Dairy Energy Efficiency

Dairy Cooperative Partnerships for Improved Efficiency Program Adoption

Conservation Applied Research & Development (CARD)
FINAL REPORT

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Abstract

This project tested an innovative program approach to delivering energy savings measures to Minnesota's dairy farm community. By partnering with a local milk cooperative, this project surveyed 57 cooperative member dairies to gather data about dairy farm size, equipment use, and energy behavior toward targeted energy efficiency services. Using the data, the project team identified 30 cooperative member dairies with significant energy savings potential and provided 30 on-farm energy audits to quantify energy savings potential and determine specific recommendations. The project team also developed a dairy farm energy benchmarking tool so Minnesota dairies could determine how their energy use measures relative to hundreds of dairies in the region. Upon completion of the dairy farm audits, the project team followed up with individual dairies and networked with local electric utility staff, USDA program agents, and dairy equipment suppliers to encourage efficient technology implementation based on the energy audit recommendations. Overall, the project team found energy efficient lighting, placement of variable speed drives on milk pumps, and efficient water heating provided the most cost-effective energy savings.

Table of Contents

List of Figures

List of Tables

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Executive Summary

This project tested an innovative programmatic approach, partnering with a milk cooperative, for delivering energy saving measures to Minnesota's dairy community. The Minnesota Project and GDS Associates (the project team) worked with the milk cooperative Hastings Cooperative Creamery Company (HCCC) to access a high number of dairy producers through a trusted source. The project team leveraged the milk cooperative network to gain direct access to producers to promote improved efficiency programming designed specifically for dairy operations and to collaborate with electric utilities, USDA agents, and equipment suppliers.

The project team collaborated with HCCC field staff to collect data from milk cooperative member dairies about on-farm energy practices and equipment in use. Using the data, the project team selected 30 dairies with significant energy savings potential and conducted on-farm energy audits to pinpoint energy savings opportunities. Additionally, the project team developed a dairy energy benchmarking tool for Minnesota dairies to compare their energy use with the industry standard. The milk cooperative strategy was very effective at gathering relevant data to better target energy efficiency efforts on dairies. Partnering with HCCC facilitated access to cooperative member dairies that otherwise would have been difficult to achieve as an "outsider" organization. In particular, collaborating with HCCC field officers and milk haulers was advantageous because of the familiarity these HCCC staff members have with member dairy farms and their shared interests in profitable operations.

The geography of the milk cooperative partnership presented a challenge. In the instance of HCCC, dairy farms were spread across five electric utilities, six counties, and seven USDA service offices. Liaising between this number of entities and programs was a temporal and organizational challenge. Given the breadth of the geography, there was less peer-to-peer dairy farm communication than anticipated and HCCC staff did not have the time capacity to work with dairy farm members individually on energy matters.

Nonetheless, the project identified lighting recommendations on 29 of 30 farms. This recommendation had the most aggressive payback period with a median of 3.6 years and mean of 2.2 years and kilowatt hour savings per farm median of 4,589 and mean of 7,081, respectively. Implementing variable speed drives on receiver jar milk pumps presented a mean simple payback of 6.6 years and median payback of 6.8 years and kilowatt hour savings per farm median of 4,286 and mean of 7,486, respectively. Among other findings, the project team found many dairies were hesitant to upgrade equipment due to uncertainty about the dairy market, possible dairy expansion, and farm transition planning.

Overall, the milk cooperative strategy will see more success by limiting a campaign's scope to a specific electric utility territory. Setting aside resources for milk cooperative field staff or leadership to discuss energy efficiency through newsletters or at milk cooperative meetings would likely improve equipment implementation. To the extent electric utility staff or installing electricians can help milk producers address the upfront costs through conservation improvement program rebates or facilitating USDA program funding, electric utilities should see an increase in conservation improvement programming activity in collaboration with dairy cooperatives.

Introduction

This report details an innovative program approach to delivering energy savings measures to Minnesota's dairy farm community. By partnering with a local milk cooperative, this project was able to document significant energy savings potential within the cooperative, create a dairy energy benchmarking tool, and work to develop synergistic relationships between the electric utilities, dairy farmers, and the milk cooperative. The goals of this report is to aid electric utility staff and Conservation Improvement Program administrators in working with the dairy community to capture electric energy savings.

Background

Electric utilities frequently search for opportunities to implement energy efficiency improvements to help them meet their Conservation Improvement Program (CIP) goals.[1] Dairy farms, which consume a significant amount of energy in electric cooperative and some investor-owned utility territories, present significant electrical energy savings opportunities due to their reliance on pumps, motors, and ventilation for milk extraction, milk cooling, and cow comfort.

The milk extraction, cooling, and cow comfort components of dairy operations place these farms on the higher end of the spectrum for electrical energy consumption. Dairies are faced with mounting consumer pressure to reduce their environmental footprint [2] and have a business interest in keeping milk production inputs to a minimum. Further, the vast majority of Minnesota dairies are located in rural communities on rural electric cooperative power lines in light of spatial needs for herds, outbuildings, and typical zoning requirements.

This project leveraged a partnership with Hastings Cooperative Creamery Company, a Southeastern Minnesota milk cooperative, to test a new method of energy efficiency implementation not explored through the traditional utility energy efficiency services model. The project also identified the implementation challenges and benefits, dairy producer acceptance, cost-effectiveness, potential for replication across other farm types, and potential for CIP partnerships between utilities and agricultural associations.

[1] Minnesota Statute 216B.241 pertains to the Conservation Improvement Program. This statute establishes for each individual utility and association an annual energy-savings goal equivalent to 1.5 percent of gross annual retail energy sales. The savings goals must be calculated based on the most recent three-year, weather-normalized average.

[2] *See e.g.* Time, How Meat and Dairy are Hiking Your Carbon Footprint, July 26, 2011 (last visited Feb. 26, 2015); World Wildlife Fund, Sustainable Agriculture –Dairy (last visited Feb. 26, 2015); Innovation Center for U.S. Dairy, 2013 U.S. Dairy Sustainability Report, 9 (2013) (last visited Feb. 26, 2015).

The Minnesota Dairy Industry and Cooperative Organization

Minnesota ranks seventh in the nation in milk production with approximately 463,000 milking cows[3] across 4,746 dairies.[4] Milk from Minnesota dairies had a sales value of $1.538 billion in 2012.[5] These figures represent an increase in the number of milk cows and sales value, but a decrease of 1728 dairy farms since the 2002 Agricultural Censes.[6] Over the past decade, Minnesota dairies have been consolidating into larger operations, a trend that likely represents the development of significant electrical load centers for rural electric utilities.

The state's first milk cooperatives developed in the late 1910s with the assistance of the University of Minnesota Extension after dairies had struggled to earn fair prices from milk dealers.[7] Today, the majority of Minnesota dairy farmers participate in twenty-three milk cooperatives around the state including larger cooperatives such as Land O'Lakes, Associated Milk Producers, Inc., and First District Association.[8] Dairy farmers and their respective cooperatives leverage teams of milk haulers to transport raw milk from their farms to the cooperative creameries for processing and pasteurization before retail sale.

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[3] National Agricultural Statistics Service, 2013 State Agricultural Overview – Minnesota (last visited Feb. 26, 2015)

[4] National Agricultural Statistics Service, 2012 Census of Agriculture – Minnesota, Table 12. Cattle and Calves Inventory: 2012 and 2007, 2012 (last visited Feb. 26, 2015).

[5] Minnesota Farm Guide, Census of Ag shows dedicated dairy farmers in Minnesota, June 1, 2014 (last visited Feb. 26, 2015).

[6] *Id*.

[7] University of Minnesota – Extension, Extension History, 2014 (last visited March 14, 2015).

[8] United States Department of Agriculture, Agricultural Marketing Service – Dairy Programs as of October 23, 2014 (last visited March 13, 2015).

On-Farm Dairying Practices

In Minnesota, most milk is harvested from cows raised in intensive production systems with tie-stall barns[9] or free stall barns[10], and open lots. Some Minnesota dairy farmers use pasture-based systems or a combination of intensive production and pasture-based farming. Across Minnesota and the U.S., black and white Holstein cows make up nine out of every ten dairy herds. The Holstein breed is famous for its ability to produce large volumes of milk, butterfat and protein.[11] Additional milk breeds in Minnesota include Ayrshire, Brown Swiss, Red & White, Jersey, and Guernsey among others.[12]

In brief, the dairy cycle begins with young female cows, not yet impregnated, known as heifers. Raising heifers represents a significant investment – up to 25% of operating costs – and is often performed by customized heifer-raising farms.[13] Heifers do not produce a marketable product – milk – until they reproduce and start lactation. Once the heifer is impregnated, gestation lasts for nine months. Upon calving, the mother and calf are separated and the mother becomes a "fresh" dairy cow and produces milk regularly. The calf is moved to a calf pen and is fed colostrum for the first several weeks, and later a milk substitute with appropriate nutrients as the calf is weaned off of a liquid diet.

Typically, dairy cows are bred in 10-14 month cycles. In order to maximize milk production, dairy farmers halt milking in re-bred dairy cows approximately 45 days before parturition. This "dry period" increases milk yield and minimizes metabolic problems at calving.[14] Following calving, most cows achieve peak milk production 45 to 90 days in milk (or after calving) and then slowly lose production over time (140-305 days postpartum) until they re-enter the "dry period".

Dairy farms in the U.S. range in electricity consumption between 400 and 1,700 kilowatt-hours (kWh) per cow annually, or $0.035 to $0.045 per hundredweight (cwt) of milk produced.[15] According to estimates, electric utility costs on Midwest dairy farms range from 2-5% of all milk

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[9] Tie stall barns contain individual stalls for each adult milking cow. Each stall is large enough for a cow to stand or lay in while secured to a post with a rope. Tie stalls are separated by a curved metal bar that prevents cows from bumping each other. Cows bed on a variety of materials, including hay, sand, wood shavings or specialized mats for comfort.

[10] Free stall barns also contain individual stalls for each adult milking cow though cows are not restrained and are free to enter or leave a stall as they desire.

[11] Holstein Association U.S.A, Holstein Breed Characteristics, 2015 (last visited March 16, 2015); Environmental Protection Agency, Ag 101: Dairy Production Systems, 2012 (last visited March 16, 2015).

[12] University of Minnesota –Extension, 4H: Learning about Dairy (last visited March 16, 2015).

[13] University of Minnesota – Extension, Feeding Strategies for Post-weaned Heifers, 2006.

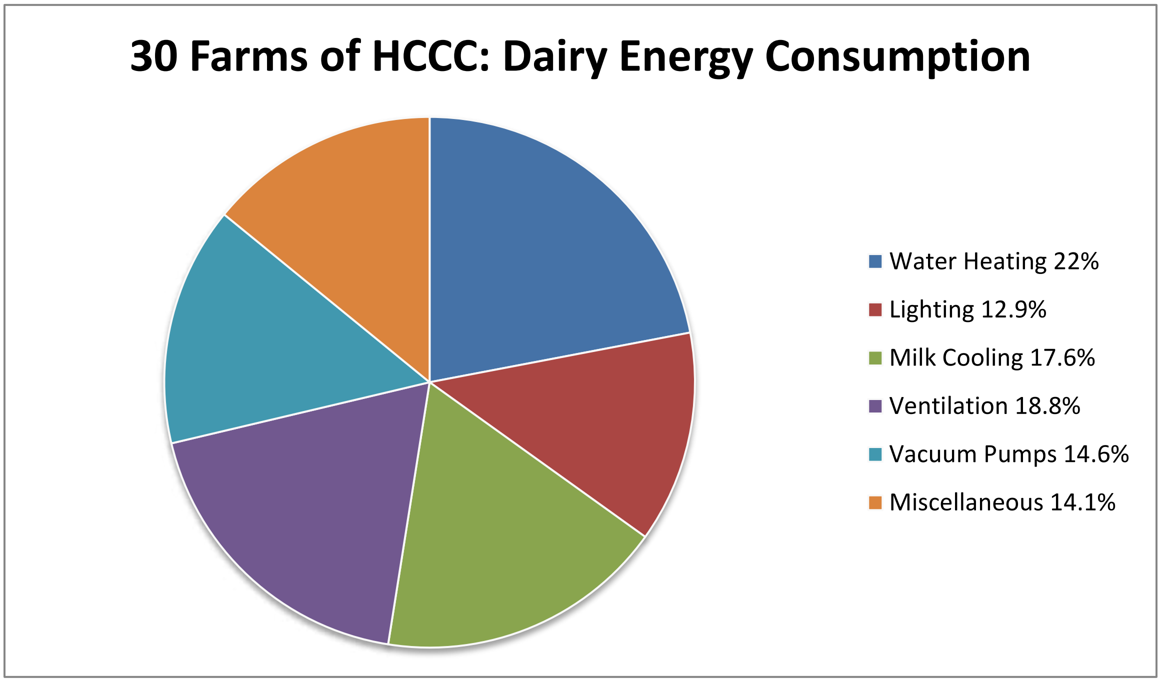
[14] Penn State University – Extension, Pasturing Dry Cows and Heifers, Nutrition of Dairy Cows on Pasture-based Systems, 2003 (last visited March 16, 2015).

[15] The Manager, How much energy does your dairy use?, June 2005 (last visited March 16, 2015).

production costs.[16] General estimates indicate that milk cooling accounts for the bulk of electricity usage at 25%, followed by lighting (24%), ventilation (22%) and vacuum pumps (17%). The remaining 12% is made up of water heating, manure handling, feeding equipment, and miscellaneous use.[17]

By comparison, this project, with a small sample size of 30 dairies found water heating made up 22% of energy consumption, followed by milk cooling (17.6%), ventilation (18.8%), and vacuum pumps (14.6%) and lighting (12.9%). The remaining 14.1% was made up of miscellaneous use including milk pasteurizers, waterers, laundry and small motors. The milk harvesting process and related energy consumption fit well into three categories: Milk Extraction, Milk Cooling, and Cow Comfort.

Figure 1: General Energy Consumption from 30 participating HCCC farms



Milk Extraction

Milk is harvested from dairy cows two or three times daily, depending on the farm. In short, this involves attaching teat cups to the cows' udders in the milking parlor and using a vacuum pump to pull the milk from the cows into a milk receiver jar. A second pump sends the 95° - 98° F cow body temperature milk from the receiver jar through a well-water plate cooler, if present, and into the bulk tank. Many dairies still use regular vacuum pumps for the extraction process. Regular vacuum pumps are often inefficient because the pump runs at a constant

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16 Wisconsin Dept. of Ag., Trade & Consumer Protection, Dairy Farm Energy Management Handbook, 2006 (last visited March 16, 2015).

17 *Id.*

speed regardless of how many milking units are in use. These pumps tend to be over-sized because they are designed to meet maximum demand at all times (a full milk parlor at every milking).

- Installation of a variable speed drive (VSD) (also known as a variable frequency drive or VFD) on a vacuum pump can save between 50-65% in electricity costs by regulating the vacuum. VSDs change the speed of the vacuum pump based on pressure sensor readings on the vacuum line near the milk receiver jar. VSDs are economical for dairies with longer periods of pump run time, approximately 8 or more hours. VSDs for smaller dairies and shorter pumping times do not present the same cost savings opportunities due to equipment costs, though there are energy savings opportunities.[18]

- VSDs on milk pumps provide a steady flow of milk through plate coolers to maximize cooling. In turn, this reduces demand on refrigeration compressors in bulk tank cooling and can improve milk freshness by cooling milk more quickly.

Milk Cooling

Once the milk is in the milk receiver jar, it is pulled by a second "milk pump" into the bulk tank where it is cooled by compressors to approximately 37-39° F to maintain freshness. The milk lines are then rinsed with hot water that enters the lines between 150° – 170° F and should not drop below 120° F when it exits the lines in order to break up milk fats and reduce bacteria count. After the raw milk pick up by the milk hauler, the bulk tank must also be washed with 150 – 170° F hot water and sanitizer. Dairies use laundry washers and dryers to wash the many towels used to wipe down cow udders. They also sterilize towels in dryers with high temperatures to eliminate mastitis-causing bacteria.[19] This segment of the milk harvesting process presents several energy efficient technology opportunities: dairy plate coolers, scroll-type refrigeration compressors, refrigeration heat recovery units, and efficient clothes washers and dryers.

- Dairy plate coolers run well water and milk in opposite pipes through a series of metal plates. The warm milk is cooled as heat is absorbed by the cold well water on the opposite side of the stainless steel plates. The near-98° F milk is cooled to approximately 55°-60° F before entering the bulk tank where it is cooled down to 37-39° F before milk pick up. The "pre-cooling" effect depends on the temperature of the well water, ratio of water to milk in gallons per minute, and the number of times the milk passes the cold-water channels.[20]

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[18] *Id*.

[19] Colorado State Univ., College of Veterinary Medicine & Biological Science, Use of Cloth Towels to Wash and Dry Udders, (1998) (https://www.cvmbs.colostate.edu/ilm/proinfo/cdn/98articles/Use%20of%20Cloth%20Towels%20to%20Wash%20and%20Dry%20UddersJul98.pdf), last visited March 31, 2015.

[20] Wisconsin Public Service, In-Line Milk Cooling, (last visited March 31, 2015).

- Scroll-type refrigeration compressors use 20%-30% less electricity than traditional reciprocal compressors. Additionally, they have fewer moving parts, meaning they are less prone to equipment failure, and run at a lower decibel level. Scroll compressors feature dual spinning scrolls that compress and move refrigerant more efficiently than other traditional compressors. Upgrading to scroll-type refrigeration compressors often make the most sense where older compressors are near the end of their product life, or in conjunction with the installation of a new bulk tank.[21]

- Refrigeration Heat Recovery (RHR) units make water heating systems more efficient by collecting heat that would normally be exhausted into the air and using it for water heating. An RHR unit absorbs heat from hot refrigerant from the compressors and pre-heats water before it enters the water heater. Additionally, refrigeration compressor efficiency may increase where RHR units lower refrigerant temperature quickly to enhance condensation. This technology extends the life of both the water heating and refrigeration systems.[22]

- Hot water energy consumption can be managed with operational changes in dairies. Heating hot water above 165° F is often excessive for typical dairy use. Beyond operational changes, energy auditors typically recommend high energy efficient water heaters with thermal efficiencies at or near 90% and minimal standby losses. Where appropriate, energy auditors may recommend a switch from liquid propane to natural gas or high efficiency electric water heating.

- Upgrading from residential to commercial laundry equipment or to Energy Star-rated residential laundry equipment may also be recommended for dairy operations where energy audits find worthwhile energy savings. Such recommendations depend on the age of the equipment, available fuel sources, and practices of the dairy (i.e. cloth towels versus disposable towels).

Cow Comfort

Milk producers and researchers alike understand cow comfort directly impacts milk production, herd health, and profitability.[23] Cow comfort depends almost entirely on the barn environment, including clean and soft stalls, comfortable footing (cows walk on their toes[24]),

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[21] Extension.org, S. Sanford, Refrigeration Systems for Milk Cooling, (last visited March 31, 2015); Wisconsin Public Service, Scroll Compressors, (last visited March 31, 2015).

[22] USDA, Natural Resource Conservation Service, Energy Self-Assessment, Refrigeration Heat Recovery (last visited March 31, 2015).

[23] *See e.g.* Extension.org, Univ. of Florida, A. De Vries, Economics of Heat Stress: Implications for Management (2014) (last visited March 31, 2015); Univ. of Kentucky – Cooperative Extension Service, D. Ammaral-Phillips, Comfortable Dairy Cows are More Profitable for their Owners (last visited March 31,2015).

[24] Purdue University Extension, K. Hepworth, M. Neary, & S. Kenyon, Hoof Anatomy, Care and Management in Livestock (2004).

fresh air, clean water, and good visibility. In terms of energy consumption, cow comfort depends on proper ventilation, livestock watering, and good lighting.

- Ventilation is necessary to remove dust, odor, pathogens and moisture from barns and to provide fresh air to livestock. In the summer months, proper ventilation is necessary to avoid or mitigate decreases in milk production from heat stress. Different barns have different ventilation requirements: Most small barns use a series of box fans, while larger operations might employ a cross-ventilation system.
    - Box fans or cross-ventilation fans: Energy auditors may recommend upgrading ventilation systems to fans with higher airflow efficiency, stated in cubic feet of air per minute per watt (cfm/watt). These efficiencies are based on third party testing by the University of Illinois' Bioenvironmental and Structural Systems Laboratory (BESS Lab)[25].
    - High volume, low speed (HVLS) fans: For loose structures or free-stall barns, energy auditors may recommend HVLS fans to displace a series of smaller fans that total in greater horsepower (HP) size and energy consumption, but move less air than an HVLS fan. HVLS fans are ceiling fans with .75 to 1 HP motors and large diameters from 8 to 24 feet. They move high amounts of air slowly which can create a strong cooling effect for livestock.[26]
- Low energy or no energy waterers are another possibility for dairy operations to save energy costs. Traditional automatic waterers consist of an insulated base and heated bowl that fills with water from a pressurized line. A float-operated valve, which the cows nuzzle down when they drink, controls the level of water in the bowl. These kinds of automatic livestock waterers have heating elements that range from 600 to 1,000 watts. On cold days, the heating elements may be on for extended periods of time, thus consuming large amounts of electricity. In contrast, low or no energy waterers can save anywhere from 20% to 80% of energy costs, depending on design.[27] Low or no energy waterers conserve energy by super-insulating the drinking tank or draining water from the drinking bowl into an underground reservoir below the frost line to prevent water from freezing.
- Lighting is an important part of the dairy barn environment. Proper light levels ensure feed and water intake by dairy cows. Many milk producers practice a technique called long day lighting (LDL) where cows are exposed to a photoperiod of 16-18 hours, followed by 6 to 8 hours of darkness. This is a proven technique that

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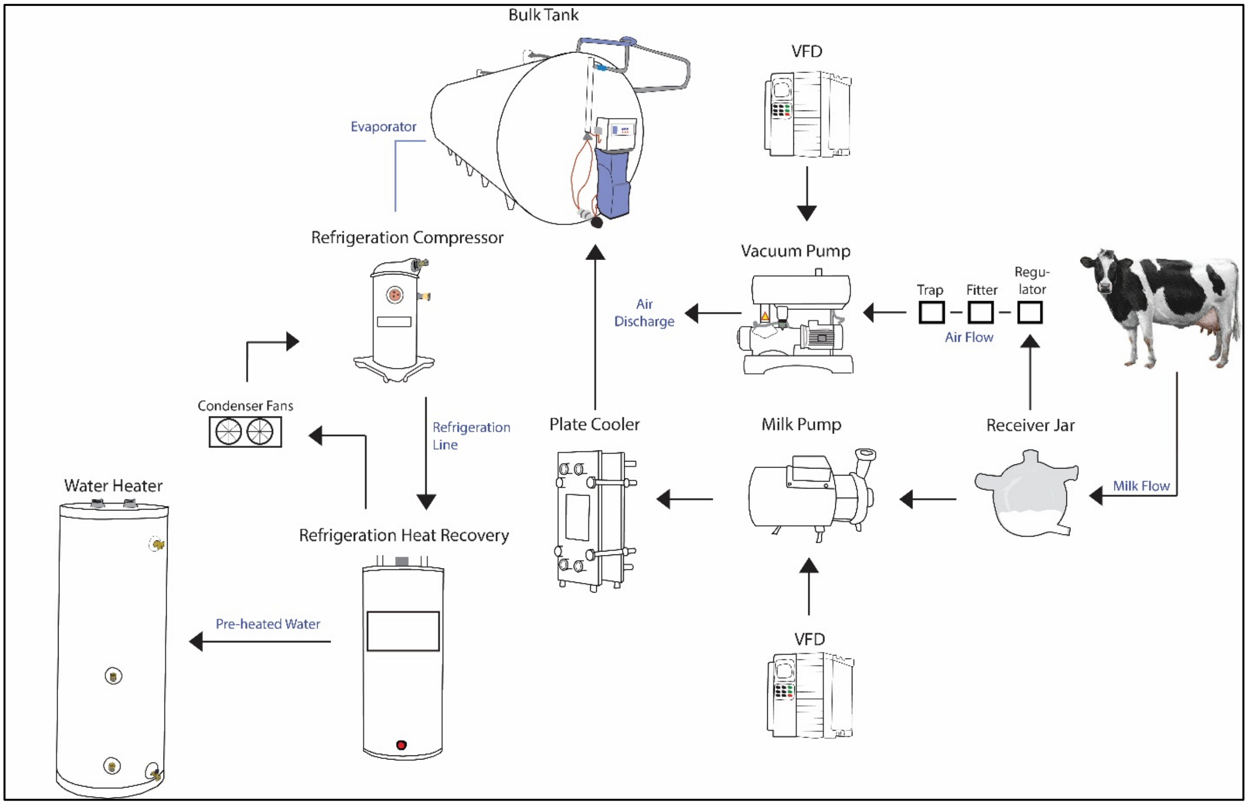
[25] Univ. of Illinois at Urbana-Champaign, Dept. of Agriculture & Biological Engineering, Bioenvironmental & Structural Systems Laboratory (BESS Lab).

[26] Univ. of Wisconsin Extension, D.W. Kammel, M.E. Raabe & J.J. Kappelman, Design of High Volume Low Speed Fan Supplemental Cooling System in Dairy Free Stall Barns.

[27] Province of Alberta, Canada, Office of Agriculture & Rural Development, Agri-Facts: Automatic Livestock Waterers (2008).

can boost milk production from 5% to 16%.[28] Energy auditors regularly recommend upgrades from T-12 to T-8 tubular fluorescent fixtures and high-bay LED lamps to increase light levels in the barn. LED fixtures offer a win-win for dairies by reducing production costs and increasing production.[29]

Figure 2: Milk Harvesting Process



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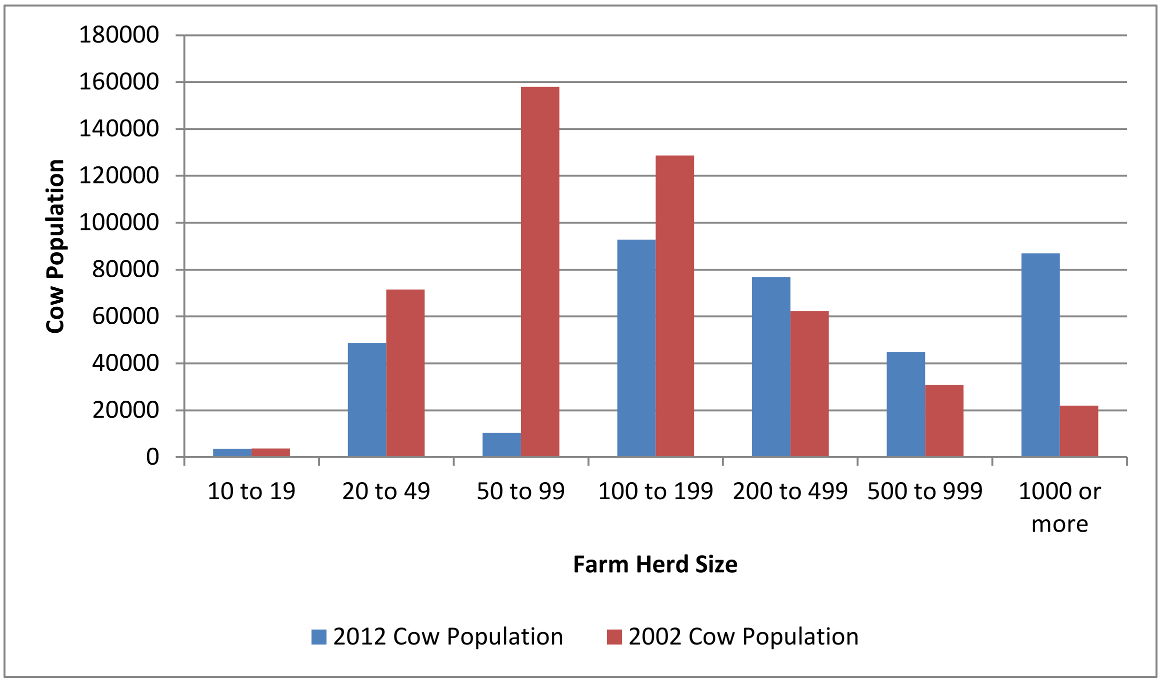
[28] Extension.org, Univ. of Illinois, G.E. Dahl, Effect of Photoperiod on Feed Intake and Animal Performance (2013).

[29] Michigan State University Extension, M.C. Gould, Increase Milk Production and Reduce Energy Consumption with Long Day Lighting (2015).

Herd Size and Energy Efficiency

Like any industry, certain cost advantages appear as dairy herd sizes increases. In practical terms, milk producers are able to spread out equipment and operational costs over more cows. Long-term trends in the dairy industry in Minnesota and nationwide show an increase in the number of dairies with 1,000+ herd sizes and a decrease in the number of smaller dairies. Nationally, the midpoint dairy farm size[30] has risen sharply over two decades. In 1992, the midpoint was 101 cows, but by 2012 the midpoint had risen to 900 cows.[31] Minnesota has seen this same trend in the last decade as well. Figure 3 shows the distribution of milk cow population per farm herd size and the trend toward larger herds between 2002 and 2012. Figure 4 represents the shift in the farm population from small dairy farm to greater numbers of large dairy farms.

Figure 3. USDA National Agricultural Statistics Service, 2012 and 2002 Agricultural Censes, Table 12. Cattle and Calves Inventory[32]



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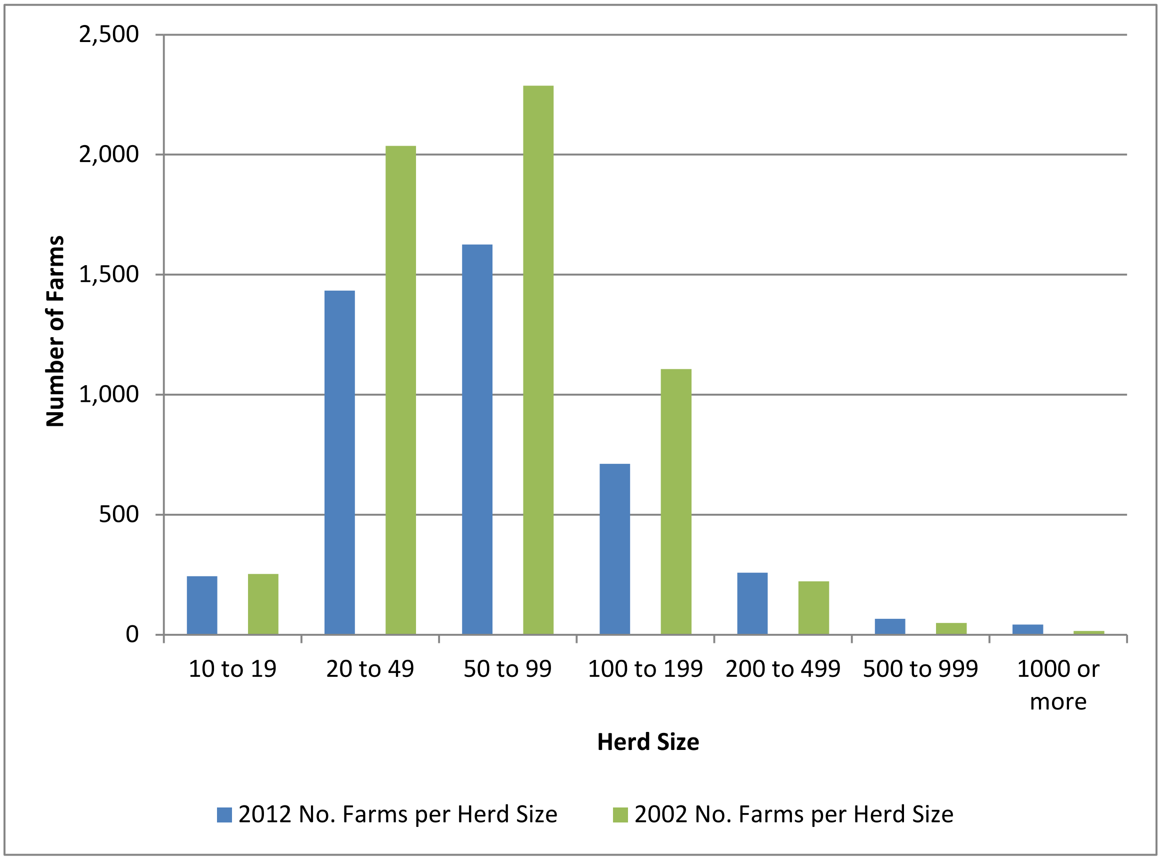
[30] The number that shows herd size at which half of all cows are in larger herds and half are in smaller herds.

[31] USDA, Economic Research Service, J. MacDonald and D. Newton, Milk Production Continues Shifting to Large-Scale Farms, 2014.

[32] USDA, Natl. Agricultural Statistics Service, 2012 Census of Agriculture – State Data, Table 12: Cattle and Calves – Inventory and Sales 2012 and 2007 (2012); USDA, Natl. Agricultural Statistics Service, 2002 Census of Agriculture – State Data, Table 12: Cattle and Calves – Inventory and Sales 2002 and 1997 (2002)

Figure 4. USDA National Agricultural Statistics Service, 2012 and 2002 Agricultural Censes, Table 12. Cattle and Calves Inventory[33]



With the caveat that every dairy is unique, this trend suggests a "Goldilocks" target for dairy farm energy efficiency. Smaller dairies are often not able to justify efficient equipment upgrades because the energy cost savings payback is too long, even with conservation improvement program rebates. At the other end of the spectrum, larger dairies could justify efficient equipment upgrades without rebates based on quick energy cost savings paybacks alone. Dairies with herd sizes in the middle with 100-199 herd size are likely the best conservation improvement program targets because an equipment rebate would push the costs of an equipment upgrade into a reasonable range of energy savings payback to spur implementation. Additionally, mid-sized dairies may be considering expansion as a method to address margin compression in the dairy industry in recent years.[34]

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33 USDA, Natl. Agricultural Statistics Service, 2012 Census of Agriculture – State Data, Table 12: Cattle and Calves – Inventory and Sales 2012 and 2007 (2012); USDA, Natl. Agricultural Statistics Service, 2002 Census of Agriculture – State Data, Table 12: Cattle and Calves – Inventory and Sales 2002 and 1997 (2002).

34 University of Minnesota Extension, Jim Salfer, Margin compression – what does it mean for my dairy (2013).

Related Research on Dairy Farm Energy Efficiency

Several entities associated with strong dairy industries have investigated energy efficiency opportunities for milk producers. These initiatives range in purpose from identifying energy savings, enhancing dairy profitability, and measuring sustainability.

- **New York State Research & Development Authority (NYSERDA) - 2003 Dairy Farm Energy Audit Summary**. Under NYSERDA's FlexTech Program, private vendor DL Tech conducted 32 energy audits on dairy farms in central and northern New York. The reports summarized and highlighted collective patterns of basic farm data, energy usage and energy utilization indices (EUI). Additionally, the vendor broke down energy use on dairies and identified the relationships of present and future energy conservation options to better analyze recommended energy conservation measures (ECM). The Summary found that installation of variable speed drives (VSDs) on vacuum pumps presented the greatest savings potential, especially for farms with long milking hours. Milk plate pre-coolers were the next major ECM proposed because cost effectiveness is tied to the volume of milk produced, and volume and temperature of well water available. The greatest number of ECMs proposed was for energy efficient lighting due to newer efficient lighting technology at the time.[35]
- **University of Wisconsin Extension, Center for Dairy Profitability – "2005 Limited Comparison of Energy Costs in Wisconsin Dairy Systems" by Tom Kreigl.** This project examined whether grazing dairy operations were more energy efficient than confinement operations. Researchers compared ten years' worth of farm financial data from 43 grazing operations against hundreds of confinement dairy farms from two management associations. The project employed a life cycle analysis to measure the energy and material flows associated with all stages of production. Researchers included utilities, gasoline, fuel and oil, as well as chemicals and fertilizers in the energy analysis and determined that pasture-based dairies had lower energy costs per CWT equivalent of milk than confinement farms across the ten-year period.[36]
- **Colorado Energy Office, 2013 Agricultural Energy Market Research Report.** The Colorado Energy Office (CEO) commissioned the Agricultural Energy Market Research Report to examine opportunities for energy efficiency in Colorado's agricultural sector. The study[37] determined that irrigation accounted for 50% of the total electric expenses in 2008 for the state's agricultural sector. It also concluded that dairies represent significant energy efficiency opportunities because of their energy intensiveness and 24 hours-365 days a year operating schedules. In the spring of 2014, the CEO began a pilot project to address barriers that prevent milk producers from investing in energy efficiency.

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[35] NYSERDA, Dairy Farm Energy Audit Summary, July 2003.

[36] Univ. of Wisconsin – Extension, Center for Dairy Profitability, T. Kreigl, Limited Comparison of Energy Costs in Wisconsin Dairy Systems (2005).

[37] Colorado Energy Office, Colorado Agricultural Energy Market Research – Phase II: Market Research Report (2013).

Through a third-party vendor, CEO provided free energy audits and technical support to 12 agricultural producers and issued grants up to $25,000 each to producers interested in implementing energy efficiency recommendations. Eight producers implemented improvements, investing $233,000 and leveraging $168,000 in incentives including utility rebates. CEO is launching a statewide program in 2015 that will be made available to all Colorado dairies and farmers with mechanical irrigation.[38]

Project Description

This project tested an innovative programmatic approach to delivering energy saving measures to Minnesota's dairy community. The project team partnered with the milk cooperative Hastings Cooperative Creamery Company (HCCC) to access a high number of dairy producers through a trusted source. The project team leveraged this systemic approach of gaining direct access to these identified producers to encourage electric utilities, equipment suppliers, and HCCC itself to consider improved efficiency programming designed specifically for dairy operations. The project team collaborated with HCCC field staff to collect data from milk cooperative member dairies about on-farm energy practices and equipment in use. Using the data, the project team selected 30 dairies with high energy savings potential and conducted on-farm energy audits to pinpoint the energy savings opportunities. Additionally, the project team developed a dairy energy benchmarking tool for the Minnesota dairies to compare their energy use with the industry standard. The two-year project demonstrated the strengths, weaknesses, and synergies possible through the milk cooperative partnership strategy to assist electric utility companies accomplishing conservation programming.

Project Objectives

The project aimed to gather useful dairy farm data from HCCC in order to identify energy consumption trends and on-farm equipment use. With this data in hand, the project team prioritized dairy farms with significant energy savings potential and conducted 30 on-farm energy audits conducted per the American Society of Agricultural & Biological Engineers (ASABE) Standard 612 – Type 2, which establishes procedures for conducting farm energy audits (detailed below in section titled "Dairy Farm Energy Auditing"). The project team developed and promoted a dairy energy benchmarking tool to encourage other Minnesota dairies to consider their energy use. Overall, this project tested the "milk cooperative strategy" as a new approach for electric utilities in agricultural areas to deliver energy efficiency services for accomplishing Conservation Improvement Program goals and serving their agricultural constituents.

[38] Colorado Energy Office, Colorado Dairy and Irrigation Efficiency Pilot Program, 2015.

Milk Cooperative Strategy - Sampling and Methodology

The project team developed a baseline energy use and equipment survey (see Appendix A) informed by prior research studies, knowledge of Midwestern dairy practices, and professional judgment. The survey was administered by HCCC field staff and milk haulers to all of HCCC's Minnesota member dairies, crossing several electric utility territories and counties, and ranging from 40 to 500-cow herd sizes. Successfully, all 57 dairy farms responded to the survey. The project team then compiled this data into a score sheet and prioritized farms based on energy behavior, equipment type and age, and willingness to receive an on-farm energy audit. Thirty dairy farms received dairy energy audits in all. After completion and delivery of the audits, the project team followed up with these farms individually by phone, mailing and making in-person visits to encourage implementation of identified ECMs. Additionally, the project team notified local electric utility account representatives, USDA program administrators, and equipment suppliers of the project and connected dairies to this network to encourage efficient technology implementation.

Strengths

The milk cooperative strategy was very effective at gathering relevant data to better target energy efficiency efforts on dairies. Partnering with Hastings Cooperative Creamery Company facilitated access to cooperative member dairies that otherwise would have been difficult to achieve as an "outsider" organization. In particular, collaborating with HCCC field officers and milk haulers was advantageous because of the familiarity these HCCC staff members have with member dairy farms and their shared interests in profitable operations. Field staff members make regular visits to dairy farms to work with producers on a range of matters, including general herd health, nutrition, milk quality, feed supply, and general liaising between the creamery and the farm. Depending on the farm, milk haulers visit the dairy every day or every other day to collect raw milk and deliver it to the creamery for processing and sale. These established relationships were invaluable for collecting detailed information about on-farm dairy practices.

The project team believes data collection was successful because the baseline energy survey was user-friendly and encouraged by HCCC field staff. The survey was limited to one-page with mostly check-the-box and fill-in the blank responses. It targeted specific equipment, practices, and energy expenditures. It included pictures for ease of equipment identification and was hand-delivered by HCCC field staff and collected by field staff or the milk haulers. This quantifiable data made identifying farms with significant energy efficiency opportunities much more straightforward.

Weaknesses

The geography of milk cooperatives member dairies does not correlate with electric utility or USDA service territories. In the instance of HCCC, dairy farms were spread across five electric utilities, six counties, and seven USDA service offices. Liaising between this number of entities and programs was a temporal and organizational challenge. Given the breadth of the geography, there was much less peer-to-peer dairy farm communication than anticipated by the project team and no identifiable "neighborhood effect". Additionally, HCCC field staff did not have the capacity to follow up with each participant farm specifically on energy matters. Liaising between utility companies about rebates and equipment suppliers about the audit reports was not within their bandwidth.

Other factors outside the scope of this project also presented a challenge. Specifically, the Minnesota dairy industry is undergoing a generational change. Several producers that participated in this project were hesitant to upgrade equipment because they were nearing retirement and had not identified anyone to take over their operation. Other producers stated they would be exiting their dairy operation in the near future because of market volatility. At least one producer determined in the months following the on-farm energy audit he would not be using the audit report because he was doubling the size of his dairy in order to remain competitive in the changing dairy marketplace.

Potential for Replication

The milk cooperative strategy, with some modifications, has strong replicability potential for electric utilities in light of the 23 dairy cooperatives operating in Minnesota. Limiting the scope of any future project to dairy farms in a specific utility service territory would simplify outreach efforts and build familiarity with conservation improvement program actors. A direct line of communication between electric utility account representatives and dairy cooperative field staff would make conservation improvement programming more efficient. Arming milk cooperative field officers with basic energy efficiency information and educating them about the purposes and design of the conservation improvement program would also be helpful. Nonetheless, leveraging milk cooperative personnel to gather dairy energy information is a very efficient way to identify energy savings opportunities toward accomplishing conservation improvement program goals.

Dairy Energy Benchmarking Tool

The dairy energy benchmarking tool was designed to help farmers across the state understand how their energy use compares to industry standards. From 28 different required data inputs that primarily relate to operation size, energy cost expenditures, and average daily milk production, a milk producer can understand how his farm energy use compares to other farms of similar size and production rate. The benchmarking tool estimates dairy cooling energy usage normalized by milk production. Data inputs for the tool include specifications for the following equipment: well water pre-cooler, refrigeration heat recovery unit, scroll refrigeration compressors, variable speed vacuum pump controls, water heater, and variable speed milk pumps if a pre-cooler is installed on the dairy. The energy usage calculations are based on proprietary data collected by project partner GDS Associates from hundreds of dairy farms in the Midwest and the 30 dairy energy audits associated with this project.

The dairy benchmarking tool is useful for encouraging milk producers to think about their energy consumption. The benchmarking tool results display a thermometer graphic that indicates whether a farmers is very efficient (green), average (yellow), or needs improvement (red). The tool is downloadable in Excel format and easily shared with electric utilities and their members. The project team has promoted the tool to the Minnesota Department of Agriculture and milk producers associations in the state. It is be hosted by the University of Minnesota Extension's Regional Sustainable Development Partnership's Clean Energy Resource Teams website.[39]

Dairy Farm Energy Auditing

Despite the variability in farm size and operational practices, dairy farm energy audits and reporting are uniform because of adherence to standards established by the American Society of Agricultural & Biological Engineers (ASABE). ASABE Standard 612[40] establishes procedures for conducting on-farm energy audits to assess and document current farm energy usage and provide an estimation of energy savings from implementing identified ECMs in the milking process, though behavioral recommendations are also common. The standard has two types: Type 1 audits are general and report on major activities; Type 2 audits are more detailed with a report that includes all major activities and their components. This project employed the detailed Type 2 audit standard.

Energy Baseline Reporting

Regardless, of the audit type, Standard 612 guides the reporting of data and the preparation of specific recommendations for energy reduction and conservation. It specifies each report must:

- Describe the overall management scheme for the enterprise.
- Address enterprise-specific management operations as required by the audit type (Type 1 or Type 2).
- Include energy use and cost data from the enterprise for the most recent 12-month period.
- Describe major activities associated with the enterprise.
- Describe activity and primary equipment involved.

[39] The Dairy Energy Benchmarking tool can be downloaded from the Clean Energy Resources Teams website at http://www.cleanenergyresourceteams.org/dairy-form.

[40] American Society of Agricultural and Biological Engineers, Standard 612 Performing On-Farm Energy Audits (2009).

- Document the type of energy resource used and current energy consumption for each major activity, including electrical service information (single or three phase; voltage) and natural gas or propane service information.
- Describe components of major activities as appropriate (Type 2 only).
- List the manufacturer of equipment and the component factory ratings (hp, efficiency, Btu input, and Btu output).
- Describe management use efficiencies (i.e. whether there are manual systems in place that could be automated).
- Summarize annual energy use by energy source.

Energy Assessment and Recommendations

In a Standard 612 audit report, details of the baseline energy use of the dairy enterprise are followed by recommendations to improve energy conservation and efficiency. These recommendations must:

- Report energy savings at the farm level in units useable and understandable by the farmer.
- Make appropriate energy savings recommendations for each major activity including a comparison to the baseline condition for:
    - Estimated cost of replacement or upgrade of equipment.
    - Estimated energy and cost savings, including appropriate assumptions and documentation.
    - Estimated simple payback period (in years) for implementing each recommendation.

Practical Notes

Farming enterprises are complicated businesses and should be approached by energy stakeholders with some degree of flexibility. Farming is weather and seasonally dependent: scheduling dairy energy audits is best done in the winter months (December - March) or after spring planting in the summer (June - August). Spring planting and fall harvesting takes up the majority of farmers' time on mixed farming enterprises (i.e. cash crop and dairying), leaving little time for the necessity of milking cows. A weather event, like a rainy day, might open up some time for farmers on the dairy since working in a muddy field would be a challenge. The project team found that early communication with the farm decision-maker made scheduling energy audit data collection visits easier.

Additionally, it is critical that energy auditors and electric utility staff observe farm hygiene. Biosecurity to protect herd health is important. Individuals who regularly visit different farms should wear disposable plastic booties or shoe covers, or be sure to clean boots of mud followed by a disinfectant spray. Putting the booties on or changing footwear before stepping into the barn demonstrates courtesy, knowledge, and respect for the enterprise.

Dairy Energy Audit Findings

Audit findings for the thirty farms in Hastings Cooperative Creamery Company that accepted energy audits are presented below. On the tables that follow, each line reflects the summary information for measures recommended at a single farm. (For example, a lighting recommendation at a single farm may include replacing multiple fixtures of multiple wattages. The summary data provided reflects the total energy savings, cost, and simple payback of all those replacement bulbs based on the bulbs that are currently installed at that farm. The methodology for calculating energy savings follows ASABE Standard 612. This methodology provides recommendations in comparison to the base-line condition in energy units understandable to the dairy farmer (i.e. Kilowatt hours). Since farms ranged in size and operational practices, not all farms received the same energy efficiency recommendations and some farms did not receive recommendation for some end use technologies. In terms of high-level statistics, herd size ranged from 40 to 500 cows. The mean herd size was 105 cows and the median herd size was 72 cows.

Lighting

Twenty-nine of 30 farms received energy efficient lighting recommendations though no farm had identical lighting equipment. Lighting recommendations had the most aggressive simple payback periods with a median of 3.6 years and mean of 2.2 years. Recommended measures ranged from one lamp replacement of incandescent bulbs with compact fluorescent bulbs, to rewiring and installing LED fixtures.

Table 1: Lighting Recommendations

Herd Size	Electrical Savings (kWh)	Propane Savings ($)	Energy Savings (MMBTU)	Installed Cost ($)	Energy Cost Savings ($)	Payback (yrs)
60	2850	N/A	9.7	4165	285	14.6
40	15287	N/A	52.18	8490	1834	4.6
60	10162	N/A	34.7	1800	1219	1.5
160	9646	N/A	32.91	2360	1061	2.22
60	460	N/A	1.6	286	64	4.5
49	7374	N/A	25.17	1610	737	2.18
77	7359	N/A	25.1	1762	883	2
45	1850	N/A	6.3	1640	241	6.81

Herd Size	Electrical Savings (kWh)	Propane Savings ($)	Energy Savings (MMBTU)	Installed Cost ($)	Energy Cost Savings ($)	Payback (yrs)
155	1993	N/A	6.8	1076	239	4.5
40	2920	N/A	10	1200	263	4.56
84	2805	N/A	9.6	518	337	1.54
240	8760	N/A	29.89	2596	963	2.7
120	1780	N/A	6.1	1510	233	6.1
500	32979	N/A	112.5	7005	3628	1.93
72	11520	N/A	39.3	2060	1383	1.49
140	34569	N/A	117.98	4753	3803	1.25
75	1602	N/A	5.5	263	176	1.49
80	6484	N/A	22.1	812	713	1.1
60	6577	N/A	22.4	2420	658	3.7
40	5000	N/A	39.3	1085	601	0.55
50	1820	N/A		201	200	0.88
55	10560	N/A	36	703	1374	0.5
45	800	N/A	2.7	349	88	4
73	1490	N/A	5.1	515	164	3.1
40	3303	N/A	11.3	342	342	1
300	3359	N/A	11.4	2304	356	6.5
80	4589	N/A	16	4162	603	6.9
70	1393	N/A	5	95	165	0.6
175	6049	N/A	21	1307	655	2
AVG: 105	**7080.7**	**0**	**25.6**	**1978.9**	**802.3**	**3.3**
MDN: 72	**4589**	**0**	**18.5**	**1510**	**601**	**2.2**

Variable Speed Drive – Receiver Jar Milk Pump

Ten farms received recommendations to install a variable speed drive on their milk receiver jar milk pump. With a mean herd size of 89 and median herd size of 71, installing a VSD on the receiver jar milk pump presented a mean simple payback of 6.6 years and median payback of 6.8 years. Project costs ranged from $3,400 to $3,600.

Table 2: Variable Speed Drive - Receiver Jar Milk Pump Recommendations

Herd Size	Electrical Savings (kWh)	Propane Savings ($)	Energy Savings (MMBTU)	Installed Cost ($)	Energy Cost Savings ($)	Payback (yrs)
40	7516	N/A	25.65	2000	902	2.2
60	3472	N/A	11.8	3600	417	8.6
160	6296	N/A	21.48	3600	693	5.2
155	5890	N/A	20.1	3600	707	5.09
84	3172	N/A	10.8	3200	381	8.41
72	4888	N/A	16.7	3600	587	6.14
140	8878	N/A	30.3	3600	977	3.69
69	4843	N/A	16.5	3600	484	7.4
50	2912	N/A		3600	309	11.2
55	3244	N/A	11.1	3600	422	8.5
AVG: 88.5	5111.1	N/A	18.3	3400	587.9	6.6
MDN: 70.5	4865.5	N/A	16.7	3600	535.5	6.8

Water Heater Recommendations

Energy auditors recommended high efficiency water heaters to 19 dairy farms. This technology had an average simple payback of 6.2 years and median simple payback of 5.6 years, making water heater upgrades a reasonable investment. This recommendation pairs well with current conservation improvement programming – every electric utility in this project footprint offers high efficiency water heater rebates, including off-peak water storage programming as a load control measure.

Table 3: Water Heater Recommendations

Herd Size	Electrical Savings (kWh)	Propane Savings ($)	Energy Savings (MMBTU)	Installed Cost ($)	Energy Cost Savings ($)	Payback (yrs)
40	0	420.1	43.27	3500	412	8.5
60	0	274.4	25.1	2000	357	5.6
160	16756	-664.9	-3.67	2000	979	2.04
60	0	240.1	22	3000	312	6.41
49	17794	-506.2	14.36	3000	514	5.84
155	13447	-530	-2.65	2000	289	6.93
84	17737	-525.2	46.9	2000	834	2.4
120	6376	-332	21.8	2000	299	6.69
500	0	466.1	42.6	2000	606	3.3
72	0	260.3	23.8	2000	338	5.91
75	0	100.2	9.2	2000	130	15.36
80	16632	-620.4	-0.02	2000	1023	2
40	0	274.4	23.81	2000	357	5.61
50	13007	-431.2	4.93	2000	870	2.3
55	0	585.4	53.6	2500	761	3.3
45	9423	-355.4	-0.4	2000	699	4.5
73	0	86.1	7.9	2000	112	17.9
40	7208	37	1.89	3200	535	6.5
50	21337	N/A (nat gas)	25	10000	1874	5.3
AVG: 95.2	7486.3	939.2	17.8	2603.3	589.3	6.2
MDN: 60.0	4286.0	66.5	18.1	2000.0	514.0	5.6

Scroll-type Refrigeration Compressors

Auditors suggested scroll-type refrigeration compressors to eleven participant farms. This recommendation has a long payback period and cooperative member dairies indicated they would act on this recommendation during a significant event, such as an expansion, transfer of ownership, or transition to a new generation. At a minimum, this recommendation points to scroll-type refrigeration compressors as the best technology if working with or targeting dairies that are in an upgrading phase.

Table 4: Scroll-type Refrigeration Compressors

Herd Size	Electrical Savings (kWh)	Propane Savings ($)	Energy Savings (MMBTU)	Installed Cost ($)	Energy Cost Savings ($)	Payback (yrs)
60	406	0	1.4	3200	41	78.8
160	944	0	3.22	6000	104	57.75
60	3048	0	10.4	3200	427	7.5
49	2195	0	7.49	$1,200	219	5.47
45	1644	0	5.6	3200	214	14.98
155	2827	0	9.65	2000	339	5.89
120	4603	0	15.7	3200	575	5.56
75	3168	0	10.8	3200	348	9.18
80	3632	0	12.4	6000	400	15
60	905	0	3.1	3200	91	35.4
45	806	0	2.8	3200	89	36.1
AVG: 82.6	2198.0	0.0	7.5	3418.2	258.8	24.7
MDN: 60	2195	0	7.5	3200	219	15

Variable Speed Drive – Vacuum Pump Recommendations

Energy auditors recommended variable speed drives for vacuum pumps for 18 cooperative member dairies. The average and median simple paybacks were 14.2 and 9.2 years, respectively. Energy savings paybacks were dependent on a combination of existing technology efficiency, pump runtime, and installed cost; vacuum pump recommendations did not correlate to herd size directly. For example, a 40-cow dairy had a reasonable energy cost savings payback of 6.63 years, whereas a 140-cow dairy had an energy cost savings payback of 6.73 years. This variability suggests that utility rebates based on a per hp reduction (i.e. $30 rebate/hp) is a good program design model. This type of rebate design allows rebates to be adjustable to each individual farms.

Table 5: Variable Speed Drive - Vacuum Pump Recommendations

Herd Size	Electrical Savings (kWh)	Propane Savings ($)	Energy Savings (MMBTU)	Installed Cost ($)	Energy Cost Savings ($)	Payback (yrs)
60	1817	0	6.2	10000	182	55
40	7309	0	24.95	7000	877	7.98
60	8532	0	29.1	10000	1024	9.8
155	8702	0	29.7	10000	1044	9.58
120	17745	0	60.6	10000	2220	4.51
72	6716	0	22.9	4000	806	4.96
140	9453	0	32.26	7000	1040	6.73
80	6219	0	21.2	9000	684	13.2
60	3705	0	12.6	10000	370	26.7
40	4797	0	22.92	3500	528	6.63
45	2165	0	7.4	10000	238	41.99
73	5915	0	20.2	9000	651	13.8
40	6043	0	20.6	6800	626	10.8
300	3066	0	105	11000	3256	3.4
80	4521	0		5300	594	8.9
70	6851	0	23	6150	813	7.6
175	2384	0	130	22910	2779	8.2
150	3476	0	12	6150	385	16

Herd Size	Electrical Savings (kWh)	Propane Savings ($)	Energy Savings (MMBTU)	Installed Cost ($)	Energy Cost Savings ($)	Payback (yrs)
AVG: 97.8	6078.7	0.0	34.2	8767.2	1006.5	14.2
MDN: 72.5	5979.0	0.0	22.9	9000.0	745.0	9.2

Refrigeration Heat Recovery

Energy auditors recommended RHR units to 11 producers. With an average and median simple paybacks of 7.8 and 8.5 years, respectively, this recommendation had a modest payback. However, in conversations with participating farmers, often the barrier was limited space available in the milk parlor to house the RHR unit.

Table 6: Refrigeration Heat Recovery Recommendations

Herd Size	Electrical Savings (kWh)	Propane Savings ($)	Energy Savings (MMBTU)	Installed Cost ($)	Energy Cost Savings ($)	Payback (yrs)
60	5049		17.2	3100	505	6.14
40	0	277.8	28.63	2800	272	10.28
60	0	248.5	22.7	3500	323	10.83
49	0	137.7	12.61	2500	344	7.26
77	2924	0	10	3200	351	9.1
45	0	309.3	28.3	3100	773	4.01
40	0	209.1	20.9	3100	366	8.47
84	7537		25.7	3100	904	3.43
140	0	221.9	20.3	3100	344	9.01
80	16632	620.4	-0.02	2000	1023	2
60	0	134.7	12.3	3100	209	14.9
AVG: 66.8	3571.3	102.1	18.1	2963.6	492.2	7.8
MDN: 60.0	0.0	209.1	20.3	3100.0	351.0	8.5

Ventilation

Energy auditors recommended fan upgrades for only four dairy operations, a very small sample size. With a simple payback range of 2.2 to 11.3 years, it is difficult to draw any generalizations from ventilation upgrade recommendations.

Table 7: Ventilation Upgrade Recommendations

Herd Size	Electrical Savings (kWh)	Propane Savings ($)	Energy Savings (MMBTU)	Installed Cost ($)	Energy Cost Savings ($)	Payback (yrs)
75	7739	0	26.4	3000	851	3.52
50	2812	0		3500	320	11.3
40	1857	0	6.3	415	192	2.2
80	949	0	3	1100	125	8.8
AVG: 61.3	3339.3	0.0	11.9	2003.8	372.0	6.5
MDN: 62.5	2334.5	0.0	6.3	2050.0	256.0	6.2

Plate Cooler Recommendations

Energy auditors recommended plate cooler additions to four of thirty farms. This low number is because most farms had already implemented plate coolers into their operations. The baseline survey found few farms without plate coolers to begin with. Regardless, plate coolers for these farms had modest paybacks with an average 9.5 and median 8.8 years.

Table 8: Milk Plate Cooler Recommendations

Herd Size	Electrical Savings (kWh)	Propane Savings ($)	Energy Savings (MMBTU)	Installed Cost ($)	Energy Cost Savings ($)	Payback (yrs)
60	3230	0	11	3500	323	10.8
120	4761	0	16.3	3500	595	5.88
140	4629	0	15.8	3500	509	6.87
45	1949	0	6.6	3100	214	14.5
AVG: 91.3	3642.3		12.4	3400.0	410.3	9.5
MDN: 90.0	3929.5		13.4	3500.0	416.0	8.8

Farmer Acceptance of the Program

On the whole, HCCC and participating member dairies were supportive of the project. Many commented positively on the depth and detail of the audit reports and appreciated the effort. At the time of this writing six operations had either implemented one or more audit recommendations or had applied to the Minnesota Livestock Investment Grant Program, USDA-NRCS Environmental Quality Incentives Program, or sought out local utility rebate funding. In conversations, several cooperative member dairies commented that some of the suggested upgrades with longer paybacks (scroll-type refrigeration compressors, refrigeration heat recovery units, and ventilation) are usually done when a farm changed hands or when the equipment fails, and not merely at the suggestion of an energy audit. Others commented that they understood the energy savings, but feared how new equipment might impact operations if the newer equipment had some unforeseen consequence, not necessarily energy related.

Overall, many cooperative member dairies indicated that upfront cost was the biggest barrier to implementing the recommendations since they often involved spending more than $1,000 in installation costs and new equipment. The project team learned that some utility staff and farmers were not aware of different funding opportunities through the USDA and MN Dept. of Agriculture. Additionally, participating farms showed hesitancy at filling out grant paperwork and had concerns about the complexity of the USDA programs. One suggested the grant making processes were tilted in favor of the well-connected.

Conclusion

Using the milk cooperative strategy to gather farm energy data and identify energy efficiency opportunities is effective. Collaborating and communicating openly with agricultural cooperative field staff about data collection and how the data will serve jointly the milk cooperative and electric utility is critical. The value of the milk cooperative strategy relies on the relationships field staff have with farmer members. Those relationships must be valued by fully explaining why data is being collected, where the data is going, and how it will be used to help the individual member dairy. Respecting farmers' time by crafting a brief, pointed survey and not making them go out of their way by deploying the survey via field staff and milk haulers (or whoever regularly visits the operation) should yield valuable data as it did with this project.

In terms of energy efficiency implementation, the milk cooperative strategy has barriers that may be overcome by limiting project scope to a specific electric utility territory. Setting aside resources for milk cooperative field staff or leadership to discuss energy efficiency through newsletters or at milk cooperative meetings would likely improve equipment implementation. To the extent electric utility staff or installing electricians can help milk producers address the upfront costs through conservation improvement program rebates or facilitating USDA program funding, electric utilities should see an increase in conservation improvement programming activity.

Appendix A: Energy Efficient Dairy Survey

Copy of the survey instrument used to gather data about dairy farm equipment.

Energy Efficient Dairies

Name: ______________________________________

City/State: ___________________________________

Phone: ______________________________________

Email: _______________________________________

Would you be interested in a farm energy assessment at no cost to you? *(See back for more)* Y / N

Herd Size: No. Milking Cows: __________________

No. Other Cows: ____________________

Avg. monthly electric bill: $______________________

Avg. monthly gas/propane bill: $_________________

Bills include house, or just farm? _________________

Milk vacuum pump runtime: ____________hrs/day

In the last 10 years have you installed any of the following?


Variable Speed Drive

1. Variable Speed Drive on Vacuum Pump? Y / N
2. Variable Speed Drive on Milk Pump? Y / N
3. Plate Cooler/Pre-Cooler? Y / N


Plate Cooler


Scroll Compressor

4. Scroll-type Refrigeration Compressors? Y / N
5. Refrigeration Heat Recovery? Y / N


Refrigeration Heat Recovery


Waterers

6. Low/No Energy Waterers? Y / N
7. Tractor Block Heater Timer? Y / N


Block Heater Timer


High Efficiency Lights

8. High Efficiency Lights? Y / N

If so, what kind? (T-8, T-5, LED, etc.) ___________________________________

Do you use space heaters to supplement winter heating in the milk house? Y / N

What type of milk line water heating do you have? Electric LP/Natural Gas

How old is/are your water heaters? 1-5 yrs 5-10 yrs 10-20 yrs >20 yrs

the MINNESOTA PROJECT

About the survey

The purpose of this survey is to:

1. Establish a baseline for the types of equipment currently being used by patrons of Hastings Cooperative Creamery Company

2. Determine which dairy farms will be contacted to receive one of 30 farm energy assessments The Minnesota Project will be providing as part of its Dairy Cooperative Partnerships for Increased Energy Efficiency program

Your personal information will not be shared with anyone other than The Minnesota Project and Hastings Cooperative Creamery Company. Survey data will only be shared in aggregate form without distinguishing personal information.

The Minnesota Project has received support from the Division of Energy Resources' Conservation Applied Research and Development (CARD) program to test an innovative approach to helping dairy farmers utilize and access energy savings measures through a partnership with Hastings Cooperative Creamery Company.

Over the course of 2013, we will deliver 30 agricultural energy assessments to patrons of Hastings Cooperative Creamery Company to provide you with a detailed report of the energy use of your dairy equipment, recommendations for upgrades, information about payback times and available funding resources, as well as connect you with utility staff and equipment suppliers for rebate programs.

These energy assessments (also called "energy audits") are covered by the CARD grant and come at no cost to you, the farmer, or to Hastings Cooperative Creamery Company. Please indicate your interest on the front of the survey.

What to expect with a farm energy assessment

A professional energy auditor will contact you to arrange a farm visit. On the day of the visit, he/she will examine and photograph your equipment, write down information on specific items, and ask about your utility bills, farming practices and equipment use (how often, how long per day, etc). The process usually takes a few hours.

Afterward, they will write up a detailed report of your farm's energy usage, as well as energy saving technologies and techniques specifically suited for your farm. They'll tell you about current rebates and tax incentives for installing energy saving devices and can help isolate where your biggest savings will be, so you don't have to do everything at once. The report will be yours to keep and use as you wish. A copy will be shared with The Minnesota Project, Hastings Cooperative Creamery Company and your electric utility so that they can offer rebate programs tailored to your farm.

The Minnesota Project is a 501(c)(3) nonprofit that champions programs for the sustainable production and equitable distribution of energy and food in communities across Minnesota. These programs are focused on the development, conservation and efficient use of renewable energy; farm practice and policy that promote profitable farms that protect and replenish the environment; and the production and consumption of local, sustainably grown foods.

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