Energy Audit Report for the

Center for Environmental Farming Systems

at

Cherry Research Farm, Goldsboro, NC

North Carolina Department of Agriculture and Consumer Services

March 2007

Study conducted by the

National Center for Appropriate Technology

and the

Center for Environmental Farming Systems

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Table of Contents

Executive Summary

This report presents findings from an energy audit conducted by the National Center for Appropriate Technology (NCAT) at Cherry Research Farm, home of the Center for Environmental Farming Systems (CEFS). This study took place in the fall and winter of 2006-7.

Major energy-consuming facilities at the farm include a dairy, grain storage and drying system, farm shops, greenhouses, offices, and a wide variety of farm machinery and vehicles. The largest “direct” energy expenses are for transportation fuel (59 percent of energy costs) and electricity (33 percent), with smaller expenses for propane and natural gas. When nitrogen fertilizer (made from natural gas) is viewed as an “indirect” energy expenditure, it accounts for 22 percent of the farm’s energy costs and 30 percent of the farm’s energy consumption.

At the time of the study, the farm was already pursuing an innovative plan for reducing its transportation fuel costs by building a biodiesel manufacturing plant. This audit focused mainly on electricity and propane. We did not identify any conservation opportunities for natural gas, which is used in the grain dryer, a service building, and a mechanic’s shop.

NCAT looked at 21 energy conservation opportunities (ECOs) in detail, and did a basic evaluation of several others. These included heat recovery, lighting and insulation improvements, innovative greenhouse heating methods, solar water-heating, and burning waste oil for heat. Recommendations also included such simple measures as changing the settings on thermostats. If the recommendations in this report were implemented, the farm would save over $6,000 per year (at current energy prices), a 22 percent reduction in electricity and propane usage and costs.

NCAT identified the greatest energy saving opportunities at the dairy, where large amounts of electricity and propane are used to cool milk, heat wash water, and move fluids. The dairy was found to be using 43 percent of all electricity and 51 percent of all propane on the farm. NCAT’s study showed that energy consumption at the dairy could be greatly reduced by using cold tap or groundwater to partially cool warm milk, and by using heat reclaimed from the milk to partially warm wash water.

The study also included a survey of renewable energy demonstrations that could be done at the farm. Geothermal heating and cooling, wind energy, and microhydro power were not recommended for the site, but all of the following were recommended for further investigation: anaerobic digestion, biodiesel (including oilseed crops and oilseed crushing), solar crop drying, various uses of solar electricity, and solar water heating.

Summary: Energy Conservation Opportunities

- *Program and use setback thermostats. (Service Building) (ECO #9)*
  Cost $0, annual energy savings $156, simple payback immediate.

- *Replace insulation that has been moved over time. (Service Building) (ECO #10)*
  Cost near $0, annual energy savings $6, simple payback immediate.

- *Pursue with Progress Energy a change in rate schedules. (Hammer Mill) (ECO #15)*
  Cost $0, annual energy savings $1,061, simple payback immediate.

- *Increase office thermostat setback/set up by 4 degrees. (Office) (ECO #20)*
  Cost $0, annual energy savings $35, simple payback immediate.

- *Insulate water heater. (Dairy) (ECO #3)*
  Cost $20, annual energy savings $44.55, simple payback 0.4 year.

- *Install hand-operated timer control on radiant electric heaters. (Dairy) (ECO #4)*
  Cost $100, annual energy savings $178.42, simple payback 0.6 year.

- *Install photocell control on exterior fixture. (Metal Shop) (ECO #14)*
  Cost $25, annual energy savings $36.90, simple payback 0.7 year.

- *Move photocells for lights. (Shed) (ECO #13)*
  Cost $75, annual energy savings $89.32, simple payback 0.8 year.

- *Install a programmable thermostat. (Shop) (ECO #5)*
  Cost $150, annual energy savings $138, simple payback 1.1 year.

- *Install a waste oil burning unit heater. (Shop) (ECO #6)*
  Cost $5,000, annual energy savings $2,160, simple payback 2.3 years.

- *Use heat exchanger to pre-cool milk and pre-heat water for cleaning. (Dairy) (ECO #1)*
  Cost $2,000, annual energy savings $722.47, simple payback 2.8 Years.

- *Replace radiant electric heaters with propane fired heaters. (Dairy) (ECO #4a)*
  Cost $2,000, annual savings $567.72, simple payback 3.5 years.

- *Install polycarbonate doors on south side, so sunlight warms shop. (Shop) (ECO #7)*
  Cost $2,000, annual energy savings $464, simple payback 4.3 years.

- *Install a door between office and porch. (Office) (ECO #19)*
  Cost $150, annual energy savings and simple payback cannot be determined.

- *Replace water heater with instant (point-of-use) water heater. (Office) (ECO #18)*
  Cost $500, annual energy savings $82.80, simple payback 6.0 years.

- *Install water cooled condensing for refrigeration system. (Dairy) (ECO #2)*
  Cost $3,000, annual energy savings $388.22, simple payback 7.7 years.

- *Replace T-12 lighting with T-8 lighting. (Service Building) (ECO #11)*
  Cost $2,550, annual energy savings $303.59, simple payback 8.4 years.

- *Retrofit fluorescent lighting fixtures. (Shop) (ECO #8)*
  Cost $400, annual energy savings $28.23, simple payback 14.2 years.

- *Replace lighting with T-8 fluorescent. (Office) (ECO #21)*
  Cost $450, annual energy savings $28.08, simple payback 16.0 years.

- *Move heater outside, use boiler and piping to heat beds. (Small Farm Unit Greenhouse)*
  Cost $7,600, annual energy savings $198.36, simple payback 30.6 years. (ECO #16)

- *Use solar power to pump water out of a small river for bioremediation, storage for irrigation, and aquaculture. (Small Farm Unit) (ECO #17)*
  Cost $5,000, annual energy savings $72.00, simple payback 69.4 years.

- *Increase attic insulation levels, installing another R-11. (Service Building) (ECO #12)*
  Cost $513, annual energy savings $2.56, simple payback 200 years.

- *Use solar water-heater to pre-heat wash water. (Dairy)*
  Heat recovery is a far more cost-effective option

- *Install a corn-burning stove. (Mechanic Equipment Repair Shop)*
  Some environmental issues to consider. Proceed cautiously.

- *Change lighting fixtures. (Sheds)*
  Not enough savings to be worthwhile, unless replacing failed lamps and ballasts.

- *Change controls so hammer mill and feed system can run independently. (Hammer Mill)*
  Custom-designed system, not easily adjusted.

- *Passive solar greenhouse (Small Farm Unit)*
  Expensive per square foot in comparison with hoop houses.

- *Rebuild irrigation pumps and motors or redesign system. (Small Farm Unit)*
  Retrofit cost probably not justified for this small system, which is not heavily used.

Section 1
Introduction and Site Description

This energy audit for the Center for Environmental Farming Systems (CEFS) was conducted at Cherry Research Farm by the National Center for Appropriate Technology (NCAT), between November 2006 and March 2007.

One main purpose of the audit was to facilitate excellent energy management at Cherry Research Farm, including both energy efficiency improvements and opportunities for incorporating renewable energy into the farm's operations. To the best of our knowledge, no systematic energy audit or study had previously been done at Cherry Farm. The farm wanted to reduce its energy costs and had recently been required by the North Carolina Department of Agriculture to achieve substantial energy savings.

Another purpose of the audit was educational. CEFS wanted to model good energy management practices, increasing its capacity to provide energy-related demonstrations, programs, and information to area farmers. With technical assistance from NCAT, CEFS is designing energy-efficiency and energy-generation demonstrations suited to the farm's climate and site.

Piedmont Biofuels, of Pittsboro, North Carolina, provided helpful technical assistance during this study: visiting Cherry Research Farm and advising the farm on its proposed biodiesel processing plant. CEFS, NCAT, Piedmont Biofuels, and other partners are planning an energy risk management workshop for area farmers that will take place in July 2007.

Energy-related risks are a significant concern for North Carolina farmers. A high percentage of farms in the state are dairies and small farms, and both of these groups face special energy-related risks. More than almost any other agricultural operation, dairies rely on energy: for milking (vacuum pumps), cooling and storing milk, heating wash water, and lighting. Small farms often operate with slim profit margins and meager cash reserves, reducing their ability to absorb energy-related cost increases or supply disruptions.

Funding for this study came from the USDA Risk Management Agency (RMA), through a Cooperative Partnership Agreement with NCAT, as part of a project called "Managing Farm Energy Risk." RMA was an actively involved partner in all phases of this project. NCAT and CEFS would like to thank RMA for the agency's support and involvement in this project.

About the Center for Environmental Farming Systems and Cherry Research Farm

Located just outside Goldsboro, North Carolina, the 2,200 acre Cherry Research Farm is one of the largest of North Carolina's 18 agricultural research stations, and is owned and operated by the North Carolina Department of Agriculture & Consumer Services (NCDA). At the time of this study, twenty-three NCDA employees were managing the farm, which was originally a State Farm and a source of food and therapeutic labor for adjacent Cherry Hospital, a mental hospital. Besides Cherry Hospital, state-owned facilities nearby include three prisons and a hospital.

Cherry Farm is the home of the Center for Environmental Farming Systems (CEFS), established in 1994 as one of the nation's largest centers for the study of environmentally sustainable farming practices. Research at the farm includes studies by three organizations: the North Carolina Department of Agriculture & Consumer Services, North Carolina State University, and North Carolina A&T State University. CEFS holds frequent workshops, field days, and other events to share research results with area farmers and to increase public understanding of agriculture and its relationship with the environment. The Center prides itself on being highly accessible to the faculty, students, extension workers, farmers, and citizens it serves.

The farm has six functional units:

- a 170-cow Pasture-based Dairy Unit
- a 100-cow and 175 acre Pasture-based Beef Unit
- a 30 acre Small Farm Unit, conducting research relevant to small farming operations
- a 200+ acre Farming Systems Unit, conducting long-term research on five farming systems
- a 100+ acre Organic Research Unit
- an Alternative Swine Unit, with a planned capacity of 1,000 swine

Besides these six units, the farm contains 1,400 additional acres where corn and other field crops are grown. During summer months there is some irrigation, with water pumped from the river and delivered by overhead sprinklers or drip irrigation systems.

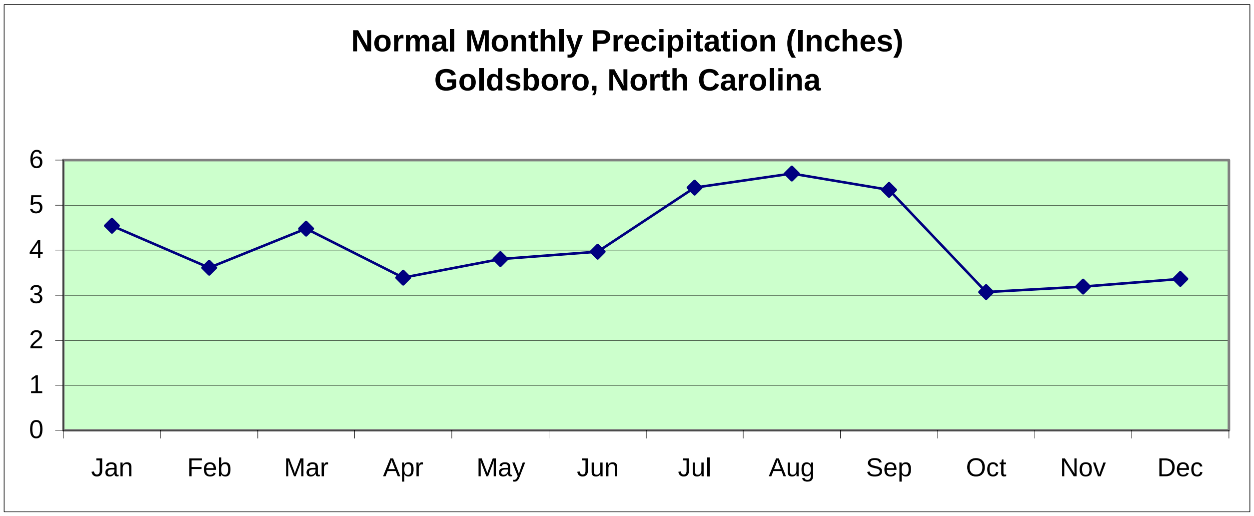
Location and Climate

Cherry Research Farm is located in Wayne County, in the Central Coastal Plain region of Eastern North Carolina, at latitude 35.3° and longitude –78.0°. Average annual precipitation for the past 30 years has been 50.0 inches. Normal monthly high temperatures ranging from 54°F in January to 91°F in July. Normal monthly lows range from 33°F in January to 71°F in July.

The Neuse River flows along one boundary of the farm, and a small tributary – the Little River – enters the Neuse just south of the farm. Elevation is approximately 79 feet above sea level, and the topography is generally flat.

In recent years, the farm has had limited success at digging wells, and has relied on municipal water from the city of Goldsboro for many of its operations. The farm used 6,700,000 gallons of water in FY 2005-6, and paid three quarters as much for water as it paid for electricity, at a cost of $0.0026 per gallon. The farm managers recognize the extreme importance of conserving water and reducing the farm's reliance on municipal water. In the winter of 2007, the farm dug a successful well generating around 25 gallons per minute at 50 feet of depth, and was making plans to dig additional wells.

The State Climate Office of North Carolina maintains a weather station at Cherry Research Farm, measuring and recording air temperature, barometric pressure, wind speed and direction, relative humidity, evapotranspiration, soil temperature and moisture levels, and solar radiation. Real-time and historical data are at www.nc-climate.ncsu.edu/cronos/index.php?station=GOLD.


Normal Monthly Precipitation (Inches)
Goldsboro, North Carolina
0
1
2
3
4
5
6
Jan
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Mar
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May
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Aug
Sep
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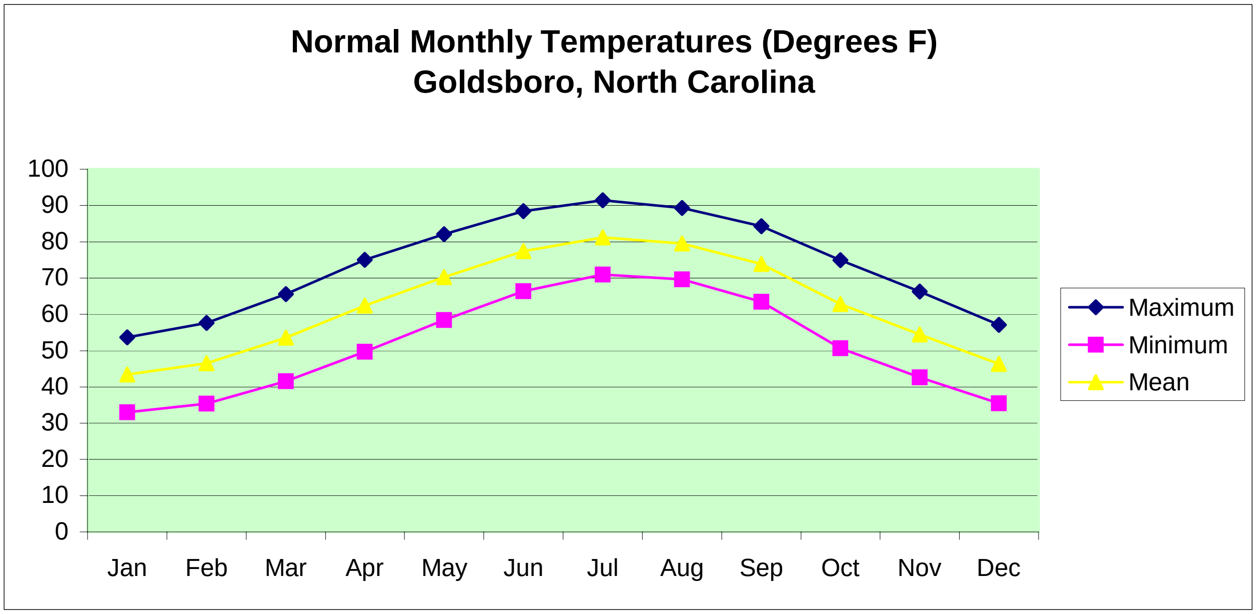
Normal Monthly Temperatures (Degrees F)
Goldsboro, North Carolina
0
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20
30
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70
80
90
100
Jan
Feb
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Maximum
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Section 2
Energy Use

Equipment and research projects at Cherry Research Farm are constantly changing. At the time of this study, major energy-consuming facilities included:

- a 16-cow dairy parlor
- grain bins, grain milling and mixing equipment, and a grain dryer
- two farm shops
- a swine facility
- irrigation systems
- greenhouses
- a number of offices, storage buildings, and trailers
- trucks, tractors, and a wide variety of other vehicles and farm equipment

Energy Analysis Procedure

NCAT made an initial visit to Cherry Research Farm on November 17, 2006. During a second visit on January 26, 2007, one of NCAT's energy engineers spent about six hours taking photos and recording observations with a hand-held voice recorder. The farm's managers also provided utility bills and energy expense records, which were complete and well-organized.

NCAT and CEFS subsequently held hour-long phone meetings about once per week from February through March 2007. During these calls, NCAT staff asked many follow-up questions and brainstormed project ideas. Most of the analysis was done by engineering staff in NCAT's office in Butte, Montana.

For the most part, the energy analysis focused on identifying "low-hanging fruit," significant energy-saving opportunities with a quick payback. There were three main steps in this process:
(1) Discovering where energy dollars were being spent on the farm, mainly by reviewing energy bills and energy expense records.
(2) Describing energy conservation opportunities.
(3) Estimating costs and simple payback for each energy conservation opportunity identified.

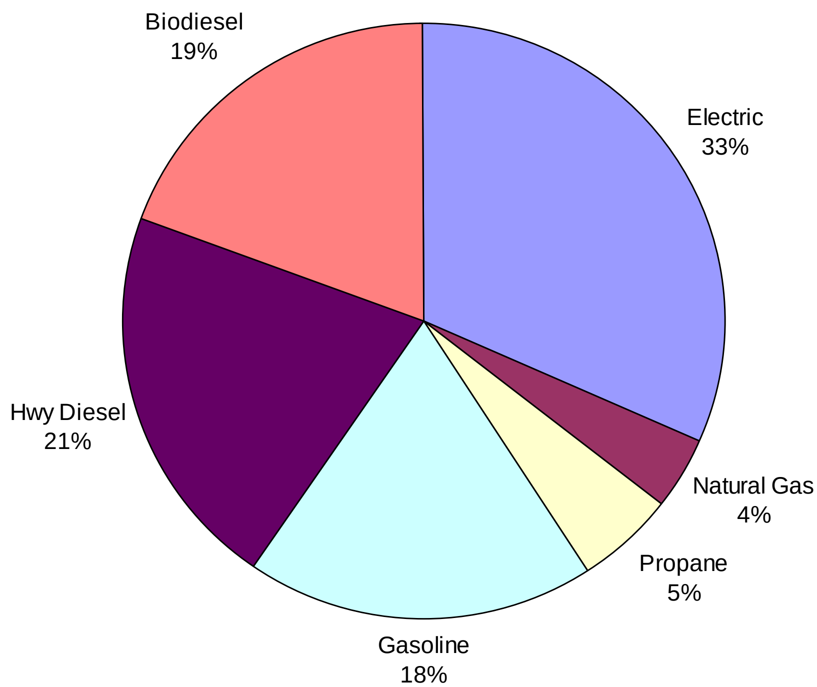
The concept of simple payback is useful for ranking and prioritizing options, but leaves out many important considerations. NCAT did not do an exhaustive analysis for any of the measures described in this report. A lifecycle cost analysis would include equipment wear and longevity, maintenance costs, and other considerations. A more complicated economic analysis might look at net present value of future energy savings, or at the internal rate of return on investments.

In this report, opportunities with shortest simple payback (generally less than five years) are shaded green, those with a longer payback (generally 5 to 15 years) are shaded yellow, and those with the longest payback (generally over 15 years) are shaded orange. In a few cases, yellow shading simply means "long or uncertain payback" and orange shading simply means "very long payback," even though we did not calculate a simple payback.

Overall Energy Usage and Cost

During fiscal year (FY) 2004-5, the last year for which complete records were available, 59 percent of the "direct" energy expenditures at Cherry Farm went to transportation fuels: diesel fuel, gasoline, and biodiesel. 33 percent was spent on electricity. The balance was spent on propane and natural gas. (Fiscal years at Cherry Farm run from July through June.)

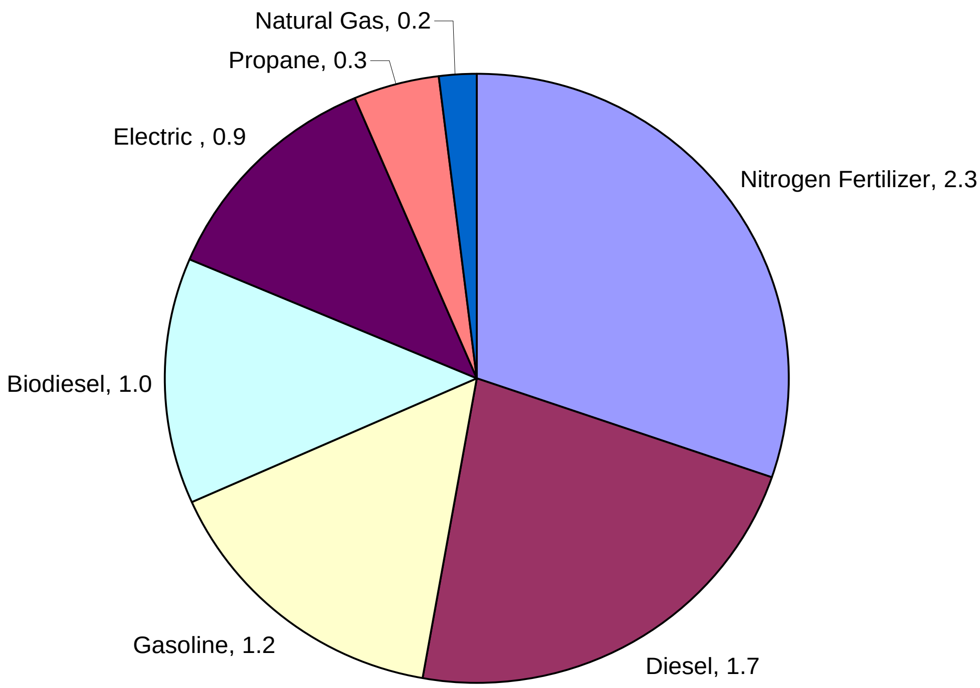
FY 04-05 Direct Energy Costs



There are many ways of looking at energy consumption. The chart above includes only "direct" energy consumed at the farm. The use of fertilizer can be viewed as an "indirect" energy expenditure, since fertilizer manufacturing requires large quantities of energy. The liquid fertilizer used at Cherry Farm is 30 percent nitrogen by weight, and is made from natural gas and other chemicals through an energy-intensive process requiring temperatures as high as 1500°F.

For comparison purposes, different forms of energy are commonly converted into *British Thermal Units (Btu)*. A Btu is defined as the amount of thermal (heat) energy needed to raise the temperature of one pound of water by one degree Fahrenheit. (It may also be visualized as about the same amount of energy released by burning an ordinary wooden match.) About 120 tons of liquid nitrogen are applied annually at Cherry Farm. By a conservative estimate, the manufacturing of this fertilizer requires 2.3 billion Btus: about 30 percent of all Btus consumed by the farm each year and 22 percent of the farm's energy expenditures. CEFS is researching a number of ways of reducing fertilizer inputs, including reducing tillage, using green and animal manures, and organic farming. The following chart includes nitrogen fertilizer and shows direct and indirect energy consumption at Cherry Farm, measured in billions of Btus.

FY05-06 Direct and Indirect Energy Consumption (billions of Btus)



A more comprehensive study (not attempted here) could look at "primary" energy contained in the raw fuels used to produce and deliver electricity and fuel to the farm. For example, making and delivering one Btu of electric power takes two to five Btu of coal, oil, natural gas, or some other fuel. Coal and oil-fired electric power plants are around 35 percent efficient, natural gas plants are 20 to 55 percent efficient, and line losses in North Carolina may be around ten percent.

<u>Gasoline and Diesel Fuel Usage</u>

In FY 2004-5, the last year for which complete records are available, vehicle fuel was the number one direct energy cost at Cherry Farm, totaling 31,499 gallons. This included 10,320 gallons of gasoline, 12,931 gallons of diesel for highway use, and 8,248 gallons of biodiesel. Approximate energy equivalents for these fuels per gallon are 115,000 Btu (gasoline), 130,000 Btu (diesel), and 119,000 Btu (biodiesel).

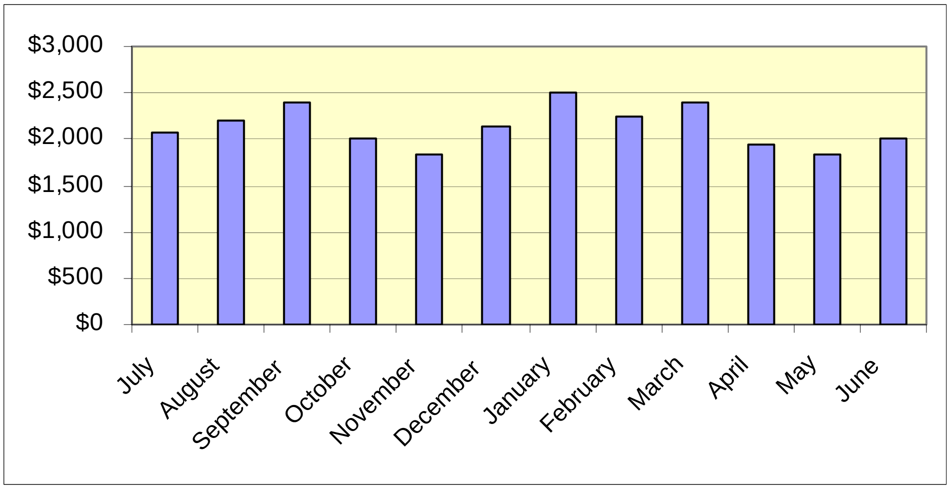
Biodiesel is a vegetable oil-based fuel that can be used in unmodified diesel engines, and is produced by mixing vegetable oil with an alcohol (usually methanol) to which a catalyst has been added (usually either sodium hydroxide or potassium hydroxide). At the time of this study, Cherry Farm was in its third year of purchasing biodiesel from a local retailer. The farm has been purchasing biodiesel mixed at a 20 percent blend (B20) with ordinary diesel fuel.

At the time of this study, the farm was beginning to build its own biodiesel processing plant. When completed, this plant will make biodiesel from waste cooking oil, including used fryer oil from the North Carolina State Fair and possibly from nearby prisons and hospitals. The farm intends to produce biodiesel during the winter months, in approximately 350-gallon batches. CEFS hopes to research a wide variety questions related to biofuels, including agronomic studies of oilseed crops and economic studies of farm-scale biodiesel production.

Electricity Usage and Costs

Electricity was found to be the number two direct energy cost at Cherry Farm.

FY 05-06 Electricity Costs



A *kilowatt-hour* of electric energy is equivalent to 3,417 Btus of thermal energy and may be visualized as ten 100-Watt lightbulbs burning for one hour.

Cherry Research Farm has ten electric service accounts with Progress Energy. Eight of these are classified as "Small General Service" and billed according to schedule SGS-8. Two accounts, for the dairy and the grain bins, are classified as "Medium General Service" and are billed under schedule MGS-8. These two rates work very differently. The SGS-8 and MGS-8 rate schedules (as of March 2007) are included as an appendix to this report, and are described briefly below.

Small General Service (SGS-8) customers pay for each kilowatt-hour used, according to a "declining block" rate structure: 10.042¢ per kWh for the first 750 kWh, 8.324¢ for the next 1,250 kWh, and 7.857¢ for all additional kWh. For example, a customer using 1,000 kWh would pay $75.32 (750 × $0.10042) + $20.81 (250 × $0.08324) + $12.00 (Customer Charge) + $3.25 (sales tax) = $111.38.

Medium General Service (MGS-8) customer enjoy a lower rate (6.195¢) for each kilowatt-hour used, but they also pay a *Demand Charge* of $4.89 per kilowatt of demand. For example, a customer using 1,000 kWh, whose demand was 40 kW, would pay $61.95 (1,000 × $0.06195) + $195.60 (40 × $4.89) + $12.00 (Customer Charge) + $8.08 (sales tax) = $269.55. Demand charges are explained below.

Electric demand is the rate at which electric energy is delivered, generally measured in kilowatts. *Demand charges* allow utilities to recover the costs of maintaining the capacity to service their customers, and follow the general principle that customers with large power requirements should pay for the costs they impose on the system. There is a real cost to the utility (in poles, wires, etc.) in creating and maintaining the capacity to serve large customers, and demand charges impose these costs on the customers who need this extra capacity.

In order to measure the demand-related costs that large customers are imposing on the system, utilities install *demand meters*. A demand meter essentially records the maximum power drawn (demand) in any 15 minute interval during the billing period in kilowatts. This meter is reset to zero at the end of the billing period.

In March 2007, Progress Energy's MGS-8 customers are paying a minimum Billing Demand charge of $147.60 per month (based on 30 kilowatts @ $4.89 per kW), and this demand charge can be higher under a variety of circumstances (listed below). All MGS-8 customers pay at least for the full demand recorded by their demand meters – say, $171.15 (35 kW × $4.89 per kW) if the demand meter reading is 35 kW. The demand charge can be even higher if there was a spike in demand recorded any time during the previous 11 months.

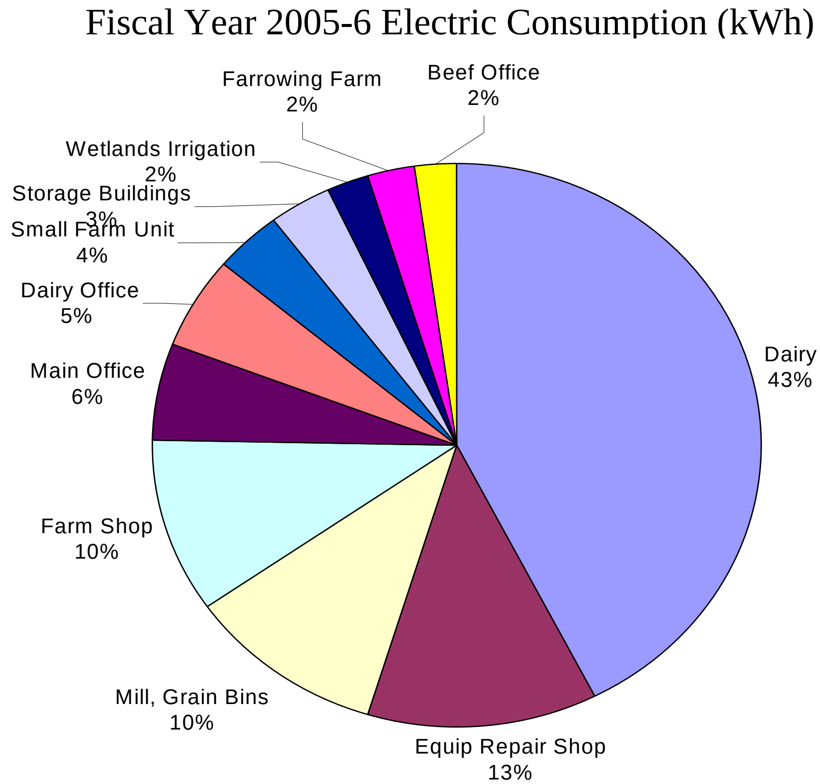
The billing demand is the largest of five amounts:

- Metered 15 minute demand during the billing period.
- 80% of the maximum 15 minute demand for July through October in the preceeding 11 months.
- 60% of the maximum 15 minute demand for November through June of the preceeding 11 months.
- 75% of the "Contract Demand" until the billing demand first equals or exceeds the Contract Demand
- 30 kW

Two facilities at the Cherry Research Farm are demand metered: the dairy and the grain drying/feed manufacturing facility. There are opportunities to save on the demand charges for both of these facilities:

- Replacing the radiant heaters in the dairy with propane fired heaters could save $234.72 per year in demand charges.
- In the grain drying/feed manufacturing facility, demand is highest during about two weeks each fall when the feed operation and grain dryer are operating simultaneously. Not running the grain dryer at the same time as the feed mill operation could save 14 kW in October, resulting in $68.46 savings in October and $54.77 for each of the other months, a total savings of $670.91 per year in demand charges. The easiest way to accomplish this would be to store bagged feed product and never operate the feed operation at the same time as the grain dryer is operating.

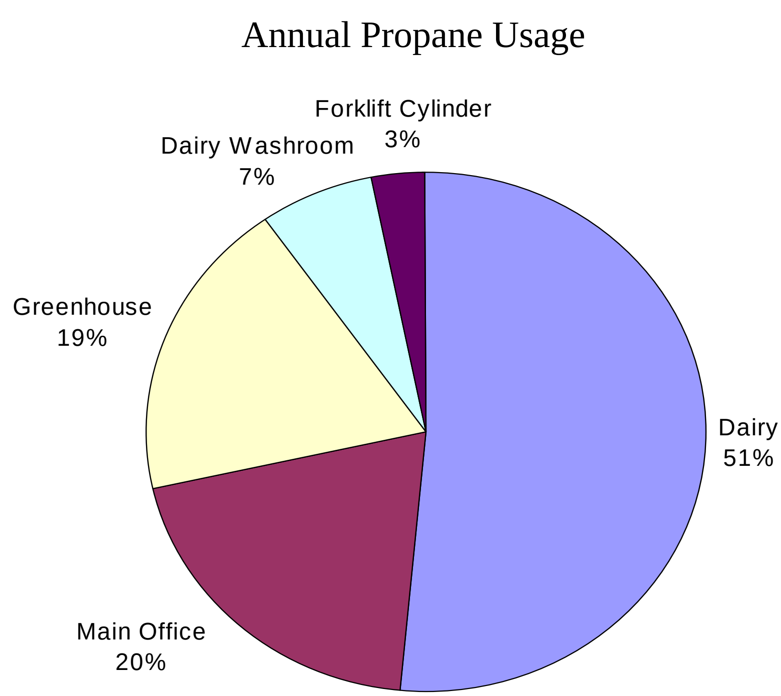
As shown in the following chart, the dairy was the largest user of electricity on the farm, consuming 43 percent of all electricity, mainly to cool milk.



Propane Usage

Also known as *liquified petroleum gas* or *LP gas*, propane (C_3H_8) is made from petroleum during oil or natural gas processing. A gallon of propane is equivalent to 95,475 Btus of thermal energy.

Cherry Farm used 3,393 gallons of propane in FY 2005-6. The dairy consumed slightly over half of all propane used on the farm, mainly to heat wash water.



Natural Gas Usage

Natural gas is commonly measured in *therms*, a unit of heat energy equal to 100,000 Btus and approximately equivalent to burning 100 cubic feet (often abbreviated as *CCF*) of natural gas.

Commercially available natural gas is almost pure methane, chemically CH_4.

Cherry Farm used 1,562 therms of natural gas in FY 2005-6, in the grain dryer, service building, and mechanic's shop.

Section 3

Energy Conservation Opportunities

Dairy

Electric account #555 791 0287

The largest energy-consuming facility on the farm, the dairy uses energy to heat wash water, cool milk, run vacuum pumps, move milk and water, and for other purposes. Electric usage has ranged from 5,700 to 15,000 kWh per month over the past year.

The milking parlor is open on three sides, with minimal lighting. Four 3,000-Watt radiant electric infrared heaters generally run 12 hours per day for the comfort of workers. The farm eventually wants to enclose the parlor, and at that time they will look at other heating options.

There are two milkings per day, delivering 1,000 gallons of milk per day into a bulk tank, where it is cooled by two electric refrigeration systems: one 61,000 Btu and the other 38,000 Btu. The milk must be cooled rapidly (within a couple hours) from 102°F to 37°F.

Everything in the dairy that is touched by milk must be cleaned and sterilized after each milking. Each day, 3-400 gallons of wash water are heated from 65°F to 180°F by a 90-gallon, propane-fired water heater, consuming approximately 353,000 Btu per day.

Previous to this energy audit, the dairy had already installed variable frequency drives (VFDs) on its vacuum pumps as an energy-saving measure. VFDs cause pump motors to speed up or slow down to match system requirements. When a lot of vacuum is needed (such as when running wash water through the system), the pump motors speed up. When only a small amount of vacuum is needed, the pump motors slow down.

Energy Conservation Opportunity (ECO) #1: Reclaim heat from milk. Circulate cold city or well water through a heat exchanger to cool milk before it goes to the storage tank.

- Estimated cost: $2,000
- Estimated annual savings: $722.47 ($508.99 propane + $216.48 electric energy)
- Simple payback: 2.8 years

Discussion

- The warmed water from the heat exchanger will go into the propane-fired water heater for final heating (as wash water), or can be used to water the cows.
- We can recover 53,376 Btu per day from the milk directly to city water. The heat exchanger can raise the temperature of the city water from 65°F to 81°F and drop the temperature of the milk from 102°F to 86°F. This also decreases the refrigeration load, resulting in electric energy savings.

- ♦ We assume that propane is $1.28 per gallon, the existing propane water heater is 80 percent efficient, electricity is $0.06195 per kWh, and that cows are milked 241 days per year.

ECO #2: Install a liquid-cooled condenser before the existing air-cooled condenser in the refrigeration system.

- ∗ Estimated cost: $3,000
- ∗ Estimated annual savings $388.22 (electric energy)
- ∗ Simple payback: 7.7 years

<u>Discussion</u>

- ♦ We assume that all of the energy rejected from the refrigeration system is removed to city water. Some of this energy displaces propane. (See previous ECO.) The condensing temperature is dropped from 100°F to 82.5°F, saving 50% of the electric energy of the refrigeration system. This assumption may be optimistic, depending upon the actual compressors being used. We assume that there is a 15% reduction of energy for every 5°F decrease in condensing temperature. City water temperature will not be constant over the course of a year. We are assuming average conditions of 65°F city water temperature. If the water temperature is lower than 65°F there will be more energy savings.
- ♦ We assume that propane costs $1.28 per gallon, and that the existing propane water heater is 80 percent efficient.

ECO #3: Insulate water heater.

- ∗ Estimated cost: $20
- ∗ Estimated annual savings: $44.55
- ∗ Simple payback: 0.4 year

<u>Discussion</u>

- ♦ We assume that a water heater insulator will save four percent of the propane used by the dairy. $1,113.63 × .04 = $44.55 per year
- ♦ It will still be cost-effective to insulate this water heater even if Energy Conservation Opportunities1 and 2 above are implemented, although the payback will be somewhat longer.
- ♦ From www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=13070:

  "Unless your water heater's storage tank already has a high R-value of insulation (at least R-24), adding insulation to it can reduce standby heat losses by 25% – 45%. This will save you around 4% – 9% in water heating costs.

  If you don't know your water heater tank's R-value, touch it. A tank that's warm to the touch needs additional insulation.

  Insulating your storage water heater tank is fairly simple and inexpensive, and it will pay for itself in about a year. You can find pre-cut jackets or blankets available from around $10–$20. Choose one with an insulating value of at least R-8."

ECO #4: Install hand-operated timer control on radiant electric heaters in parlor, to automatically switch off the heaters when workers have left.

- Estimated cost: $100
- Estimated annual savings: $178.42
- Simple payback: 0.6 years

Discussion

- ♦ These heaters currently run about 12 hours per day. We assume the heaters would be turned off two hours per day more than they are turned off now, from November through February.
- ♦ 12 kW × 2 hours per day × 120 days = 2880 kWh × 0.06195 per kWh = $178.42 per year.

ECO #4a: Replace radiant electric heaters with propane fired heaters.

- Estimated cost $2,000
- Estimated annual savings: $567.72
- Simple payback period is 3.5 years.

Discussion

- ♦ Savings of 12 kW each of four winter months are possible. 12 kW × 12 hours per day × 120 days = 17,280 kWh. 17280 kWh × 3413Btu per kWh = 590 therms. 17,280 kWh × 0.06195 = $1070.50 per year electric costs. If this electric use is switched to propane, we will reduce the cost to 590 therms × $1.25 per therm = $737.50 per year. The estimated demand savings would be 12 kW × 4 Months × 4.89 per kW-Month = $234.72 per year. Estimated total savings = $333.00 + $234.72 = $567.72.hese heaters currently run about 12 hours per day.
- ♦ We assume the heaters would be turned off two hours per day more than they are turned off now, from November through February.

Mechanic/Equipment Repair Shop

Electric account #051 072 084

The second-largest consumer of electricity on the farm, the equipment repair shop contains a wide variety of power tools, such as drill presses, welders, and air compressors. Electric usage over the past year has been 2,300 to 3,500 kWh per month.

ECO #5: Install and use programmable thermostat.

- Estimated cost: $150
- Estimated annual savings: $138
- Simple payback: 1.1 years

Discussion

- ♦ Set back temperature in the shop from 70°F to 50°F for 14 hours per day during the week, and set back 24 hours per day on weekends.
- ♦ Energy savings estimate for this application comes from

  www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorProgrammableThermostat.xls

ECO #6: Install a waste oil burning unit heater.

- Estimated cost: $5,000
- Estimated annual savings: $2,130 ($1,750 energy + $380 tipping fees)
- Simple payback: 2.3 years

Discussion

- ♦ We assume the shop generates 1,000 gallons of waste oil per year.
- ♦ Propane cost per therm is $1.25. Each gallon of waste oil = 140,000 Btu or 1.4 therms. A waste oil unit heater could burn about one gallon per hour. This translates into about 1,000 hours of operation of one of the two heaters per year. 1.4 therms per hour × 1,000 hours × $1.25 per therm = $1,750 energy savings per year.
- ♦ The shop currently pays a tipping charge of $0.38 per gallon to have waste oil taken away. 1,000 gallons per year × $0.38 per gallon = $380 tipping fee savings per year.
- ♦ CleanBurn specs can be seen at www.cleanburn.com/CBFurnaceSpecs.pdf.
- ♦ Waste oil unit heaters cost about $5,000 installed. (See Lanair web page printouthttp://www.lanair.com/scripts/_viewProduct.cfm?ID=9DEA5DE4-2E7A-47A6-93CE-A85CA3E06DAB)

ECO #7: Install polycarbonate doors on south side of the shop, so sun warms shop in winter.

- Estimated cost: $2,000
- Estimated annual savings: $464
- Simple payback: 4.3 years.

Discussion

- ♦ Solar gain would be approximately 3.6 kWh per square meter per day average in the winter (December through March).

- We assume that sliding doors would be fabricated out of lexan panels, with a door opening of 5 meters by 4 meters. Total energy available is 20 sq.m. × 3.6 kWh per day per sq.m. × 121 days = 8,712 kWh thermal.
(See http://rredc.nrel.gov/solar/pubs/redbook/PDFs/NC.PDF)
- We assume that propane is displaced at $1.25 per therm. 8,712 kWh × 3,413 Btu per kWh ÷ 80% efficiency ÷ 100,000 Btu per therm × $1.25 per therm = $464 per year.
- Note that any use of the doors by the people working in the shop will subject the doors to possible damage and will increase the payback period.

ECO #8: Retrofit fluorescent lighting fixtures.

- Estimated cost: $400
- Estimated annual savings: $28.23
- Simple payback: 14.2 years

Discussion

- Replace two 2-lamp T-12 lamps with 2 ballasts with two 2-lamp T-8 lamps with one electronic ballast
- Replace three 4-lamp T-12 lamps with 2 ballasts with three 4-lamp T-8 lamps with one electronic ballast
- We assume a cost of $0.08324 per kWh (highest rate on this account) × savings of 339 kWh per year = $28.23 per year.
- We assume that CEFS has an electrician on staff.

Install a corn-burning stove.
Dozens of manufacturers make corn-burning stoves, and corn is already being grown at Cherry Farm, making this appealing as a "free" and locally-grown energy source. Corn should not be burned in most wood-burning stoves, and the ash needs special handling to avoid clogging air flow. For some background, see http://burncorn.cas.psu.edu.

CEFS may wish to demonstrate this technology for area farmers. Corn burning remains controversial, however, partly because of ethical issues surrounding "burning food." The ash is also high in phosphorus and must be handled carefully to keep it out of streams. We recommend that CEFS proceed cautiously.

Service Building

Electric account #575 852 4754

The Service Building contains offices and a meeting room for lunch. Electric usage is highest in the hot months from June through October. The building is in good condition, with vinyl double-pane windows, metal doors, and approximately R-11 attic insulation. This insulation has been moved aside in places to accommodate wiring and ductwork changes.

ECO #9: Program and use existing setback thermostats.

- Estimated cost: $0
- Estimated annual savings: $156
- Simple payback: Immediate.

Discussion

- Set back temperature for 14 hours per day from 70°F to 60°F in the heating season, and set the temperature up for 14 hours per day from 78°F to 88°F in the cooling season. On the weekends, the setback and set up should be for 24 hours per day.

ECO #10: Replace insulation in attic that has been moved over time.

- Estimated cost: near $0
- Estimated annual savings: $6
- Simple payback: Immediate

Discussion

- Annual savings are small partly since the building is a commercial building. Building envelope has less effect on energy use than it would in a residential building.

ECO #11: Replace T-12 lighting with T-8 lighting.

- Estimated cost: $2,550
- Estimated annual savings: $303.59
- Simple payback: 8.4 years

Discussion

- Seven 2-lamp T-8 fixtures @ $50 + 22 4-lamp T-8 fixtures @ $100 = $2,550.
- We estimate savings of 4,480 kWh per year @ $0.08324 per kWh (highest rate on this account).
- We estimate increased propane usage of 5.17 million Btu per year, since T-8 fixtures will generate less heat.
- Note: Lamp and ballast replacement may cost less than replacing the whole fixture, which would decrease payback period.

ECO #12: Increase attic insulation levels, installing another R-11 on top of the existing R-11.

* Estimated cost: $513
* Estimated annual savings: $2.56
* Simple payback: 200 years.

Discussion

- ♦ Insulation cost approximately $0.18 per sq. ft. installed × 2,850 sq.ft. = $513.
- ♦ Note that the energy model assumes the temperature setbacks described above, in ECO #9.
- ♦ Adding insulation in the attic of commercial buildings has a long payback period because the loads in the building are generally caused by the occupants and equipment in the building rather than by weather.

Sheds

Electric account #547 109 3475

This account includes a wash station, organic grain bin, and miscellaneous storage buildings, including the "organic shed." Over the past year, electric usage has ranged from about 600 to 1,200 kWh per month. There are photo cell controls on some of the sheds to turn lighting off during the daytime, but these are located inside the sheds and are not responsive to daylight.

ECO #13: Move photocells for shed lights.

* Estimated cost: $75
* Estimated annual savings: $89.32
* Simple payback: 0.8 year

Discussion

- ♦ We assume that 15 200-Watt high pressure sodium vapor (HPSV) lamps will be switched off an average of 12 hours per day
- ♦ We are assuming a highest-block energy rate of $0.08324 per kWh.
- ♦ We assume that 200 Watt lamp + 45 Watt ballast = 245 Watts for the fixture.
- ♦ 245W × 12 × 365 ÷ 1,000 = 1,073 kWh annual savings × .08324 per kWh = $89.32 per year.

Change the lighting fixtures.

* Not enough energy savings to be worthwhile unless replacing failed lamps and ballasts.

Grain Bins and Hammer Mill / Feed System, Metal Shop

Electric account #348 900 1556

The grain system processes mostly corn, although it has the capability of mixing grains from multiple bins. The farm generally dries corn for about two weeks per year. The grain dryer is natural gas fired and holds 200 bushels of grain.

There are two 17,500-bushel grain storage bins and two 6,000-bushel bins. Each bin has a fan, used to maintain moisture levels. If grain is brought in at suitably low moisture, the bin fans can also be used to dry grain.

A metal shop and storage building are on the same electric account. These facilities together have used 1,700 to 3,300 kWh of electricity per month over the past year, with highest usage in September and October.

ECO #14: Install photocell control on shop exterior fixture.

- Estimated cost: $25
- Estimated annual savings: $36.90
- Simple payback: 0.7 year

Discussion

- We assume 200 Watt lamp + 45 Watt ballast = 245 Watts for the fixture.
- 245 Watts × 6 hours per day × 250 days per year = 367 kWh × $0.10042 = $36.90 per year.

ECO #15: Pursue with Progress Energy a change in rate schedules, from MGS-8 to SGS-8.

- Estimated cost: $0
- Estimated annual savings: $1,061
- Simple payback: Immediate.

Discussion

- In January 2007, this account was billed $357.90 at Medium General Service (MGS-8) rates, and would have been billed $269.50 at Small General Service (SGS-8) rates, a savings of $88.40. $88.40 × 12 = $1,061.
- Electric usage on this account appears to be just barely above the threshold to be classified as Medium General Service. A minor change in loads or management might qualify this account for the Small General Service category. MGS-8 rates are charged for facilities with a electric demand of more than 30 kW. This facility had less than 30 kW load for 5 out of the last 12 months. We feel that if the facility is operated in such a way as to minimize running equipment at the same time (e.g. grain dryer and hammer mill) the demand charges could be decreased significantly. For example, the peak facility demand was set in October 2005, and this peak demand affected the billed demand for the next eleven months according

to the 80% rule (see demand rate discussion above). The two operations that might be running at the same time are the grain dryer and the hammer mill operations. The grain dryer has an electric demand of approximately 14 kW when operating, and the hammer mill operation has an electric demand of at least 21 kW. If these systems are run together in October, they will set the demand charge for the facility for the next eleven months.

- Analysis of the previous year's energy bills should determine whether changing rate schedules would be advantageous.

Change controls so the hammer mill and feed system can run independently.

- Currently, the hammer mill must be operating when grain is being moved by the auger. Significant savings may be available if the hammer mill and feed system could be run independently.
- However, the system appears to be quite efficient. It was also custom designed, and is not easily adjusted.
- We recommend consulting with the system designer before pursuing energy saving opportunities in this system.
- We also recommend installing a high-efficiency motor the next time a motor needs to be replaced.

Small Farm Unit Greenhouses

Electric account #382 944 6529

There are three greenhouses at the Small Farm Unit: plastic hoop houses with aluminum hoops. One greenhouse is uninsulated and unheated, one is insulated and unheated, and the third is insulated and heated with two propane-fired Modine unit heaters. Electric heat mats are used under germinating crops. Humidity in the heated greenhouse has been a problem, destroying mechanical components in the heaters.

ECO #16: Heat soil instead of air space in the greenhouse. Use a boiler located outside the greenhouse and piping to put heat into beds.

- Estimated cost: $7,600
- Estimated annual savings: $198.36
- Simple payback: 30.6 years

<u>Discussion</u>

- We assume that a conventional water heater is used. We recommend leaving at least one propane-fired unit heater in place, in order to be prepared for cold weather.
- The water heater will supply water at 170-190°F, and will require return water at around 110°F. Since the beds (approximately 13 ft × 4 ft) cannot be heated much higher than 70°F

without harming plants, we recommend running a primary/secondary loop system to keep the temperature down.

- The greenhouse used 324.8 gallons of LP gas over the last year at a cost of $396.71. We estimate that savings of 50% are possible, yielding annual savings of $198.36. (See www.radiantroots.com and http://geoheat.oit.edu/bulletin/bull22-3/art5.pdf.)
- CEFS spends about $50 per year to maintain the existing unit heaters, and the units need to be replaced about every five years. The cost to replace each heater is about $700, for a total cost of $1,400. The cost to convert to radiant bed heating is estimated to be $9,000. (TrueLeaf Technologies). Assuming that the radiant heating system is installed in lieu of replacing the Modine propane-fired unit heaters, the net cost of the radiant heating system would be $9,000 - $1,400 = $7,600. The simple payback would be $7,600 ÷ ($198.36 + $50.00) = 30.6 Years.

Passive solar greenhouse

- Passive solar greenhouses are well-insulated structures with extensive glazing on the south-facing wall, little or no glazing on the north wall, and thermal mass inside the building (e.g. concrete slab, stonework, or tanks of water) to store the sun's heat.
- Passive solar greenhouses are expensive per square foot in comparison to hoop houses or other pre-fabricated greenhouses.
- Passive solar might be worth investigating to help reduce heating needs in hoop houses, but passive solar heating alone is inadequate – the nighttime losses are too great.

Small Farm Unit Irrigation

Electric account #735 932 3248

Description: Well water is used to water two 30-foot × 96-foot greenhouses and two 30-foot × 96-foot plots where vegetables, small fruit, and grains are grown. A gasoline-powered well pump delivers 25 gallons per minute at 50 feet of depth.

ECO #17: Use solar-powered pumping system to pump irrigation water from the Little River. Create holding and polishing ponds.

- Estimated cost: $5,000
- Estimated annual savings: $72.00
- Simple payback: 69.4 years

<u>Discussion</u>

- A pump adequate to lift water from the Little River six feet and move it about one quarter mile could create a pond demonstrating both solar electric pumping and aquaculture applications, while storing water for irrigation.

- SC Solar quoted $3,380 for a solar pumping system that would move about four gallons per minute (1,200 gallons per day) at 10 feet of total head.
- This system could be mounted on a trailer fabricated by CEFS. Trailer mounting would enable the system to be moved out of the Little River location during flooding, and would also enable the system to pump water out of a pond up to the planting area.
- The distance from the likely pumping location at the river to the nearest existing electric service is about 1,000 feet. At this distance, it is likely that the cost of a power line extension would be less than the cost of a solar pumping system.

Rebuild irrigation pumps and motors or redesign irrigation systems.

- We did not get a chance to see the irrigation systems during our audit.
- Certainly good maintenance is a good idea, and some energy savings are likely available from retrofits, but these are apparently small systems and not heavily used.

Main Office

Electric account #629 328 6255

The Service Building contains offices and a kitchen and is called "Farm Office" on electric bills. Electric usage was roughly 900 to 1,800 kWh per month during the past year.

ECO #18: Replace water heater with instant (point-of-use) water heaters, under the kitchen sink and in the bath.

- Estimated cost: $500
- Estimated annual savings: $82.80
- Simple payback: 6.0 years.

Discussion

- We assume that the only use of hot water is for hand washing and occasional dishwashing. Instant water heaters will not work for bathing.
- We assume a 20 percent savings, but published estimates vary from two percent to over thirty percent.

ECO #19: Install a door between the office and the porch.

- May improve comfort in the office are by cutting down on drafts.
- Annual savings impossible to estimate with any confidence, since we cannot assume that the door will always be closed.

ECO #20: Increase office thermostat setback/set up by 4 degrees.

- ∗ Estimated cost: $0
- ∗ Estimated annual savings: $35.00
- ∗ Simple payback: Immediate.

Discussion

- ♦ The current setback is only to 66°F in the heating season. We recommend setting back temperature for 14 hours per day from 70°F to 60°F in the heating season, and from 78°F to 88°F in the cooling season. On the weekends, the setback and set up should be for 24 hours per day. Since there is already some setback, we assume that we will save ½ of the energy of replacing a standard thermostat with a programmable thermostat

ECO #21: Replace lighting with T-8 fluorescent

- ∗ Estimated cost: $450
- ∗ Estimated annual savings: $28.08
- ∗ Simple payback: 16.0 years

Discussion

- ♦ We assume 351 kWh savings × $0.08 per kWh = 16.0 years simple payback.
- ♦ Note: Replacing the lamps and ballasts in the fixture would cost less than replacing the whole fixture and would result in a shorter payback period.

Miscellaneous Recommendations

Provide shade for fuel tanks, and use pressure relief vacuum caps, instead of conventional gasoline fuel caps.

- ∗ A 300 gallon fuel tank exposed directly to the sun will lose as much as 10 gallons per month because of evaporation.

Check for leaks and replace worn sprinkler nozzles in irrigation system.

- ∗ Leaks and worn nozzles reduce system pressure, moving the pump operating point out of the range where it is most efficient.
- ∗ Depending on the system's total dynamic head and the cost of electricity or fuel, worn sprinkler nozzles can add anywhere from $0.25 to $5.00 or more *per nozzle* annually in increased energy costs.

Section 4

Renewable Energy Demonstrations

Biodiesel

The expected completion of Cherry Research Farm's biodiesel processing plant will give the farm outstanding opportunities to research and demonstrate sustainable biodiesel production, including agronomic studies of oilseed crops, animal feeding studies using oilseed meal, and economic studies of farm-scale biodiesel manufacturing.

To reduce the energy requirements to warm oil for processing, we recommend building a passively-heated storage room in the new biodiesel facility where oil will be pre-heated – a well-insulated structure with glazing on the south–facing side. The oil itself will function as thermal mass to store heat from sunlight. This is especially important since the farm plans to make most of its fuel during the cold months.

To enhance the educational value of the biodiesel processing facility for area farmers, we recommend that CEFS explore the possibility of purchasing a demonstration oilseed crusher for use at Cherry Research Farm.

We recommend that the farm investigate solar water-heating and compost-heating as two ways to partially heat waste oil during biodiesel processing.

Ethanol

Ethanol, also known as grain alcohol or ethyl alcohol, is the kind of alcohol produced by fermenting and distilling simple sugars from biological sources. Corn ethanol production is a mature industrial process, and probably a poor candidate for small-scale demonstration at Cherry Research Farm. (For a contrasting opinion see http://permaculture.com/alcohol/index.shtml.)

Ethanol is beginning to be made from cellulose in a few demonstration plants, and North Carolina has been identified as a promising location for growing perennial "energy crops" such as switchgrass. Cherry Research Farm could conduct field trials on switchgrass and other regionally appropriate energy crops that can be made into ethanol.

We did not identify specific short-tem opportunities for ethanol demonstration projects, but Cherry Research Farm has excellent potential as a research location for studying agronomic issues related to ethanol.

Wind Energy

Because of the generally low prevailing wind speeds in the area, we do not see good opportunities for wind energy demonstrations at Cherry Research Farm.

Solar Electric (Photovoltaics)

The farm has many opportunities to demonstrate agricultural uses of solar-generated electricity, including solar electric fencing, water pumping, lighting, and other remote applications.

Livestock watering currently relies on municipal water from the city of Goldsboro, delivered to paddocks through a very extensive network of pipes. The farm could develop wells to provide water to pastures for livestock watering. These could be used to demonstrate solar pumping, including the option of a portable solar array mounted on a trailer that can be moved from one pasture to another to run several different wells. Solar pumping is cost-effective when it is the best alternative to an expensive line extension. While line extension costs vary widely, a common rule of thumb is that solar pumping is worth considering on economic grounds alone, when a line extension of more than about one half mile would be required.

To accommodate future uses of solar energy, we recommend that the farm carefully consider the orientation of any future buildings, and try to create unshaded south-facing roofing surfaces wherever possible. (Some industry observers expect photovoltaics to be cost-competitive with grid-electricity in as little as 5 to 10 years.)

Solar Water Heating

At the time of this study, large volumes of hot water were being used at only a few locations on the farm. As mentioned above, solar collectors could be used to pre-heat vegetable oil in the biodiesel processing plant. Solar water heating would also be an option for wash water at the dairy, but (as explained above) heat recovery from warm milk is a better option.

For future solar water heating demonstrations and applications, we recommend that the farm carefully consider the orientation of any future buildings, and creating south-facing roofing surfaces wherever possible.

Compost Heating in Greenhouse

In a composting greenhouse, heat and carbon dioxide are generated from manure-based compost contained in a special chamber attached to one side of the greenhouse.

Solar Crop Drying

Crop drying is a very significant cost for North Carolina farmers. Solar crop drying can be done at any scale and in almost any climate.

CEFS could demonstrate solar crop drying, as an alternative to the natural gas-fired crop dryer already in use. At a much smaller scale, CEFS could demonstrate small-scale solar drying of fruits and vegetables at the Small Farm Unit.

Anaerobic Digestion

Anaerobic digesters use bacteria to decompose animal manure in the absence of oxygen: reducing odor, producing a variety of useful products, and preventing the release of methane – a powerful greenhouse gas – into the atmosphere. The biogas produced can be used to fuel a variety of cooking, heating, cooling, and lighting applications, as well as to generate electricity.

At the time of this study, there were not enough animals on the farm to justify the cost of an anaerobic digester, and the deep-pack bedding system in place at the Alternative Swine Unit complicated manure collection.

Nonetheless, a digester demonstration would have great educational value for North Carolina farmers, and we recommend that CEFS seriously explore this possibility.

Microhydro Power

Because the terrain at Cherry Research Farm is nearly flat, we did not identify any opportunities for generating electricity with flowing water.

Renewable Energy Credits and Incentives

Information about renewable energy credits and incentives is available at www.dsireusa.org or http://attra.ncat.org/farm_energy/farm_energy_main.php. Because Cherry Research Farm is state-owned, it is unlikely to qualify for most incentives aimed at commercial or residential energy consumers.

Appendix: Rate Schedules from Progress Energy

SMALL GENERAL SERVICE
SCHEDULE SGS-8

AVAILABILITY

This Schedule is available for electric service used by a nonresidential customer at a single point of delivery, at one of the Company's standard voltages, with a Contract Demand of less than 30 kW, until the Customer's registered demand equals or exceeds 35 kW in two or more of the preceding 12 months, or until the Customer's registered demand equals or exceeds 50 kW.

This Schedule is not available: (1) for residential service, (2) for resale service, (3) for a Contract Demand of 30 kW or more, (4) whenever the monthly registered demand equals or exceeds 35 kW in two or more of the preceding 12 months, or (5) whenever the monthly registered demand equals or exceeds 50 kW. The Company may at any time conduct a test or install a demand meter to determine the maximum 15-minute demand.

When the Customer has installed generating or converting equipment that can operate in parallel with the Company's service, the Customer shall install the protective equipment acceptable to the Company that will protect the Company's employees, its other customers, and its distribution system. The Company shall have the right to suspend delivery of electricity to the Customer with such generating or converting equipment until the Customer has installed the protective equipment.

CONTRACT DEMAND

The Contract Demand shall be the kW of demand specified in the Service Agreement.

MONTHLY RATE

I. For Single-Phase Service:

A. $12.00 Customer Charge

B. Kilowatt-Hour Energy Charge:

10.042¢ per kWh for the first 750 kWh
8.324¢ per kWh for the next 1,250 kWh
7.857¢ per kWh for all additional kWh

Docket No. E-2, Subs 868 and 889

The effect of the Commission order included in the above kilowatt-hour charges is an increase, including gross receipts tax, of 0.494¢ per kWh compared to the rates in effect immediately prior to October 1, 2006.

II. For Three-Phase Service:

The bill computed for single-phase service plus $9.00.

SALES TAX

To the above charges will be added any applicable North Carolina Sales Tax.

PAYMENTS

Bills are due when rendered and are payable within 15 days from the date of the bill. If any bill is not so paid, the Company has the right to suspend service in accordance with its Service Regulations. In addition, any bill not paid on or before the expiration of twenty-five (25) days from the date of the bill is subject to an additional charge of 1% per month as provided in Rule R12-9 of the Rules and Regulations of the North Carolina Utilities Commission.

CONTRACT PERIOD

The Contract Period shall not be less than one year; except for short-term, construction, or temporary service, the Contract Period may be for the period requested by the Customer and in such event the Customer agrees:

1. That the service supplied shall be for a continuous period until disconnected; and

2. That where it is necessary for the Company to extend lines, erect transformers, or do any work necessary to supply service, except the installation of a self-contained meter, the Customer shall pay for the line extension in accordance with Line Extension Plan E.

GENERAL

Service rendered under this Schedule is subject to the provisions of the Service Regulations of the Company on file with the state regulatory commission.

ADDITIONAL CHARGES

I. Cost of Fuel Rider No. 59Z

Pursuant to North Carolina General Statute 62-133.2 and Docket No. E-2, Sub 889, the Monthly Rate includes an increment of 0.810 cents per kilowatt-hour, effective for service rendered on and after October 1, 2006.

II. Experience Modification Rider No. 59.11

Pursuant to North Carolina General Statute 62-133.2 and Docket No. E-2, Sub 889, the Monthly Rate includes an increment of 0.506 cents per kilowatt-hour, effective for service rendered on and after October 1, 2006 through service rendered on September 30, 2007.

Supersedes Schedule SGS-6
Effective for service rendered on and after October 1, 2006
NCUC Docket No. E-2, Subs 868 and 889

Carolina Power & Light Company 11
d/b/a Progress Energy Carolinas, Inc.
(North Carolina Only)

MEDIUM GENERAL SERVICE
SCHEDULE MGS-8

AVAILABILITY

This Schedule is available for electric service used by a nonresidential customer at a single point of delivery, at one of the Company's standard voltages, with a Contract Demand or a registered or computed demand of 30 kW and greater, but less than 1,000 kW. This Schedule is also available to an existing nonresidential customer if served under the Small General Service Schedule SGS on September 24, 1982 with: (1) a Contract Demand of 1,000 kW or more, until such time as service is terminated, or service is elected under another available schedule; or (2) a Contract Demand below 1,000 kW until such time as the registered or computed demand equals or exceeds 1,200 kW in two or more of the preceding 12 months or the Customer's Contract Demand is increased to 1,000 kW or more, whereupon this Schedule will no longer be available thereafter.

This Schedule is not available: (1) for residential service; (2) for breakdown, standby, or supplementary service unless used in conjunction with the applicable standby or generation service rider for a continuous period of not less than one year; (3) for resale service; or (4) for a new customer after September 23, 1982 with a Contract Demand of 1,000 kW or more, or whenever the registered or computed demand equals or exceeds 1,200 kW in two or more of the preceding 12 months.

MONTHLY RATE

I. For Single-Phase Service:

A. Customer Charge: $12.00 per month
B. Billing Demand: $4.89 per kW
C. Kilowatt-Hour Energy Charge:
6.195¢ per kWh for all kWh

Docket No. E-2, Subs 868 and 889

The effect of the Commission order included in the above kilowatt-hour charges is an increase, including gross receipts tax, of 0.494¢ per kWh compared to the rates in effect immediately prior to October 1, 2006.

II. For Three-Phase Service:

The bill computed for single-phase service plus $9.00.

CONTRACT DEMAND

The Contract Demand shall be the kW of demand specified in the Service Agreement.

BILLING DEMAND

The Billing Demand shall be the greater of: (1) the maximum kW registered or computed, by or from the Company's metering facilities, during any 15-minute interval within the current billing month; (2) 80% of the maximum 15-minute demand during the billing months of July through October of the preceding 11 billing months; (3) 60% of the maximum monthly 15-minute demand during the billing months of November through June of the preceding 11 billing months; (4) 75% of the Contract Demand until such time as the Billing Demand first equals or exceeds the effective Contract Demand; or (5) 30 kW.

SALES TAX

To the above charges will be added any applicable North Carolina Sales Tax.

PAYMENTS

Bills are due when rendered and are payable within 15 days from the date of the bill. If any bill is not so paid, the Company has the right to suspend service in accordance with its Service Regulations. In addition, any bill not paid on or before the expiration of twenty-five (25) days from the date of the bill is subject to an additional charge of 1% per month as provided in Rule R12-9 of the Rules and Regulations of the North Carolina Utilities Commission.

CONTRACT PERIOD

The Contract Period shall not be less than one year; except for short-term, construction, or temporary service, the Contract Period may be for the period requested by the Customer and in such event the Customer agrees:

I. That the service supplied shall be for a continuous period until disconnected; and

II. That where it is necessary for the Company to extend lines, erect transformers, or do any work necessary to supply service, except the installation of a self-contained meter, the Customer shall pay for the line extension in accordance with Line Extension Plan E.

GENERAL

Service rendered under this Schedule is subject to the provisions of the Service Regulations of the Company on file with the state regulatory commission.

ADDITIONAL CHARGES

I. Cost of Fuel Rider No. 59Z

Pursuant to North Carolina General Statute 62-133.2 and Docket No. E-2, Sub 889, the Monthly Rate includes an increment of 0.810 cents per kilowatt-hour, effective for service rendered on and after October 1, 2006.

II. Experience Modification Rider No. 59.11

Pursuant to North Carolina General Statute 62-133.2 and Docket No. E-2, Sub 889, the Monthly Rate includes an increment of 0.506 cents per kilowatt-hour, effective for service rendered on and after October 1, 2006 through service rendered on September 30, 2007.

Supersedes Schedule MGS-6
Effective for service rendered on and after October 1, 2006
NCUC Docket No. E-2, Subs 868 and 889