
**Project Description:** The Farm Manure-to-Energy Initiative is demonstrating and evaluating the performance of on-farm thermal technologies used to convert excess poultry litter to heat for animal housing in high-density animal production regions of the Chesapeake Bay watershed. The goal is to expand management and revenue-generating opportunities for poultry litter in concentrated animal production regions of the watershed where more manure phosphorus is produced than local crops need as fertilizer.

Thermal technologies capable of producing energy from poultry litter feedstock have only recently been developed for use at the farm-scale. While producing energy, they also convert excess poultry litter into nutrient-dense ash or biochar that can be cost-effectively transported long distances or used to replace imported commercial phosphorus in local nurseries and fresh-market vegetable operations. This initiative is evaluating the technical feasibility and environmental and economic performance of these technologies to help farmers determine whether this approach makes sense for their farm. Partners are also working to expand markets for nutrient-dense biochar and ash, as well as to increase technical assistance, information, and financing options available to farmers.

**Farm Demonstrations:** To date, partners have installed demonstration projects on three poultry farms in the Chesapeake Bay region and will help evaluate the performance of at least one additional project. The Global Re-Fuel system manufactured by Wayne Combustion (Fig. 1) is being used to compliment traditional propane-fueled heating systems in a turkey brooder house in Port Republic, VA, and on two-house broiler operations in Fort Seybert, WV and Strasburg, PA. Fueled with 180 pounds of poultry litter per hour, the Global Re-Fuel system provides approximately 500,000 Btu/hour of heat via an air-to-air heating system delivering hot air to directly to the houses. In the broiler houses, heat enters into the poultry house/s near the brooding section where heat demand is greatest, and is drawn through the rest of the house using the existing house ventilation system. Preliminary performance evaluation for the Pennsylvania system, which is providing heat for two broiler houses, suggests that propane use will be reduced by approximately 80 percent.
The Ecoremedy® gasifier, offered by Enginuity Energy LLC, is currently being installed on an organic broiler farm in Lititz, Pennsylvania. The gasifier will deliver approximately 1.25 MM Btu/hour to four poultry houses (300,000 Btu/hour each) via a hot water heating system. Heat will be distributed within the houses using Landmeco® hot water heaters. Due to the high cost of organic feed and lower stocking density, heat demand and propane use for organic production is often as much as three times greater than for commercial broiler production.

**Developing Markets for Nutrient-Dense Ash and Biochar Co-Products:**
Depending on the thermal process, poultry litter ash contains in the range of 14 to 18 percent phosphorus and 13 to 24 percent potash fertilizer. Biochar has approximately two to three times the nutrient density of original poultry litter and provides long-term carbon storage. Field trials using the ash and biochar co-products as a phosphorus and potash fertilizer for fresh market vegetable and row crop production are being conducted at the Virginia Tech Eastern Shore Agricultural Research and Extension Center. Laboratory studies indicate plant availability of the nutrients is in the range of 80 to 100 percent. Field trials on corn in the 2013 growing season indicated that poultry litter ash had the same effect on crop yield as commercial phosphorus fertilizer (triple super phosphate) when applied at similar rates of phosphorus. Additional field trials are underway over the 2014 growing season.

**Evaluating Performance and Communicating Results:** With leadership from Farm Pilot Project Coordination, Inc., project partners will be working with farmers over the 2014-2015 cold weather season to evaluate the technical, financial, and environmental performance of the
technologies. Technical performance data will be collected using in-house monitors to gather data on house temperature and humidity, as well as overall flock health. Farm partners are critical to this effort and are working closely with project partners to document technical performance of the technologies, as well as fuel feed rates, propane savings, and time and expense required for operation and maintenance.

The Environmental Finance Center is leading efforts to evaluate the financial feasibility of the technologies. Their evaluation will consider upfront costs, on-going operation and maintenance, and cost savings.

Partners are monitoring environmental performance by tracking the form and fate of poultry litter nitrogen and phosphorus, as well as collecting comprehensive air emissions data including criteria and hazardous air pollutants. Air emissions data will be collected by a certified, third party air emissions testing company using EPA-approved testing methods. Results from performance evaluation will be shared on a [clearinghouse website](http://www.extension.org/pages/68455/) hosted by eXtension and developed by the Farm Manure-to-Energy Initiative to share information about thermal manure-to-energy projects.

**Identifying Financing Resources:** Farm-scale thermal manure-to energy technologies entail significant upfront costs. Systems for heating poultry houses currently range from $75,000 to over $300,000 per house to install. Total installation costs for thermal systems that produce electricity from poultry litter could easily cost over $1 million, and may cost several million. Therefore, they are generally only recommended for larger farm. However, these technologies are in the early stage of commercialization; as they mature, prices will likely decrease. Costs can be offset by federal or state cost share programs and by savings from heat or electricity production. Costs for heating poultry houses ranges from $5,000 per year to $30,000 per year depending on the type of production (organic requires more heat than conventional), house design and ventilation, and the weather. Electricity costs are also variable and can range from $5,000 to $15,000 per house, depending on the weather, size of the house, equipment electricity demand, and utility rates. To support future projects, the Environmental Finance Center has completed a review of financing options for on-farm manure to energy technologies that includes information on cost share funding contact information in the Chesapeake Bay region.
**Lessons Learned:** Over the course of the Farm Manure-to-Energy Initiative, project partners have learned important lessons that can contribute to successful farm-scale thermal manure-to-energy projects. A summary of key lessons learned is as follows:

- Poultry litter is a good fuel but using it presents unique challenges. Systems designed for wood or other fuels are unlikely to work well with poultry litter without significant modification. Vendors offering successful poultry litter-to-energy technologies have designed their systems to work specifically with poultry litter and have invested considerable resources in research and design to develop thermal technologies and material-handling systems that perform reliably using poultry litter on farm settings.

- Poultry litter characteristics (such as moisture content) are critical to fuel performance and vary from farm-to-farm. Its characteristics are important considerations for determining whether a thermal manure-to-energy project is a good fit for an individual farm.

- Farm-scale thermal manure-to-energy technologies require considerably more time to operate and maintain than traditional propane heating systems. They are not a good fit for poultry operations where the additional work required to operate and maintain them would place an unacceptable burden on owners/staff.

- It may not be cost-effective to design a thermal system to replace 100 percent of a poultry operation’s propane requirements. The additional sizing required to meet heat demand on the coldest days of the year could increase upfront costs considerably.

- For some farms, energy conservation improvements may be a better investment than on-farm energy generation. Tools such as RETScreen can help farmers determine the technical and financial feasibility of renewable energy and energy efficiency projects.

- Permitting requirements vary considerably from state to state. Most states require information on air emissions. While the Farm Manure-to-Energy Initiative has facilitated permitting for demonstration projects in the Chesapeake Bay region, vendors offering technologies that have not previously been permitted in the proposed location may need to provide air emissions data to state permitting agencies. Air emissions testing services by certified emissions testing companies using EPA methods are expensive. Costs for criteria pollutant testing range of $7,000 to $10,000, and costs for comprehensive pollutant testing (including hazardous air pollutants) range from $45,000 to over $60,000.

- Federal permitting for small farm-scale thermal manure-to-energy technologies using only poultry litter generated on the farm is relatively straightforward. Farm Manure-to-Energy partners worked with EPA and USDA to develop a [farmer checklist](#) that may be helpful to farmers in the federal permitting process. Federal permitting for larger projects using poultry litter from multiple-farms as a fuel is more complicated.

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