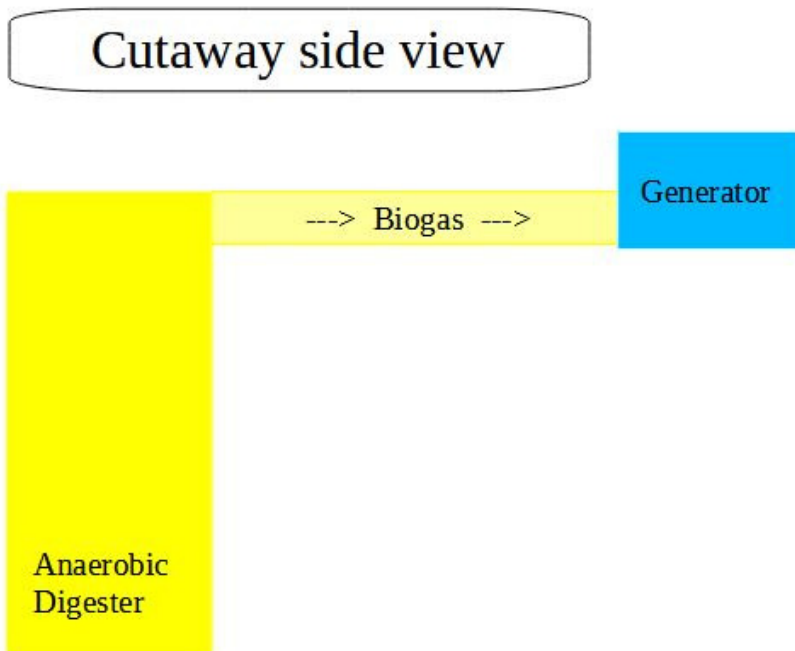


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3rd Step-Biogas Powered Generator

1. Heating the combustion air and fuel improves performance of the generator.

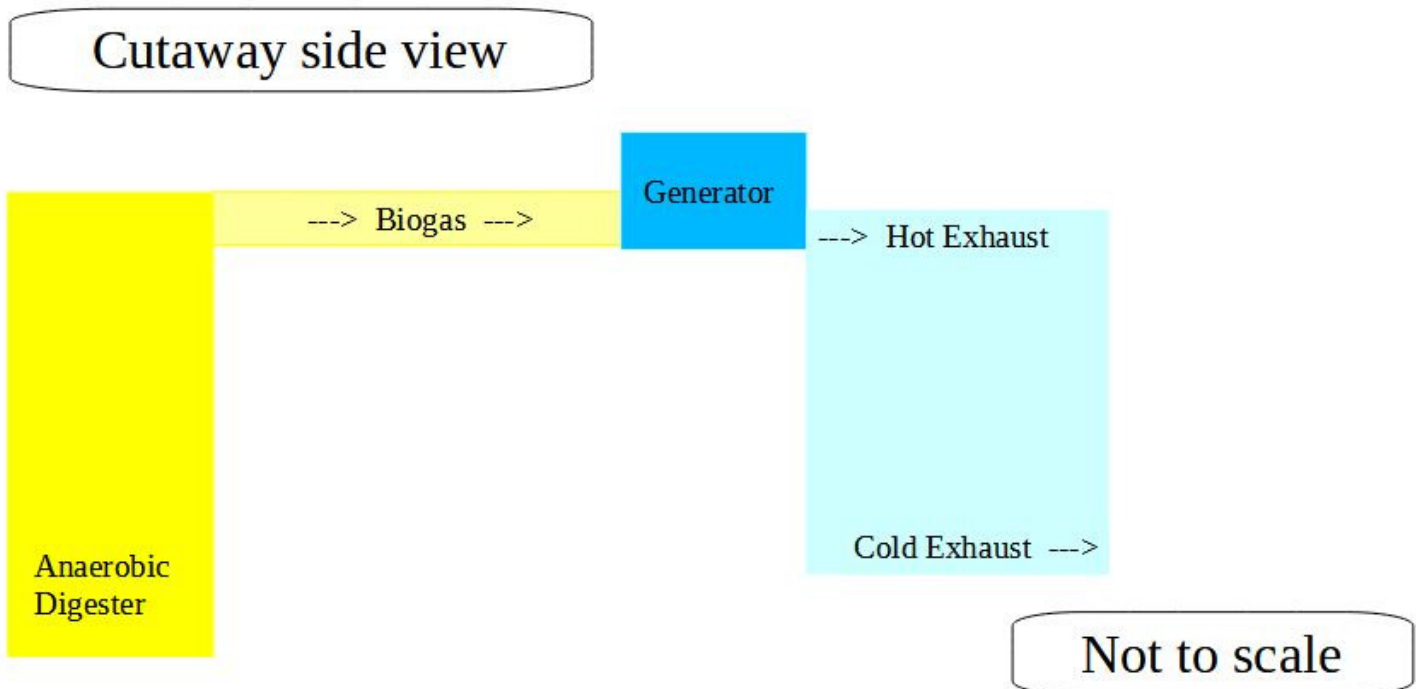
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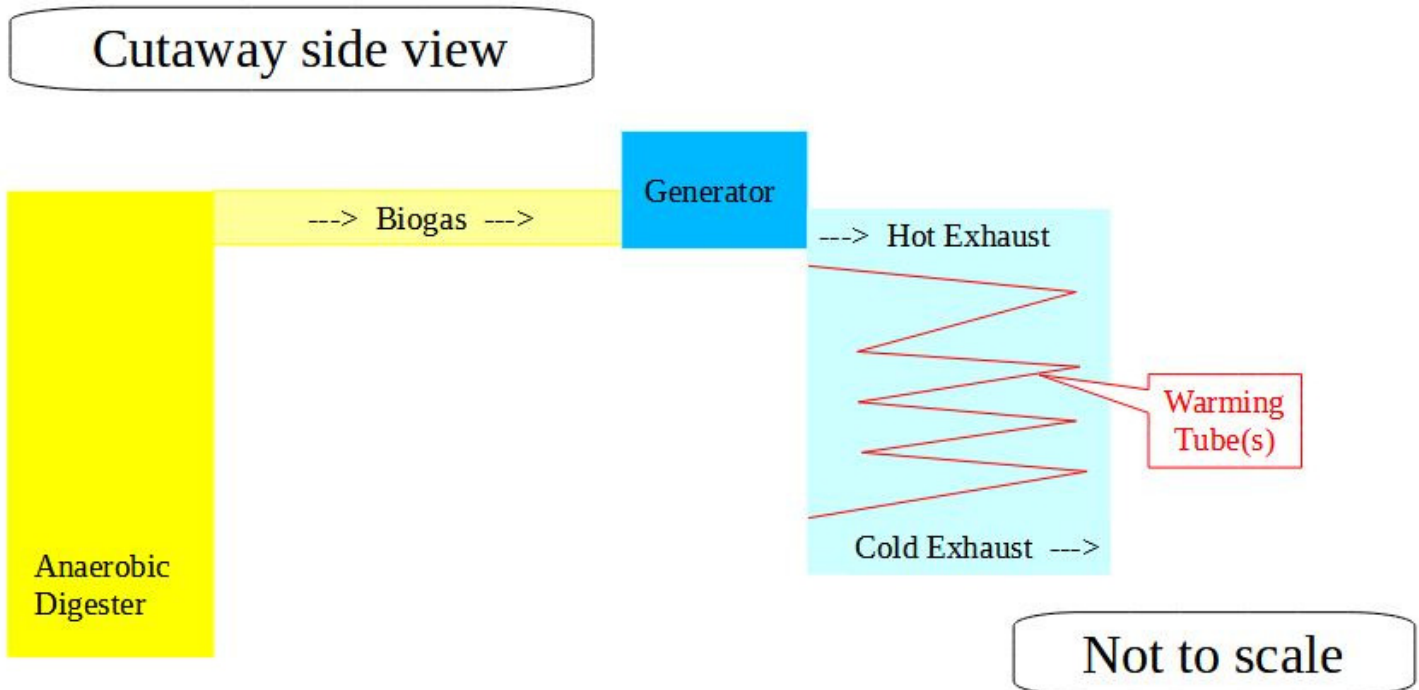
4th Step-Chimney Chamber

1. Hot air enters only at top. Air exhausts only at bottom. Therefore, hottest air is naturally held in the Warming Chamber.
 1. Receives exhaust from Generator
 2. Receives smoke from Burn Box
2. Contains and warms
 1. Warming Tube of Working Air
 2. Conduit for unsafe water supply
 3. Separate warming tube for generator air intake



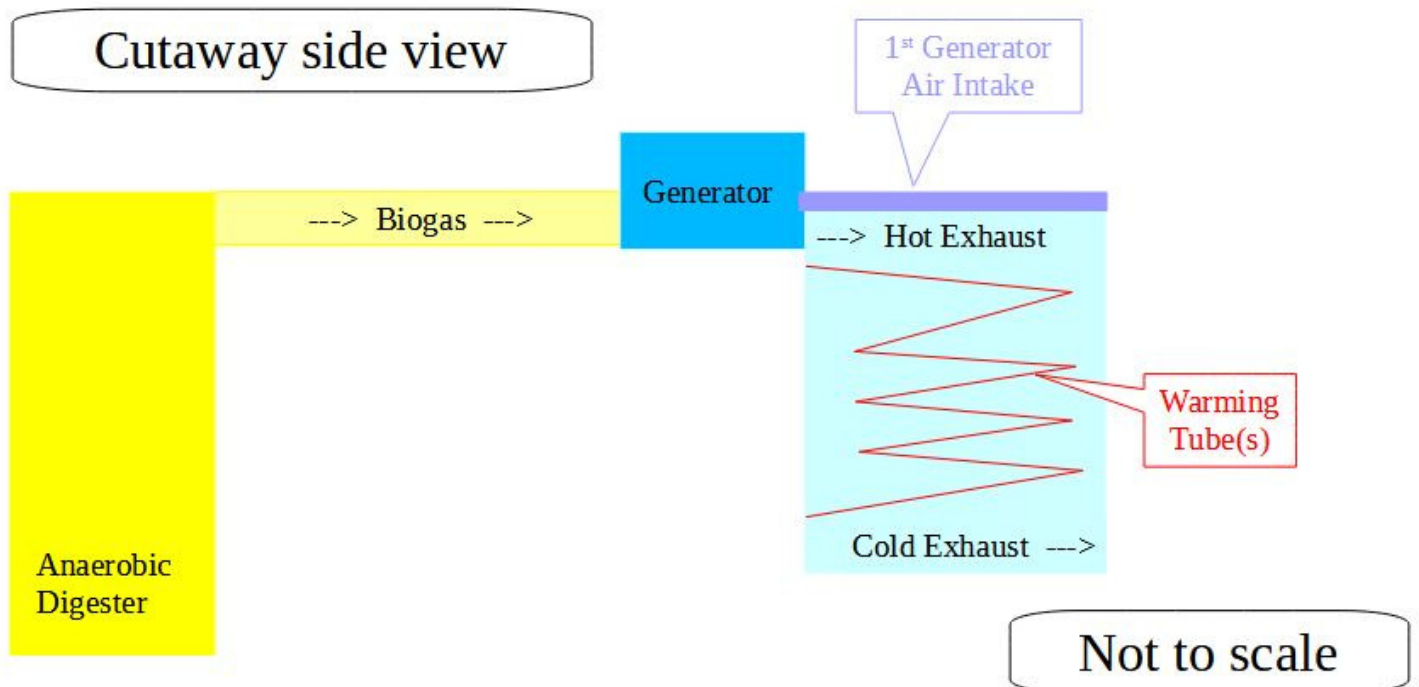
5th Step-Warming Tube(s)

1. Warming Tube (drawn in red)
 1. Enters Chimney Chamber near bottom
 2. Curls up through Chimney Chamber to direct warmed, dried air into Evaporation Box
2. Warms and dries Working Air which recirculates endlessly
3. A Stirling Engine could be used as the Heat Exchange between the heat source and the Warming Tube, providing free electricity, but reducing the purified water production.



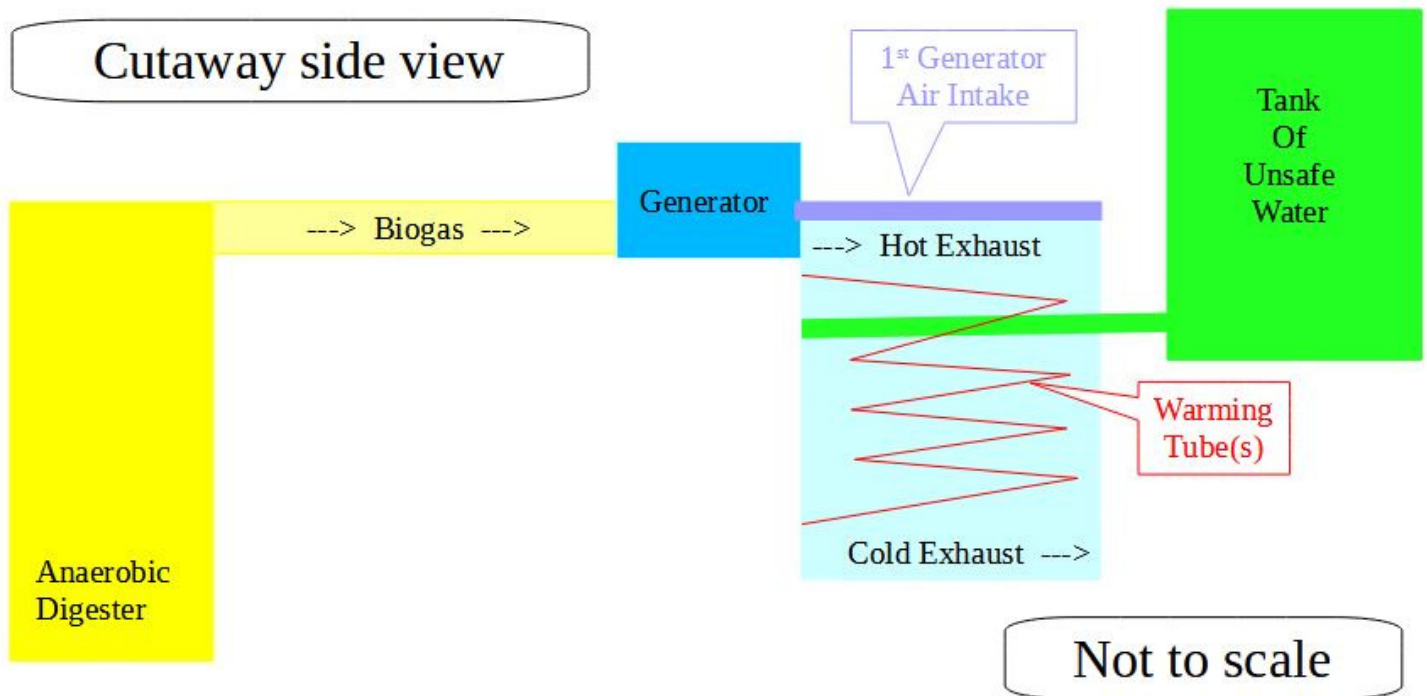
6th Step-Generator Air Intake

1. Warms combustion air to improve efficiency of the generator



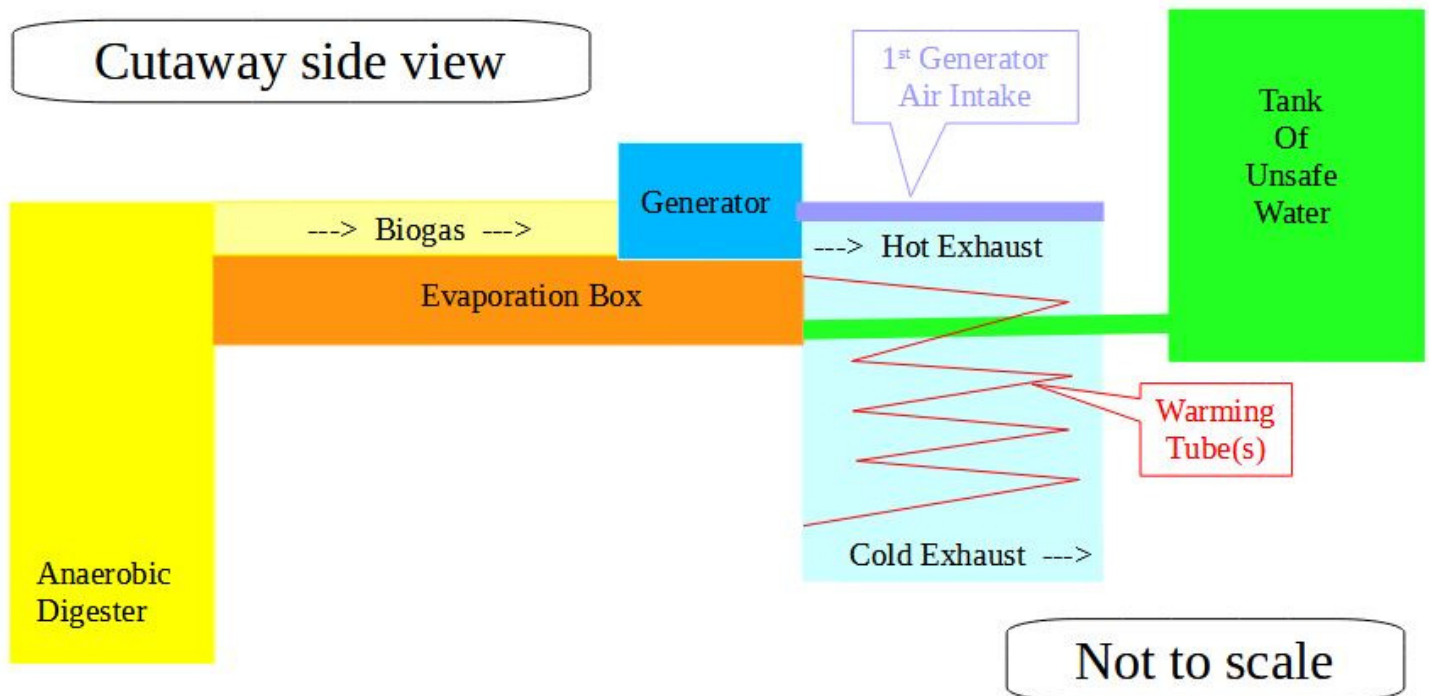
7th Step-Unsafe Water Intake

1. Unsafe water to be purified comes from the Tank via a conduit which passes through the Chimney Chamber to be warmed.



8th Step-Evaporation Box

1. Evaporation Box (drawn in orange)
 1. 65cm long by 40cm wide by 8cm high gives 5,000cm² of evaporation space.
 2. Sides and bottom of Box are one piece.
 3. Top lifts off for easy cleaning.
 4. Bottom has drain for easy flushing
2. Receives water from Tank of unsafe water
3. Water is held to 3cm deep by floating valve (not shown)



9th Step-Wicks

1. Wicks (drawn in **black**)

1. Stainless steel wool
 2. 65cm long by 7cm tall by 1cm wide hang the length of the Box
 3. the upper 5cm is the evaporation area; 2cm is in the water and 1cm of water is below the Wicks.
2. Eight air paths between Wicks are 5cm high by 4cm wide

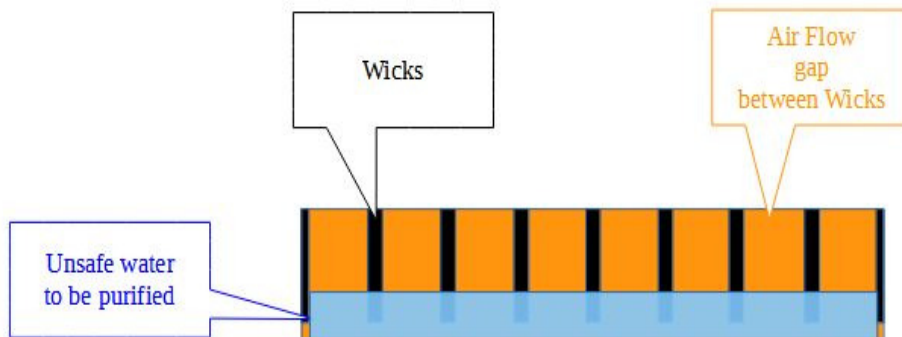
3. The bottoms of the air paths are water surface.

4. One of the 1cm wide Wicks is cut into two 0.5cm wide Wicks and hung at the sides.

1. This creates seven double sided Wicks plus the two single sided Wicks

2. making 16 evaporation surfaces

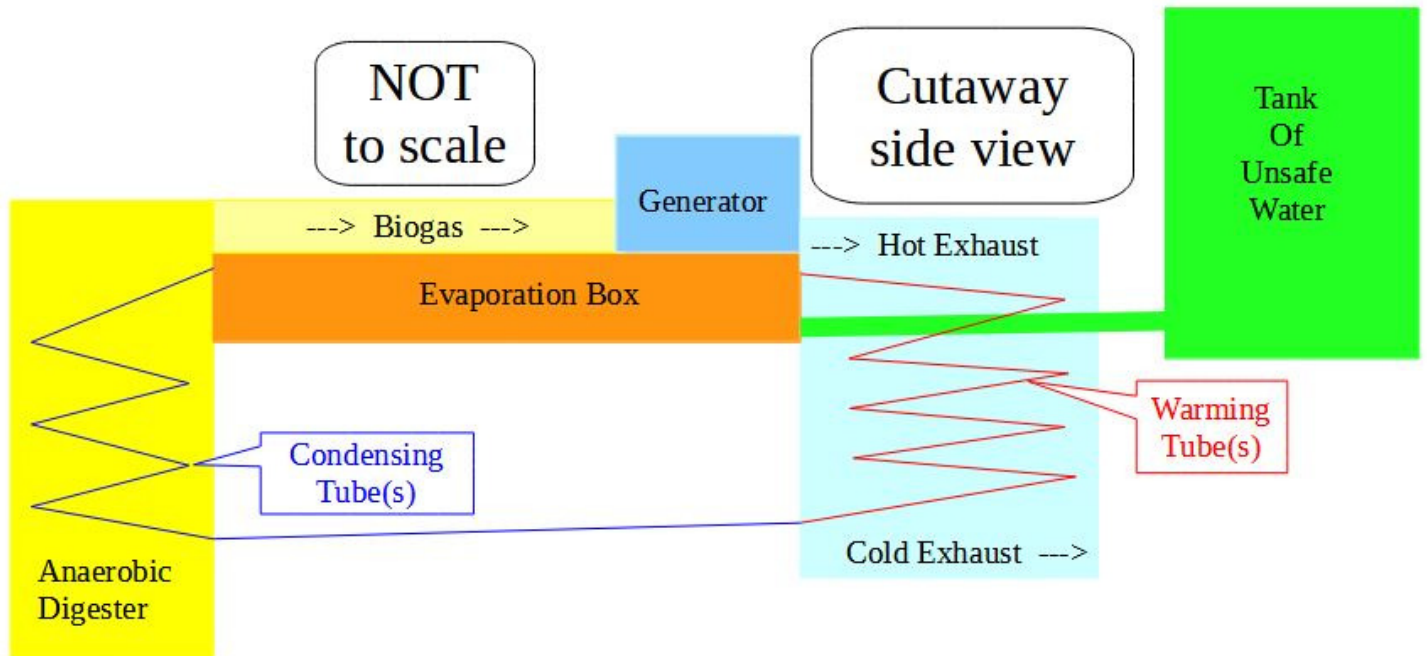
5. 16 evaporation surfaces of 65cm by 5cm equals 5,200cm² of evaporation surfaces.



Cutaway view of Evaporation Box

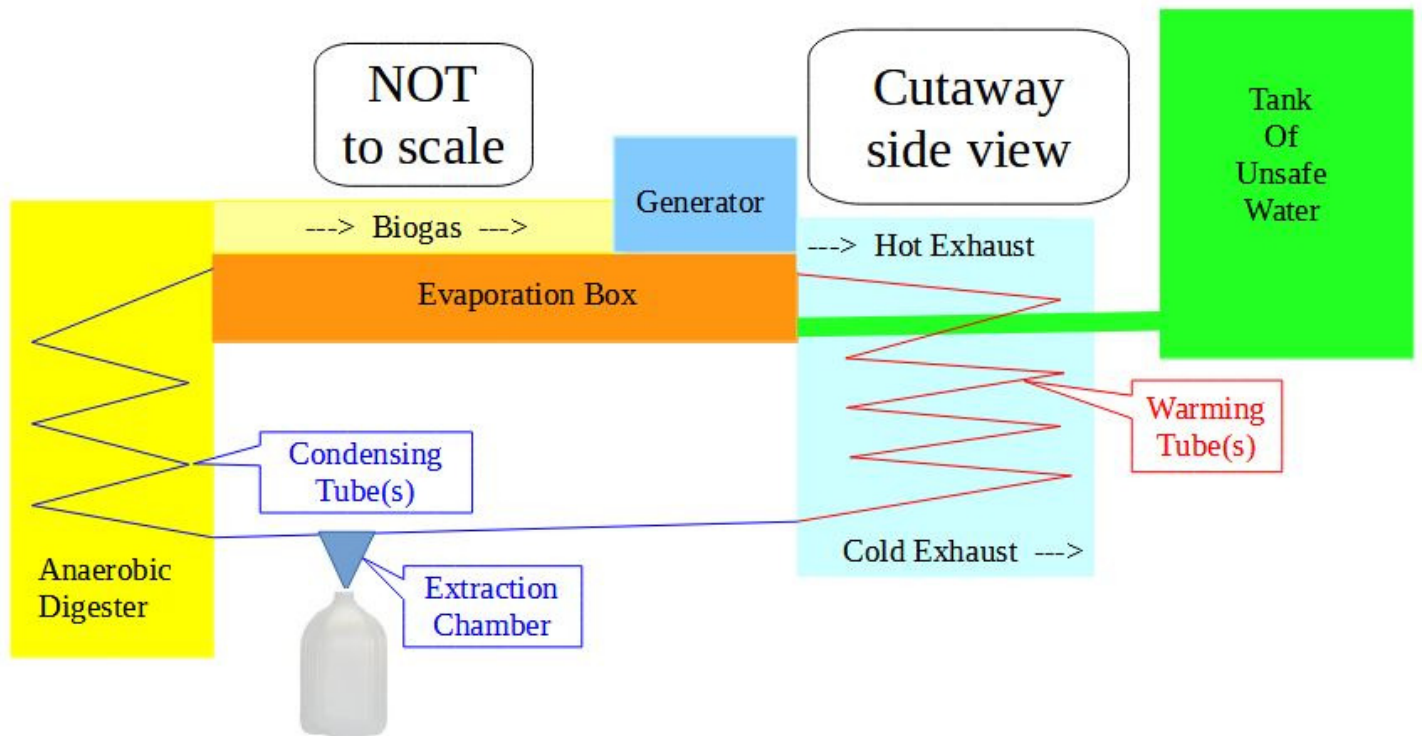
10th Step-Condensing Tube(s)

1. Condensing Tube (drawn in blue)
 1. Inside Anaerobic-Digester
 2. Receives hot, moist Working Air from Evaporation Box
 3. Curls down top to bottom within Anaerobic-Digester to facilitate cooling
2. Water condenses as the air is cooled
3. Condensing Tube runs through Extraction Chamber to allow extraction of distilled water
4. Condensing Tube then delivers the cooled, dried Working Air to the Warming Tube to restart the cycle.



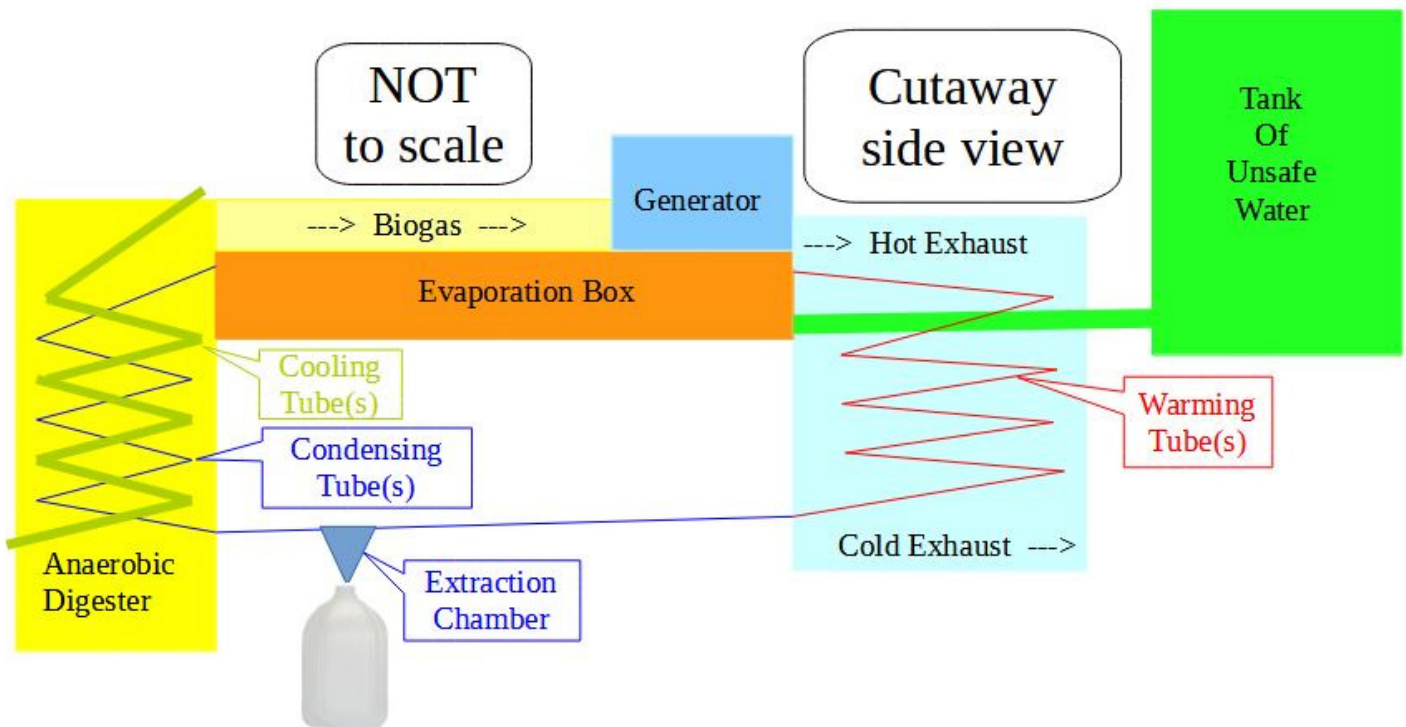
11th Step-Extraction Chamber

1. Condensed/distilled water drips down from Condensing Tube and is funneled to an attached container
2. Connection to collection container should be sealed since moisture attracts insects



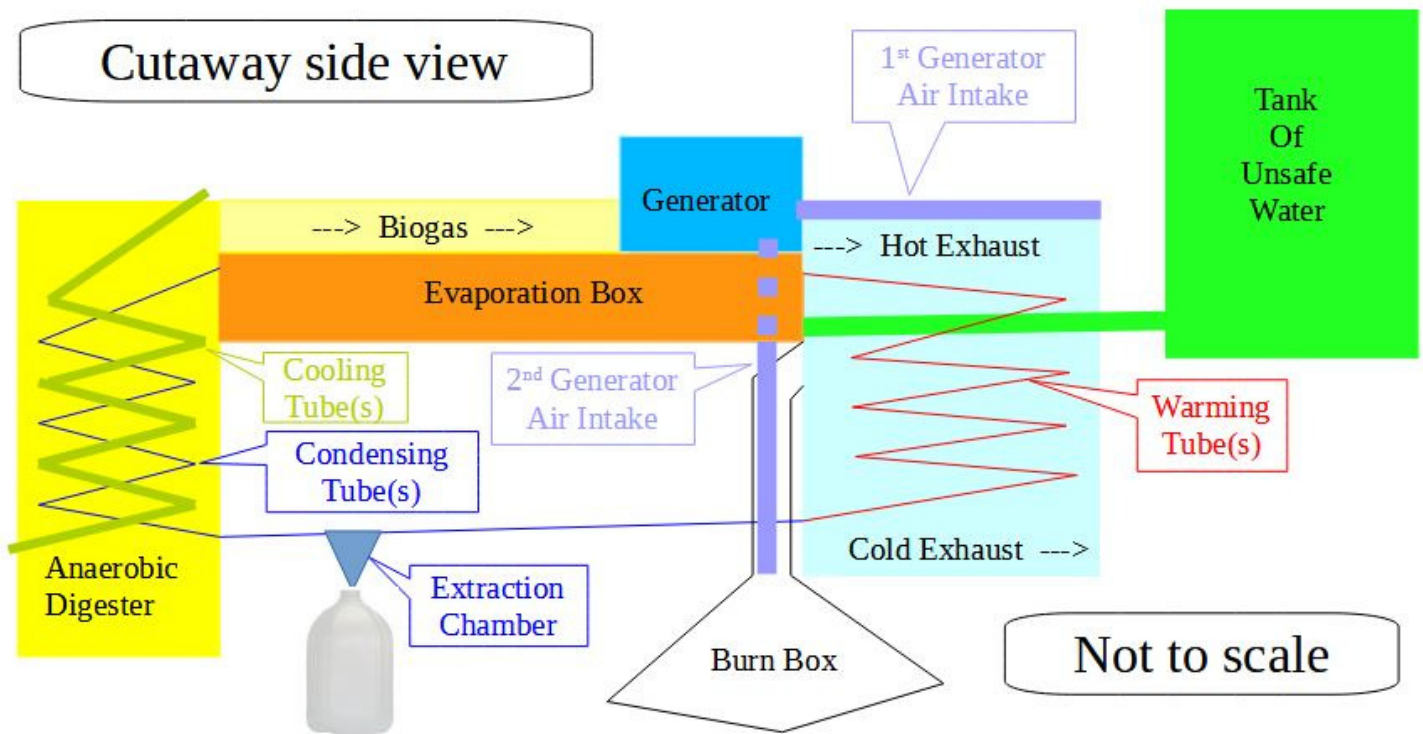
12th Step-Cooling Tube(s)

1. (drawn in moss green)
2. When/if anaerobic digester gets too hot, the Cooling Tube removes excess heat
 1. Thermal reactive valve at top regulates flow of ambient air
3. Curls up from bottom to top throughout anaerobic digester to facilitate cooling
4. Ambient air enters Cooling Tube at bottom of anaerobic digester and leaves at top
5. best thermophilic (digestion) temp is 50-57°C



13th Step-Burn Box

1. Thermal reactive valves control ambient air intakes (not shown)
 2. To control temperature of exhaust into Chimney Chamber
1. Combustion air is directed to the fuel
 2. Completion air is directed to where the smoke leaves the Burn Box



14th Step-Drying Chambers

1. The Fuel Drying Chamber is simply a chimney extension where the exhausting air is allowed to pass directly over material to be dried
2. It is perfect for drying fuel to be used the next day
3. The ambient air warmed in the Cooling Tube can be fed directly into the Food Drying Chamber
4. Being fed ambient air, it can be made food safe

