

On-Farm Evaluation and Demonstration of Small-Scale Biogas Technology

Chad Kruger (Professional + Producer Grant Program)

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Title: On-Farm Evaluation and Demonstration of Small-Scale Biogas Technology

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Fabricated experimental small-scale digester. Photo by Chad Kruger

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Fabricated experimental small-scale digester with shovel for size comparison. Photo by Chad Kruger

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Situation:

High costs for energy and inputs from nonrenewable sources pose economic threats to U.S. farms. Small diversified and organic farms, while more insulated than chemically intensive farms, are still subject to the effects of volatile energy markets.

Small farms could benefit from the use of on-farm renewable energy technologies, especially those focused on waste biomass, which could efficiently and inexpensively treat organic farm wastes, reduce odor and methane emissions and provide renewable energy.

Biogas technology, or anaerobic digestion, is being used worldwide to treat wet, organic wastes and produce biogas, a form of renewable energy. Yet fewer than 200 U.S. farms currently use the technology.

Eighty-seven percent of Washington's farms are classified as small, and many have expressed interest in adopting technologies for producing and using bio-energy.

Challenges for deploying commercially appropriate biogas technology on small-scale farms in the region include:

- Developing climate-appropriate applications and financially appropriate turn-key packages
- Evaluating the role of biogas technology in the farming systems (including trade-offs with other waste management practice, like composting)
- Providing education on use and maintenance
- Identifying technologies for the most valuable uses of the biogas (water heaters and stoves, small generators, liquid fuel conversions, etc.)

Objectives:

- Introduce farmers to the potential opportunities of small-scale biogas technology applications
- Develop an improved/modified design based on the various Asian techniques
- Deploy and evaluate pilot plants on three farms



Presenting on small-scale biogas installation experience at the Whatcom County Skills Share Fair, August 2012. Photo by Joyce Jimerson, Whatcom County Extension



Insulated biogas unit on display at the Whatcom County Skills Share Fair, September 2012. Photo by Joyce Jimerson, Whatcom County Extension

Actions:

The project team looked at existing small-scale biogas systems to assess current designs and potential deployment. A workshop with participating producers, followed by a site visit, assessed materials and local design challenges.

A conceptual design was developed by collaborating engineers in the Washington State University Department of Biological Systems Engineering, and designs were drafted in CAD.

The conceptual design was submitted as an invention disclosure to the WSU Office of Intellectual Property and shared with a biogas engineering and fabrication company, Andgar Corp. of Ferndale, WA. The company made additional recommendations to improve and simplify the design.

A final design and engineering drawings were developed in CAD and provided to Andgar to fabricate three pilot units for on-farm experimentation and demonstration.

The final design selected for fabrication is a simple "plug-flow" reactor that combines new design elements to improve feedstock mixing and flow and retention of bacteria while maintaining simplicity for fabrication with readily available materials.

The small-scale digester in various stages of fabrication.



Results:

An improved design has been developed that will provide superior performance for applications of biogas technology in the United States and around the world.

Hundreds of people (producers and others) in the Pacific Northwest have been directly introduced to the potential for small-scale application of biogas technology as an alternative waste management and energy technology.

A website was created with resources related to small-scale biogas, http://csanr.wsu.edu/pages/Small-Scale_Biogas_Technology. The following materials, among others, are available on the website:

- A Biogas Enterprise Assessment Tool – a worksheet to facilitate preliminary planning for a biogas plant on a small farm
- A presentation on applications of small-scale biogas plants in India
- Advanced small-scale anaerobic digester design tailored for household users living in cold climates (a WSU Invention Disclosure)
- Advanced Biogas Plant Design – detailed CAD drawings for an improved version of a pilot biogas plant developed at WSU

Potential Benefits:

This project contributed a viable design for small-scale biogas applications for small, integrated farm operations in the northern latitudes.

Recommendations:

Most small, integrated farms will want to "co-digest" manure with other available feedstock such as on-farm food-processing and vegetative wastes, which are generally more volatile than manure and will produce more biogas. Co-digestion can increase the complexity of a biogas project, affecting reactor sizing, design and management, and is a rapidly emerging subject of research.

The inventors of the system opted out of patenting the design, saying it was in the best interest of stakeholders to simply release the information. This will enable small farmers and gardeners to utilize the design features to build their own reactors without intellectual property concerns.

Other areas of future research:

- Material options for fabrication (steel, concrete, brick, fiberglass, plastic, etc.), including cast-off materials (plastic tanks, barrels, etc.)
- Higher uses of biogas for small farms (beyond current uses that include thermal energy for water heating, cooking and food processing), including transportation fuel, improved thermal recovery and flame-based weed control, all of which could speed adoption of biogas technology