Competitive Grant Report XP2012-06

LEOPOLD CENTER
FOR SUSTAINABLE AGRICULTURE

Farm-metered energy analyses: Getting baseline data, ground-truthing changes

Abstract: The Farm Metered Energy Analysis project was conducted to help farmers learn about their energy use patterns. The metered energy data was reported to the farmers in a variety of formats such as average monthly kWh usage by type of fuel, average cost of energy per kWh over time, etc.

Principal Investigator:

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Practical Farmers of Iowa

Budget:
$25,000 for year one
$25,000 for year two

Q What are the "energy hogs" on Iowa farms? What steps will give the biggest "bang for the buck" in helping farmers reduce these energy hogs?

A After collecting metered energy data for 14 farms, it became clear that walk-in coolers are responsible for a large portion of the electricity bill for many fruit and vegetable farms. Once this "energy hog" was identified, PFI worked with farmers to make their existing coolers more energy efficient and build conservation into the construction of new walk-in coolers.

Background

Iowa agriculture is heavily dependent on fossil fuels and farmers spend nearly a billion dollars annually on energy for crop and livestock production. This heavy use of fossil fuels not only hurts farmers' profitability, it is environmentally destructive as well. Fossil fuel in agriculture is one cause of many of current health and environmental problems, including the escalating climate change that is occurring.

Before they can tackle fossil fuel dependency, farmers must understand their baseline energy use, costs and environmental impact. In addition, there are few farmers who have verified energy efficiency practices, or "ground-truthed" promised "pay-back times" and energy production estimates for alternative energy systems. This corroboration is crucial if more farmers are to be convinced to undertake on-farm energy-saving projects.

The objectives for this project were:

1. Through farm metered energy analyses, 25 farmers will understand their energy use, costs and environmental impacts, both before and after taking energy efficiency and renewable energy steps.
2. Two hundred other farmers will consider their own energy use and potential energy savings after learning from PFI farmer leaders.
3. Project results will be shared with 120,000 Iowans through both the farm and general press and these individuals will begin to consider energy efficiency a priority.

Approach and methods

Practical Farmers of Iowa was able to gather usable energy data for 23 farmers on 14 farms, including traditional corn and soybeans, dairy, and CSA-based fruit and vegetable farms. Because of the diversity of farm types and the significant energy use in farm homes (which could not be separated from farm meters in all cases), reports were completed for each farm in addition to a summary report of the project. The data analysis proved more complicated than anticipated, due to the variety of energy sources and their respective delivery and tracking methods. For example, electricity

Sean Skeehan poses with one of the alpacas he and his partner, Jill Beebout, raise on their farm. Jill uses the alpaca wool to make yarn and value-added fiber products.

is used on-demand and paid for at the end of a set time period (monthly). Liquid propane (LP) is purchased in bulk and used over time, as needed. Depending on the farm, gasoline and diesel fuel sometimes were reported as individual vehicle fill-ups, or as upfront bulk purchases.

To carry out the analysis, an Excel tool was created that could account for forecasting or back-casting use based on the energy source. For electricity, the tool back-casted use and cost over the preceding month. For LP, the tool forecasted use until the next bulk purchase was made. The Excel tool also converted the various metrics of energy use (kWh, gallons, ft3, lbs.) into a common set of metrics that could be graphed and compared over time.

Results and discussion

After collecting metered energy data for many of the farms, it became clear that a large portion of the seasonal electricity bill for fruit and vegetable farms was used to operate their walk-in coolers. Once this “energy hog” was identified, focus was shifted from metered energy to examining performance and energy use specifically for walk-in coolers. Analysis and recommendations were made for three coolers that will apply to construction and performance of all walk-in coolers.

Three on-farm walk-in coolers were used in this study: two coolers using CoolBots with window air conditioners and one using a commercial chiller. The coolers were outfitted with temperature and electrical current logging systems to monitor the temperature inside and outside the cooler, as well as the energy use. Data was written to memory in the loggers at specific time intervals, and/or whenever the current drawn by the cooling system changed.

Both CoolBot coolers are installed inside a larger building; they are not exposed to direct sun at any time. As a result, the temperature sensors were located at selected regions inside the building, and near the cooler exterior walls. The cooler with the commercial chilling system is located outside, and is exposed to direct sun. Consequently, the east, south and west walls of the cooler become extremely warm to the touch periodically throughout the day. To determine exterior (wall) temperatures, temperature sensors were bonded to the exterior cooler wall surfaces.

Conclusions

Metered Energy Analysis

In most cases, farms could make the largest impact in carbon emissions reductions by reducing their electricity use. Electricity is an extremely inefficient energy source, and also was often the most expensive form of energy per unit. It comprised a consistently large portion of farm energy use, though it was seasonally overtaken by LP for heating or drying grain.

There was a two-fold problem with the dataset, however. First, these results for “farm energy” are in some cases more reflective of “home energy” use. A small farm operation with a large, air-conditioned house appeared to use more “farm electrical

Tim Landgraf and Jan Libbey

energy" than a larger farm with a small, efficient house. This was especially true for fruit and vegetable farms that rely on manual labor.

Selective record-keeping (not keeping records on all energy sources used) also was problematic. For fruit and vegetable farms, the highest energy use is gasoline/gasohol for deliveries and electricity for the coolers. This was reflected on each of the farms that kept complete records for multiple energy sources, including tracking every vehicle fill-up for farm deliveries and travel. Few farms kept such good records; all farms reported electricity use because the data is reported on their monthly bill. Not only did this skew the energy use assessment toward electricity for many farms, it also made comparisons based on farm type nearly impossible.

The results are, however, useful for farmers to look at in the context of their own farms. By seeing the numbers collected in multiple years, farmers can identify places to use conservation practices, save money and reduce their carbon footprint.

Cooler Analysis Conclusions
The research report on the cooler comparison provided an in-depth look at the three coolers over time periods from a few days to several months. By analyzing the coolers in this manner, seasonal issues were noted as well as thermal intrusion as the sun moves throughout the day.

Here are the most general conclusions and recommendations for coolers on fruit and vegetable farms. A full report will be available from PFI in late 2014.

CoolBot vs. Commercial Chiller

1. Walls and Ceiling: The walls and ceiling of a walk-in cooler must be designed and executed with care. The walls and ceiling must be air-tight, and should have a minimum R-value of 20.
2. Insulation Material: Fiberglass insulation with a vapor barrier is not recommended for the primary internal material. Closed cell foam is recommended in order to avoid condensation and reduction of fiberglass R-value.
3. Floor: If a cooler is installed on a large slab, and the remainder of the slab is at the ambient temperature, the slab acts as a "conductor," transferring heat into the cooler. The chilling system must combat this added heat intrusion.
4. Joint Details: When using framed lumber construction, it is recommended that there be no "direct thermal path" from the inside of the cooler to the outside environment through any structural member.

Impact of results

The cooler analysis has been especially provocative, prompting farmers who were purchasing, building or retrofitting their coolers to ask more questions about their energy efficiency. To harness the knowledge gained from new coolers being built, three farmers are documenting their building process, including labor time, materials cost and blueprints to share on the PFI website.

Farmers also have shown more interest in data-logging their energy consumption on various equipment to identify areas of improvement (low-hanging fruit), and continue to ask for more information about on-farm production of renewable energy. Several farms were identified as "energy showcase farms" because of their enthusiasm for energy recordkeeping and dedication to on-farm energy conservation and renewables. They were highlighted throughout the year at field days, other events and in media coverage. The showcase farms included: Tim Landgraf and Jan Libbey (One Step at a Time Gardens), Francis Thicke (Radiance Dairy) and Tom and Irene Frantzen (Frantzen Farm).

Education and outreach

Articles about the project appeared in six issues of the PFI newsletter, seven blog posts were shared, and eight news releases were issued. *Iowa Farmer Today* wrote two articles on the project efforts.

Results from the project were shared at several PFI annual conferences and at meetings of the Farm Energy Working Group (sponsored by the Leopold Center). Seven field days featured information on the data collected by the project:

- ZJ Farms, June 24, 2012: Making a walk-in cooler more efficient
- TJ Family Farms, July 7, 2012: Discussion of baseline data collection
- Rainbow Ridge Farm, July 20, 2012: Root cellaring to reduce/avoid energy consumption
- New Shoots Farms, September 26, 2012: Using multiple CoolBots for a large cooler
- One Step at a Time Gardens, June 23, 2013: Working toward a sun-powered farm
- Radiance Dairy, September 14, 2013: Harvesting Energy: Wind and solar power.
- Pheasant Run Farm, September 22, 2013: On-farm energy and season extension.

Leveraged funds

This project allowed PFI to leverage in-kind support from AmeriCorps for on-farm energy audits.

For more information, contact
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