

## Farm Metered Energy Analysis

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### Cooperators:

- Jill Beebout and Sean Skeeahan - Chariton
- Eric and Ann Franzeburg - Van Horne
- Gary and Nancy Guthrie - Nevada
- Susan Jutz - Solon
- Greg and Connie King - DeWitt
- Jan Libbey and Tim Landgraf - Kanawha
- Denise O'Brien and Larry Harris - Atlantic
- Tom and Irene Frantzen - New Hampton
- Craig and LaVon Griffieon - Ankeny
- Mark and Connie Tjelmeland - McCallsburg
- Francis and Susan Thicke - Fairfield
- Frank Santana - Winterset

### In a Nutshell

- Energy markets are unstable and energy purchases can make up a large portion of farm expenditures.
- The energy sources that power the majority of farm operations are based on fossil fuels and are some of the primary emitters of greenhouse gases.
- Practical Farmers members tracked energy expenditures in order to establish an energy baseline and pinpoint "energy hogs."

### Key findings:

- For vegetable farms, electricity to power cold storage and gasoline for product transportation are areas of intensive energy use.
- For crop and livestock farms, diesel for field operations and LP for grain drying are areas of intensive energy use.
- Detailed records are necessary to establish a solid energy baseline, enabling farmers to implement energy conservation measures and/or alternative energy technologies.

### Background

Despite record-low oil and gas prices in 2015, prices have trended upwards and been more volatile over the past decade (US Energy Information Administration, 2015). Annually, Iowa farmers spend nearly \$1 billion on energy for crop and livestock production (USDA-NASS, 2007). The main energy sources for agriculture are diesel, gas, liquid propane (LP) and electricity, all of which are greenhouse



*Solar panel at One Step at a Time Gardens near Kanawha*

gas-emitting energy sources responsible for contributing to climate change (IPCC, 2014).

For these economic and environmental reasons, on-farm energy has been identified as a priority area for research at Practical Farmers of Iowa. This study attempted to establish a baseline of farm energy for future research and focus areas. With this information, farmers can identify "energy hogs" and pinpoint the times of year that energy is being used. The objective of this project was to provide a baseline report of energy use on each farm, and identify areas on each farm where energy savings can be made.

### Method

For this study, 12 farms contributed between four and eight years of data, depending on available records.

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 excel tool forecasted use until the next bulk purchase was made. The Excel tool also converted the various metrics of energy use (kWh, gallons, ft<sup>3</sup>, lb) into a common set of metrics: megajoules (MJ), dollars (\$) and lb CO<sup>2</sup> equivalent. These metrics could then be graphed and compared over time. For

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each farm, the following set of graphs was provided, accompanied by a written report and the Excel file containing their data analysis.

*Cost per Megajoule over Time*

*Average Monthly Cost per Megajoule*

*Average Monthly Energy Use, by Source*

*Average Monthly Energy Spending, by Source*

*Breakdown of Average Monthly Energy Use, by Source*

*Breakdown of Average Monthly Energy Cost, by Source*

*Average Monthly Carbon Emissions, by Source*

*Breakdown of Average Monthly Carbon Emissions, by Source*

*Annual Energy Use, by Source*

*Annual Energy Cost, by Source*

*Annual Carbon Emissions, by Source*

This report highlights the main findings of each farm, and identifies a few general trends in farm energy use.

## Results and Discussion

Because of inconsistency in data collection and large variances between farm type and size, the data could not be fully aggregated and analyzed. These data inconsistencies included: energy sources included, their respective fuel delivery and use tracking methods, the type of farm operations. For



*Small-scale wind turbine at Growing Harmony Farm near Nevada*

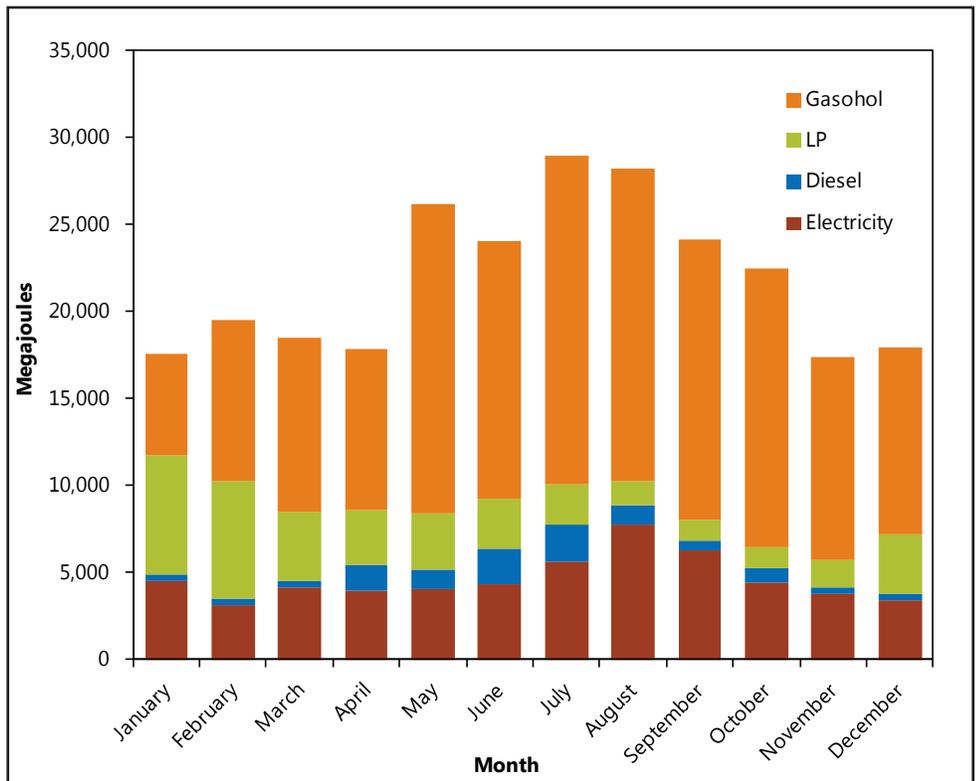


Figure 1. Average monthly energy use at Blue Gate Farm, by source, 2005–2012.

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

Instead, results and discussion will be presented on a farm-by-farm basis. Twelve farms provided sufficient information to be included in this report. While most of the farms have multiple enterprises, we have roughly grouped them into Horticulture and Crops/Livestock operations. Seven of the farms analyzed were primarily vegetable farms, while the remaining five farms were primarily crop and/or livestock operations.

### Horticulture

Jill Beebout and Sean Skeehan operate Blue Gate Farm, a community supported agriculture (CSA) and market farm near Chariton in Lucas County. For this study, they provided electricity, gasohol, LP and diesel data from 2005–2012. Gasohol and electricity were the two largest sources of energy on their farm, and **Figure 1** shows that July and August were the largest months of energy use. Gasohol was the number one source of energy on their farm, largely due to product transportation. Electricity was the second

biggest user, and increased in the summer due to the powering of fans and coolers. Electricity also accounted for more carbon emissions than other sources, even though it represented a small amount of total energy use.

Eric and Ann Franzenburg operate Pheasant Run Farm, a corn and soybeans, vegetables, herbs and flowers farm, near Van Horne in Benton County. For this study, they provided energy data for their greenhouse, so for the purposes of this study, they are included in the horticultural group. They provided electricity data from 2007–2013. July and August were their two largest months of energy use, likely as a result of electricity needs of fans and coolers.

Gary and Nancy Guthrie operate Growing Harmony Farm, a vegetable farm near Nevada in Story County. For this study, they provided electricity and LP data from 2008–2012. Their highest months for energy use were January, February and March, due to an increase in LP for heating their house. For April–June of most years, they produced more energy than they consumed via a solar panel array and wind turbine. By effectively replacing some of the grid (coal-powered) energy with renewable energy, the Guthries were able to lower their carbon footprint

dramatically.

Susan Jutz operates ZJ Farm, a CSA and sheep farm near Solon in Johnson County. For this study, she provided electricity data from 2006–2012. The two highest months for energy use were in February and March.

Greg and Connie King operate Prairie Bell Enterprises, a fruit and vegetable farm near DeWitt in Clinton County. For this study, they provided electricity and LP data from 2007–2013. December and January were the highest months of energy use on their farm, due to increased LP use and higher than average electricity use. Electricity use was the largest contributor of carbon emissions on their farm.

Jan Libbey and Tim Landgraf operate One Step at a Time Gardens, a CSA farm near Kanawha in Hancock County. For this study, they provided gasohol, electricity and LP data from 2008–2013. Electricity had been a large source of costs and CO<sup>2</sup> emissions on their farm, but after installing a solar array, they reduced purchased electricity to zero.

Denise O'Brien and Larry Harris operate Rolling Acres Farm, a vegetable and poultry farm near Atlantic in Cass County. For this study, they provided electricity data from 2008–2013. Monthly farm energy use was

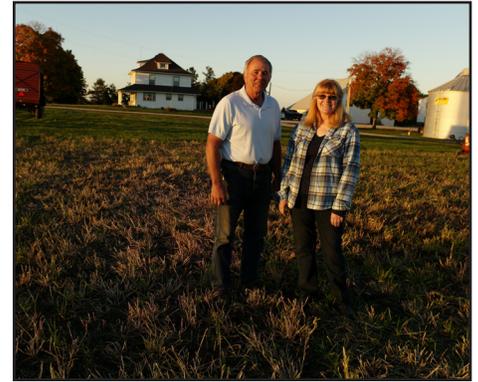
highest during February, September and March.

For horticulture farmers, electricity is commonly the primary energy use due to coolers, lighting, fans and pumps. Because electricity is mostly coal-derived and transmission is inefficient, it emits disproportionately more greenhouse gases compared to other fuels. Thus, the overall carbon emissions for electricity are higher per kWh used than other energy sources. For horticulture farmers interested in reducing their greenhouse gas emissions, this means that tackling electricity use should be an important priority, whether it is through becoming more energy efficient or by switching to an alternative electrical energy source.

Transportation fuel was another large source of energy for horticultural farmers, as markets and deliveries have them on the road several days a week. Only two horticulture farmers included transportation fuel in their recordkeeping, but on Blue Gate Farm, it was the largest source of energy use and energy costs.

### Field Crop/Livestock

Tom and Irene Frantzen operate a 385-acre crop and livestock farm near New Hampton in Chickasaw County. For this



Craig and LaVon Griffieon on their farm near Ankeny

study, they provided diesel, gasohol, gasoline, electricity and LP use data from 2004–2012. Diesel was their farm's largest energy source, and was also responsible for the most carbon emissions on their farm. Electricity use was higher in the winter months due to the electric pump required to power their geothermal heating system. Energy use was highest during May and June due to increased diesel use for field operations, as shown in **Figure 2**.

Craig and LaVon Griffieon operate a 1,120-acre crop and livestock farm near Ankeny in Polk County. For this study, they provided electricity, gasohol, LP and diesel data from 2008–2011. Diesel was the largest energy source for the Griffieons, and was also responsible for the most carbon emissions on their farm. Because of grain drying, LP makes up the majority of energy use and costs during October and November, as shown in **Figure 3**. Farm energy use was highest during February, November and December.

Mark and Connie Tjelmeland operate TJ Farms, a 320-acre field crop and egg farm near McCallsburg in Story County. For this study, they provided electricity, diesel and LP data from 2007–2012. Diesel represents the majority of energy used during spring and summer months, while LP accounts for the majority of energy use during October–December, likely for grain drying. Carbon emissions are spread evenly throughout electricity, diesel and LP. Monthly farm energy use was highest during October–December.

Francis and Susan Thicke operate Radiance Dairy, a 556-acre dairy farm near Fairfield in Jefferson County. For this study, they provided electricity, gasohol, diesel, LP and gasoline data from 2003–2011. Energy use is largely balanced across the various sources. Monthly farm energy use was highest during June and July due to

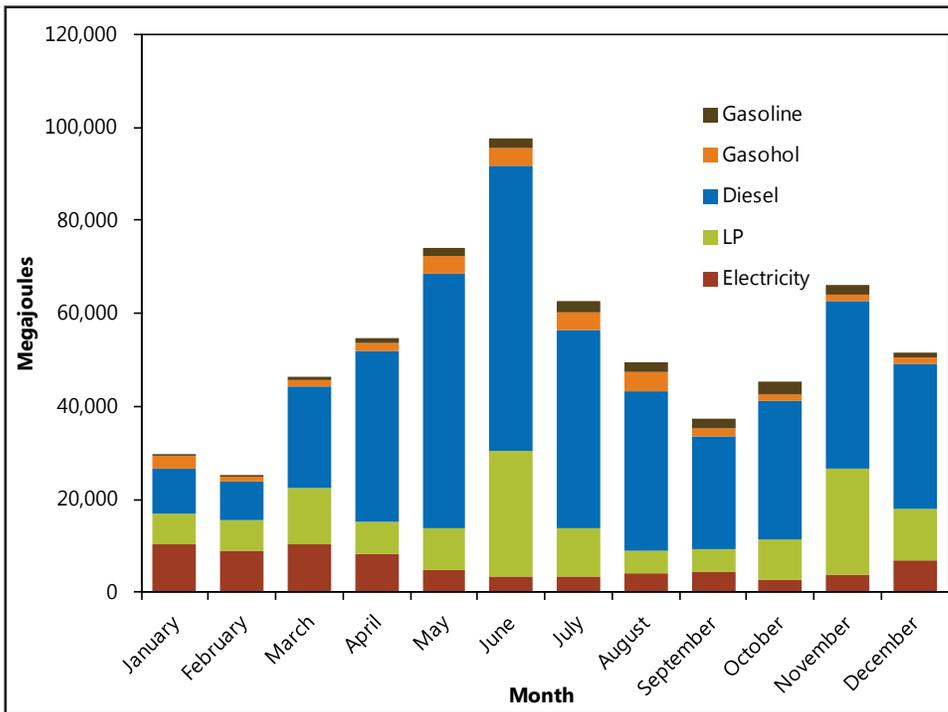


Figure 2. Average monthly energy use at the Franzen Farm by source, 2004-2012.

increased diesel use. Electricity was the source of more carbon emissions than any other sources on their farm. The Thickets have implemented many energy conservation practices to their home and farm, including solar thermal, solar photovoltaic, pond-geothermal, rotational grazing, a cupola on their house and a 40-kW wind turbine (Kolbe, 2014).

Frank Santana operates a 350-acre cattle farm near Winterset in Madison County. For this study, he provided diesel, electricity and LP data from 2007–2012. Monthly farm energy use was highest from December–February, primarily due to an increase in LP use. Energy use is largely balanced across the various sources, but electricity contributes the majority of carbon emissions.

Energy use varies dramatically among crop and livestock farmers depending on their size and enterprises. Major energy sources for crop and livestock farmers are diesel for field operations and LP for grain drying and home and building heating. Diesel and electricity are usually the top carbon emitters for crop and livestock farmers. Tracking diesel use allows farmers to see the contribution of field operations to overall energy expenditures. This is especially important for farmers with row crops, as diesel use often contributes the overall majority of energy use, energy cost and carbon emissions on their farm.

A detailed understanding of diesel records is important for understanding how changing field operations could impact energy costs. On-farm and university research has shown that diverse cropping systems require less energy inputs than



Francis Thicke in his creamery at Radiance Dairy

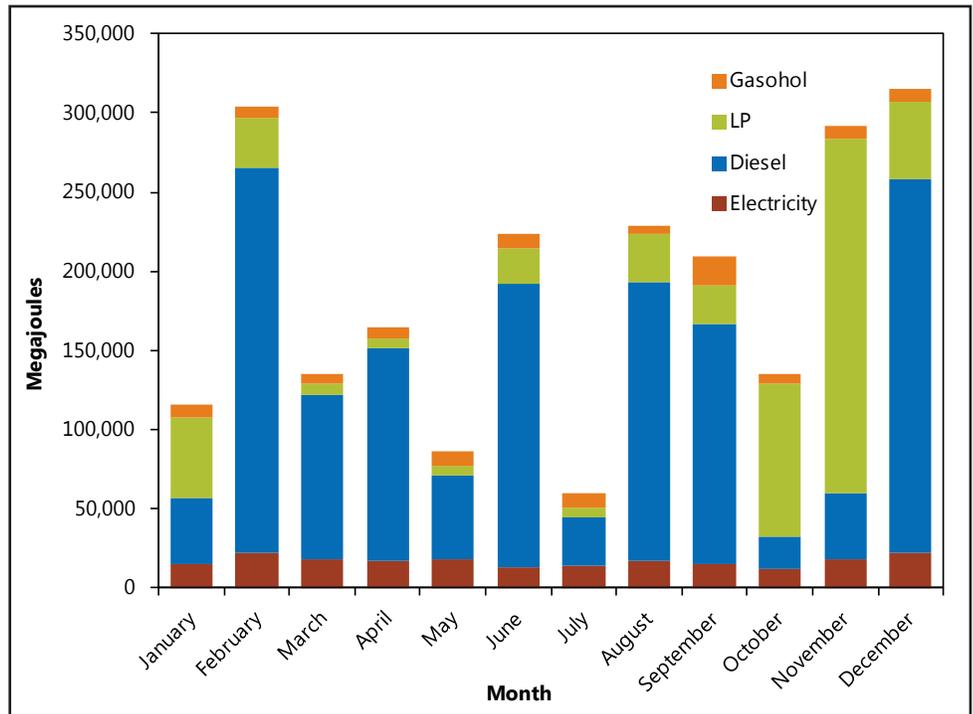


Figure 3. Average monthly energy use at the farm of Craig and LaVon Griffieon by source, 2008-2011.

continuous corn or corn-soybean rotations (Cruse et al., 2010; Carlson, 2013). While not much information is available from ISU Extension regarding energy use in vegetable production, various extension publications regarding how to track energy and how to improve energy efficiency in crop and livestock production are available at <http://farmenergy.exnet.iastate.edu/>.

### Direct vs. Indirect Energy Use

In this report, only “direct” energy use is included. “Direct” energy is the energy consumed by the end consumer, while “indirect” energy includes the energy to manufacture the product. According to the USDA Economic Research Service, in 2011 63% of energy in agriculture was direct; indirect energy contributed 37% to total use (Beckman et al., 2013). Fertilizers and pesticides are the two largest sources of indirect energy use, with nitrogen fertilizers making up the majority. For example, to commercially produce one pound of ammonia requires the energy equivalent of about 0.1 gal diesel (Kongshaug, 1998). If this study had included estimations for indirect energy use, overall energy use and overall greenhouse gas emissions would be significantly higher for some farms; especially for farms that apply significant amounts of manufactured nitrogen fertilizer.

### Conclusions and Next Steps

Farmer-cooperators established an energy baseline on a variety of farms across the state. For horticultural farms, electricity was the top user of energy, though transportation fuel nearly equaled electricity use on farms that recorded product transportation fuel costs. For crop and livestock farms, diesel, electricity or LP were the biggest energy sources, depending on the time of year.

This study shows that very detailed recordkeeping is necessary to improve energy efficiency and reduce energy costs. Farmers with years of extensive records were more easily able to identify areas of heavy energy use and implement changes to save energy and money. Not only does detailed recordkeeping allow farmers to be aware of the areas of their farm that use energy, it allows them to identify potential areas for incorporating alternative energy sources.

### Identifying energy “hogs”

For Jan Libbey and Tim Landgraf, coolers and fans in the summer were their biggest energy users. Because they had kept years of detailed records, they were able to install an appropriately sized solar array on their farm. The panels collect the most sun during the summer, which is Tim and Jan’s most intensive time of the year for energy

use.

"By determining our pattern of consumption, and learning that we have a rather regular pattern from year to year, we looked at solar PV instead of wind power, since the generating pattern of solar PV matched our consumption much better than wind," Tim says. "If you don't know how much you use, you really can't determine the feasibility of a project." They now produce more electrical energy than they consume on an annual basis. Tim discusses the process of installing a solar array in the Spring 2014 issue of *the Practical Farmer* (Kolbe, 2014).

To more accurately assess energy use on farms, recording monthly use of different energy sources instead of relying on purchase records is a good first step. This is especially important for transportation fuel and LP, which are purchased in bulk and stored for later use. Monthly meter readings could provide a more

accurate assessment of monthly LP use. By recording mileage and monthly use, farmers can get an idea of when the energy is used.

Energy use was highest during the winter months for over half the farmers who participated in the study. Furthermore, LP prices tend to rise during the fall and winter as farmers purchase fuel for grain drying and winter heating. This represents an opportunity for savings via improving energy efficiency and adding cost effective alternative energy sources. Depending on the farm, a geothermal heating system, new furnace or boiler, or a more fuel efficient vehicle or tractor could make financial sense for a farm business, but where to start depends on good recordkeeping.

Many farmers may also benefit from a professional home energy audit. Often, power companies, cooperatives, or municipalities will offer these services.

Professional energy audits for farm houses, buildings, and field work may be appropriate if more detailed data is available to work with. Tom Frantzen described this analysis as "gold plated." After learning the results of his farm's energy audit, he learned he would have been much wiser to invest in insulation before installing his geothermal heating system.

When determining which conservation measures or alternative energy sources are appropriate, a detailed financial analysis of the possible options is crucial to it being a sustainable option for the farm; not all alternative energy sources make sense for all farms. Most alternative energy sources are less versatile than fossil fuels or coal-fired electricity. Therefore, having good data to tell you exactly where and when your farm uses energy is necessary when planning an investment in energy conservation or renewable energy.

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## PFI Cooperators Program

PFI's Cooperators' Program gives farmers practical answers to questions they have about on-farm challenges through research, record-keeping, and demonstration projects. The Cooperators' Program began in 1987 with farmers looking to save money through more judicious use of inputs. If you are interested in conducting an on-farm trial contact Stefan Gailans @ 515-232-5661 or [stefan@practicalfarmers.org](mailto:stefan@practicalfarmers.org).