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Thermal Efficiency Options for the HORSE Microdigester

To: File
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This technical memo describes the standard, lowest-cost configuration for the HORSE and then some alternatives to generate more commercially valuable energy if so desired.

The standard machine comes with plug-in receptacles for small electrical equipment with a power cord and plug. It can generate up to 37 MWh of raw energy. This assumes a relatively rich food waste stream and 60% methane in the biogas (600 BTU/cubic foot approx.). Actual generation depends on the feedstock characteristics. As renewable gas that's 125 Million BTU per year.

The standard generator can generate 4.3 MWh of this energy as electrical output. The system also has accessory valves for BBQ grills, fire pits, lights, and ovens. If the user burns all the methane to make power it will make 2.5 kW electric and the rest as heat for up to 6 hours per day. The machine can store 5 cubic meters (175 cubic feet) of gas at 7.0 mbar (0.10 psi). The generator will burn all the stored biogas in about 6 hours with a full electrical demand on the generator. A higher efficiency generator would generate more kW. Our standard, lowest cost one is under 15% electrical efficiency – the rest of the energy generated is heat.

The HORSE is insulated but heat loss due to wind and cold weather is one of the largest energy leaks on microsystems. It's best to protect the HORSE and all digestion equipment from cold air and wind.

There are some options to change the efficiency and mix of energy output listed below.

1. Make hot air and hot water instead of electricity. Some gas fired boilers are over [80-93% efficiency](#) and a single HORSE can make as much as 13 GJ (max) of biomethane per year (at \$13/GJ that is more like \$1,700/year of energy value). Electrical generation can only achieve 12 – 33% efficiency (not very good).
2. Combined heat and power (generator with a water cooled engine to generate hot water) can be closer to [65-84% efficiency](#) (sum of electricity and heat i.e. Janmar 5 kW CHP).
3. Expand the digester volume and capacity. The blending tank should be able to support a second and third digester. The Janmar would need about 5-6 HORSES to run continuously 24-7, and half as many to run 12 hours a day.
4. Combine the HORSE with onsite solar to get the best of both worlds: solar during the day and bioenergy at night.
5. Consider a dual-fuel biodiesel/biomethane engine if biodiesel fuel is available and affordable.