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C&I CASE STUDIES IN
BENEFICIAL ELECTRIFICATION

Farm Irrigation Systems

BY **ALICE CLAMP**, DECEMBER 2017

SUBJECT MATTER EXPERT FOR QUESTIONS ON THIS TOPIC

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INTRODUCTION

The wise use of electricity, Beneficial Electrification, has sparked widespread re-thinking of policies that encourage or mandate less electricity use and promote infrastructure planning. Advancements in electric technologies continue to create new opportunities to use electricity as a substitute for on-site fossil fuels like natural gas, propane, gasoline and fuel oil, with increased efficiency and control. It also contributes to economic development and enhances the quality of the product used by the customer.

Electrifying industrial and commercial processes is a proven method to help local businesses stay competitive. Beneficial electrification strengthens the cooperative presence in the community and offers benefits to the electric system. Working with C&I customers is a good place to start. To provide examples of various approaches to working with C&I customers on beneficial electrification initiatives, NRECA is developing a **series of case studies**.

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MEMBER PROFILE

Delaware Electric Cooperative (DEC) is the only co-op in the state. A distribution co-op, it provides electric power to 95,000 accounts — including more than 1,000 irrigation accounts — in two Delaware counties. DEC purchases all its power from Virginia-based Old Dominion Electric Cooperative, a generation and transmission cooperative.

The Energy Conservation and Efficiency Act of 2009 required electric utilities, including cooperatives, to establish programs that would save the equivalent of 15 percent of 2007 electricity sales and demand figures by 2015.

DESCRIPTION OF PROBLEM/OPPORTUNITY

Background

The Energy Conservation and Efficiency Act of 2009, passed by the Delaware legislature and signed by the governor, designated energy efficiency as a priority energy resource in the state. The act also encouraged cost-effective reductions in energy consumption and peak demand. The act required electric utilities, including cooperatives, to establish programs that would save the equivalent of 15 percent of 2007 electricity sales and demand figures by 2015.

To reduce electricity use, DEC implemented such energy saving measures as LED lighting and geothermal heating — and, to reduce peak demand, the co-op decided to focus on farm irrigation by funding conversions from diesel-driven motors to electricity-driven ones. Launched in 2011, the program provided grants to farm co-op members for conversion. But, farm customers in single-phase areas could not undertake a conversion without the installation of a three-phase line, which could cost from $50,000 to as much as $150,000 a mile. Even with the co-op's subsidization, the cost of extending the line was too great for many farmers. As a result, DEC was only reaching approximately 30 percent of its farm customers with the conversion program.

So, DEC went back to the drawing board. It needed to find a way — other than line extension — to provide the three-phase power that electricity-driven irrigation pumps needed for operation. One option was a phase converter, but it was expensive and lost 15-20 percent of the power generated.

Over a holiday dinner, William Andrew, the co-op's CEO, discussed the problem with his daughter, who had worked as an engineer with Eaton Corp., an electrical engineering and technical services firm. "I told her that we needed a single-phase to three-phase system that was affordable, efficient, and had a good power factor," said Andrew. Her response: "I think you can do that with a variable frequency drive."

Within weeks, Eaton's drive experts had met with the co-op's engineering and operations staff. In addition to the other features of such a variable frequency drive (VFD) system, it had to be interruptible, so DEC could control peak demand as part of its demand-side management program and the state's 2015 target.

Although VFDs were used in a number of ways, the Eaton prototype was a new application in an irrigation system.

To ensure that the VFD system would perform well in the field, DEC conducted two pilot tests with center pivot irrigation systems in central and southern Delaware that had been using diesel motors. Both the tests, carried out in early spring of 2012, were successful, with no impact on power quality. In August of that year, the co-op relaunched its irrigation grant conversion program with the addition of funding for a VFD.

A variable frequency drive is an electronic phase converter, allowing an irrigation motor designed for three-phase power to run on a single-phase line.

The VFD program was able to qualify for the state's demand savings target because participants were only eligible for a VFD grant if they agreed to participate in the co-op's load control program with interruptible service. In this program, the members paid an off-peak rate.

DESCRIPTION OF THE TECHNOLOGY

Application

A variable frequency drive is an electronic phase converter, allowing an irrigation motor designed for three-phase power to run on a single-phase line (see Figure 1). A VFD varies the frequency and voltage supplied to the motor, thus varying the motor's speed. VFDs are useful for a number of situations faced by electric cooperatives and their member-consumers.

Among the features of a VFD irrigation system is its ability to pump at different rates. Some motors, such as those used for irrigation systems, are not required to run at full speed at all times. Such a system may require the maximum flow rate during peak water times, and a reduced flow rate at other times. It is inefficient to run the irrigation motor at full speed at all times.

FIGURE 1: A VFD System Installation. *Source: Delaware Electric Cooperative*

A motor with a highly variable load can provide an additional source of savings.

DEC requires a soft start on any motor of 30 hp or greater, said Troy Dickerson, DEC's manager of engineering. Without a soft start, the current could be up to five times that of a full load, and voltage could sag on the co-op's side. The VFDs used by DEC ramp up to 60 Hz anywhere between 3 and 15 seconds, essentially preventing an end-rush of current.

Many of the components in a VFD are semiconductor components that are sensitive to power or current surges, voltage spikes, line distortions, and general power anomalies. A line reactor protects the VFD from power surges and transients. The VFDs used for irrigation by DEC farm customers are manufactured with a line reactor with a 5 percent impedance, which reduces harmonics and protects the drive. The VFD also has an external filter, installed on the farm customer's side that cleans up sine waves to prevent any damage to the customer's irrigation equipment.

"There have been no power quality issues," said Mark Nielson, the co-op's vice president for staff services.

Types of Irrigation Systems

Among the types of sprinkler irrigation systems are center pivot and linear move. Most of DEC's farm customers use center pivot systems (see Figure 2).

PROGRAM STRUCTURE

Funding

DEC supports the conversion from diesel-powered motors to electricity-driven motors through two programs, one that helps to fund line extensions and one that helps to fund the installation of electric irrigation systems, including those using VFDs. The grants provide up to $15,000 toward the cost of a VFD for a motor rated at 40 hp or higher. Motors rated between 20 hp and 40 hp are eligible for a grant of $7,500.

FIGURE 2: A Center Pivot Irrigation System. *Source: AgFax*

A VFD system is between 96 and 98 percent efficient, while the efficiency of a diesel motor ranges from 30 percent to 40 percent.

Some of the funding has come from the Delaware Department of Natural Resources and Environmental Control, which offered payment to farmers who stopped using diesel motors. But, DEC provides much of the money. As of October 2017, the co-op had provided $1.249 million for its irrigation VFD program and $1.256 for its irrigation line extension program. The source of DEC's funding is a $0.0009/kWh charge on customers' bills used to support demand-side management and energy efficiency programs, said Nielson.

Off-Peak Rate

DEC farm customers who apply for the grants are required to participate in the co-op's load control program. By agreeing to accept interruptible service, farm customers pay rates that are lower than they would otherwise pay. During peak times, the farmer's irrigation system is interrupted for approximately 3 hours, three or four times a month.

With DEC's off-peak rate, farm customers can save up to 22 percent on their electric bill. This rate also has allowed the co-op to achieve a reduction in peak energy use and demand, one of the requirements of the state's Energy Efficiency Act of 2009. The co-op is able to offer favorable, off-peak rates to its customers because of the elimination of the demand component, said DEC's Nielson.

The Wheat Belt Public Power District (PPD) in Nebraska recently introduced favorable rates for its farm customers. See the sidebar ***Nebraska PPD Helps Irrigators Save Money***.

HOW DOES THE COMMERCIAL/INDUSTRIAL CUSTOMER BENEFIT?

NRECA talked with two DEC farm customers to learn about their experience with the co-op's grant program.

Richard Carlisle farms approximately 1,200 acres where he grows lima beans, green beans, tomatoes, and sweet corn, as well as soybeans and corn for agricultural uses. He has more than a dozen irrigation motors ranging in size from 20 hp to 50 hp. He wanted to switch from diesel- to electricity-driven motors for his irrigation system, but only had single-phase power. "When I learned about DEC's grant program for VFDs, I was overjoyed," he said. Carlisle was among a handful of farm customers who were the first to opt for the VFDs.

His decision was driven by considerations of efficiency and convenience. He knew that an electric irrigation system would save him time and money. A diesel motor is about half as efficient as an electric one. A VFD system is between 96 and 98 percent efficient, while the efficiency of a diesel motor ranges from 30 percent to 40 percent. And, with an electric system, said Carlisle, he could avoid the maintenance required of a diesel motor. The time spent maintaining the diesel motors — everything from batteries, fan belts, radiators, drive shafts, and fuel tanks — is time lost to irrigation. There's another benefit, too — it is quiet and nonpolluting. "I call an electricity-driven system power without smoke and noise."

Carlisle said that the electricity for his entire irrigation system costs $18,000 a year, which is roughly 30 percent less than the cost of a diesel-powered irrigation system.

As for the load control program, he admits it is “a little inconvenient,” but adds that he does not have to pay a demand charge during peak times.

Carlisle adjusts the rate of irrigation, if the soil moisture is below a certain level. “I need to be in the field to check the moisture level and look at the crops.” Because of the rolling terrain, he uses a center pivot irrigation system.

Adam Dickerson, a brother of DEC’s Troy Dickerson, farms 900 acres on which he grows soybeans, corn, and watermelon. Dickerson uses center pivot irrigation for the corn and soybeans, and subsurface drip irrigation for the watermelon.

He calls himself a “guinea pig,” as the first to apply for a VFD grant. At that time, he was using 10 diesel motors. One four-cylinder diesel engine with a 60-kW generator attached to it, for instance, used approximately 3 gallons of diesel an hour, with annual fuel costs of approximately $8,000 and annual O&M costs of roughly $450. “With the VFD, my annual electricity cost for that pump is approximately $1,100,” he said, adding that the system requires virtually no maintenance. Dickerson has since installed three additional VFDs — and he wants to install more.

The VFD system is very user friendly, said Dickerson, with a green start button and a red stop button. And, there’s no maintenance, he noted. As a result, more time can be devoted to irrigation. In addition, “it lowers greenhouse gas emissions on the farm.” Another advantage, he said, is the ability to change the pressure per square inch and the flow rate. “That wasn’t possible with the diesel motor, which had to be run continuously to get the voltage at the right level.”

Referring to the VFD’s soft start, Dickerson said it allows the water pressure to ramp up slowly, reducing stress on the irrigation system. And, the VFD system is so quiet “that you can hear yourself think,” he said.

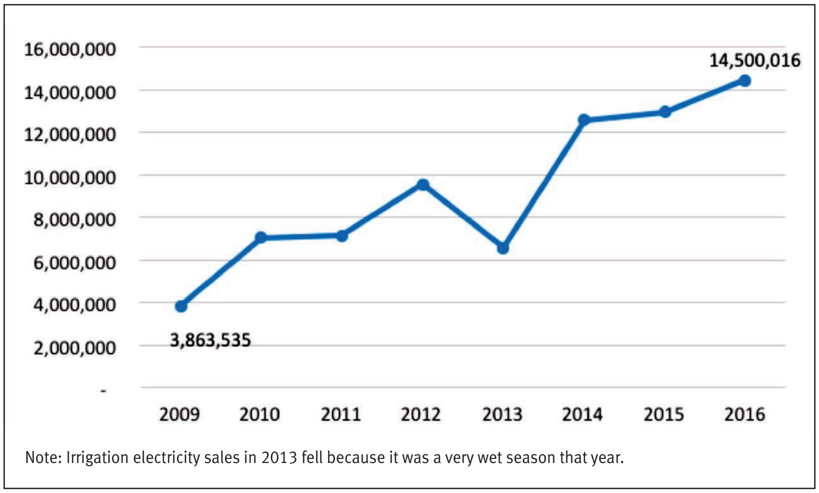

FIGURE 3: Total Irrigation kWh Sales. *Source: Delaware Electric Cooperative*

HOW DOES THE COOPERATIVE BENEFIT?

The irrigation program has benefited the co-op in several ways, said Nielson. It helped DEC meet the state’s target of 15 percent energy and demand reduction by 2015. “We were the only utility in the state to accomplish this.”

In addition, the VFD irrigation program has boosted electricity sales. Since DEC inaugurated the grant program, its sales have increased by 375 percent (see Figure 3).

The co-op was able to increase sales without increasing demand, thereby increasing its load factor.

There is also a qualitative benefit of the program, said DEC's Andrew. It reinforced the co-op's reputation as a credible advocate of the value of electric power.

WHAT ARE THE EXPECTED REDUCTIONS IN FOSSIL FUEL EMISSIONS AND COST?

The reduction in carbon emissions resulting from a conversion to an electricity-driven motor from a diesel-driven one was calculated by Keith Dennis, NRECA's senior director of strategic initiatives. "Generally, switching power for an agricultural pump from a diesel engine that is 40 percent efficient to a 95 percent efficient electric motor equipped with a 97 percent efficient VFD, results in carbon emission savings of 75.7 percent," he said. " If the pump is run for 750 hours annually, this amounts to 26,570 kilograms of carbon saved from the atmosphere each year — the equivalent of approximately 6.25 cars."

Details of Dennis' calculations are provided in the sidebar ***Estimating Emission Reductions***.

Studies show that diesel-driven motors can cost up to twice as much to operate as an electricity-driven motor.

O&M

Several studies, including those published by Pumps & Systems and NSW Farmers, indicate that diesel-driven motors can cost up to twice as much to operate as an electricity-driven motor. According to Pumps & Systems, "The economics of irrigation pumping favor electric motors."

PROGRAM PERFORMANCE FOR THE COOPERATIVE

DEC has a total of 1,063 irrigation accounts, of which 785 systems have an off-peak rate, said Nielson. Under the irrigation program, 255 diesel generators were replaced with electric motors, of which 136 were VFD systems. The remainder were converted to electric power by extending the distribution system to the location of the diesel generator, which the co-op determined would be less expensive than installing a VFD.

HOW DID THE COOPERATIVE MAKE THE SALE?

DEC pulled out all the stops when it came to promoting the VFD program. The co-op's marketing team developed a comprehensive strategy to communicate with farmers and the general public. "We needed to make sure farmers understood the benefits of installing a VFD, while also educating the public on how helping farmers install irrigation pivots and variable frequency drives was also providing a much needed boost to Delaware's economy," said Nielson.

The communications plan included:

- Press releases sent to local, regional, and industry publications
- A TV commercial, which aired on the local CBS/FOX affiliate
- A talk show segment on the VFD program and its benefits, featuring a farmer who was helped by the program (aired on the CBS affiliate)
- A brochure and poster board to be taken to various agricultural and community events
- Presentations to regional farming groups
- Numerous posts on social media touting the benefits of the program and DEC's commitment to farmers
- A YouTube video explaining the program
- An information packet containing more technical information for farmers interested in the program
- Radio talks by the-CEO discussing the program

"All our staff was very visible," said Andrew. "We spoke at farm bureaus and the state fair, and we met with farmers." Once a few farmers were on board, they really sold the program, he said.

According to the CBS affiliate, the talk show on the VFD program was seen by more than 200,000 people. And, the press release was picked up by nearly every daily and weekly newspaper in the state. Social media posts on Facebook and Twitter were viewed by thousands and the YouTube video was watched by more than 700 people.

Word of mouth played a key role, said Nielson. "When irrigation contractors and installers learned of the program, they promoted it."

The only challenge faced by DEC was the popularity of its irrigation grant program. "We had a difficult time keeping up with demand," said Nielson.

WHAT DO COOPERATIVES NEED TO KNOW OR DO?

To assess the opportunity for beneficial electrification with irrigation, cooperatives that count farmers among their commercial/industrial customers can start by identifying those who either use diesel motors for irrigation or have only single-phase power. If there are a sufficient number of agricultural members who could benefit from a conversion to electricity-driven motors — either through three-phase line extension or a VFD system — the next step is to gauge interest.

At the same time, co-ops should meet with representatives of the U.S. Department of Agriculture, as well as state environmental resource agencies, to discuss opportunities to fund beneficial electrification projects focused on irrigation. USDA's Natural Resources Conservation Services provides incentives for reducing carbon emissions resulting from diesel motors, and the USDA's Rural Energy for America Program (REAP) provides grants for conversion from diesel to electric irrigation.

With these insights, cooperatives would then be able to determine what funding they could allocate to an irrigation grant program and what kind of off-peak rate and/or load control options they could offer.

Discussions with farm bureau representatives and co-op farm customers can help to estimate likely participation in an irrigation grant program. It would also be useful to talk with other cooperatives that have initiated similar programs to learn about their experience. For an example of achievements in beneficial electrification with irrigation, see the sidebar ***Florida Diesel-to-Electric Conversion Program Benefits Agricultural Producers***. Under a 2-year program, agricultural producers in Florida — including electric cooperative farm customers — have reduced greenhouse gas emissions and energy costs by converting from diesel-driven irrigation pumps to electricity-driven ones.

Finally, it is important for cooperatives that decide to launch an irrigation grant program to educate all staff on the program availability and to pursue a variety of options in promoting the program, to help create awareness with members and ensure program success.

LESSONS LEARNED AND NEW DEVELOPMENTS

DEC's Nielson said that a co-op can benefit by getting support from the U.S. Department of Agriculture, a statewide organization or both. It is worth turning to agencies that may provide subsidies for beneficial electrification projects promoting air quality.

A program that promotes greater electricity use while benefiting customers can be good for a co-op. Nielson suggested identifying customers who could benefit from new kinds of electrical service. ■

NEBRASKA PPD HELPS IRRIGATORS SAVE MONEY

Wheat Belt Public Power District (PPD) in Nebraska did not focus on the technology used by its farm irrigation customers — until the utility's wholesale rate changed.

When that happened, the PPD decided to structure a rate that would spur irrigators to manage their energy use around peak pricing, said Tim Lindahl, the utility's general manager. The result was a rate structured around time-of-day (TOD) pricing (between 10 p.m. and noon) that would reduce demand charges for irrigators from $12 per kilowatt per month to $2/kW/month.

The rate, tested for the first time in 2017, enabled participating customers to save between $5,000 and $7,000 a field, said Lindahl. Irrigators benefit in other ways, too, he said. "They're able to use water more efficiently with this rate."

Farmers who opt for the TOD rate need to buy a hardware/software solution for their pivot — costing about $500 — that allows them to control their irrigation systems from a phone or by programming the times of operation.

"Until now, we've been competitive with diesel-driven irrigation systems, but this TOD rate will blow diesel out of the water," said Lindahl. "We're trying to make conversion from diesel to electric as attractive as possible."

Although the PPD was targeting its irrigation customers, it offered the same rate structure to other commercial customers. Large industrial customers already had a TOD rate.

To learn about the impact of the rate first hand, NRECA talked with Mike Blomenkamp, who farms nearly 1,900 irrigated acres on which he grows corn, wheat, and soybeans. He is also a PPD director, so Lindahl urged him to assess the program by opting for the rate.

Last July was one of the hottest on record for the PPD, said Blomenkamp. "The pivots came on at night and the corn never showed any signs of stress — except for an acre or two on one hilltop at the very edge of the pivot, where the corn curled a bit."

He noted: "Water is our most precious resource, and the TOD rate proves that we don't have to turn the pivot on and leave. You can get by with less water than you might think."

The TOD rate has had a "massive impact" on him, said Blomenkamp. "When you're spending in the high five figures to low six figures on irrigation, cutting that by one-quarter goes straight to the bottom line." He estimates his savings on corn irrigation at $25,000, and said the TOD rate makes him a better water steward.

The new rate also is a powerful incentive to switch from diesel irrigation to electric irrigation, said Blomenkamp. "I believe this is a game changer." However, he added, each PPD's line extension policy would have to be studied to see if it would be economically viable.

Looking ahead, Lindahl plans to promote the rate next year by emphasizing three points: cost savings, more efficient use of electricity by levelizing the peak, and the advantage of converting to electric irrigation systems.

There are two parts to the efficient use of energy, said Lindahl. "We have an overabundance of energy at night, so we're shifting much of electricity use to nighttime hours. In addition, we want to structure the program to eventually provide a balance with renewables."

Fifty irrigation systems took advantage of the rate, he said, and the feedback has been entirely positive.

For other publicly owned utilities, the biggest obstacle — or opportunity — will be the wholesale rate, said Lindahl. "If a utility's wholesale rate doesn't have peak or off-peak hours, a TOD rate will be more difficult to implement. ■

ESTIMATING EMISSIONS REDUCTIONS

The reduction in carbon emissions resulting from a conversion to an electricity-driven motor from a diesel-driven one was calculated by Keith Dennis, NRECA's senior director of strategic initiatives. "Generally, switching power for an agricultural pump from a diesel engine that is 40 percent efficient to a 95 percent efficient electric motor equipped with a 97 percent efficient VFDs, results in carbon emission savings of 75.7 percent," he said. "If the pump is run for 750 hours annually, this amounts to 26,570 kilograms of carbon saved from the atmosphere each year — the equivalent of approximately 6.25 cars."

Dennis used the following assumptions: 100 hp-rated diesel engine consuming fuel at a rate of 4.6 gal/hr. The emissions factor for diesel used was 10.17 kg CO_2 per gallon, and the emissions factor used for electricity was 0.3508 kg CO_2 per kWh, which is the emissions factor for the NERC (North American Electric Reliability Corp.) region RFCE (Reliability First Corporation/East), containing Delaware.

Base methodology using Excel Tool and Climate Registry values:

- Electric motor is 95% efficient
- Diesel engine is 40% efficient
  - Based on this 40% efficiency, 750 hours of annual usage, and 100 hp rating, the amount of total annual horsepower-hours needed was found (30,000 hph)
  - Based on this horsepower-hour total, the total annual kilowatt-hour equivalent was found (22,371 kWh) with a conversion factor of 0.7457 kWh/hp
  - The diesel engine operates at a consumption rate of 4.6 gal/hr
- Emissions factors are as follows:
  - 0.3508 kg CO_2 per kWh for the RFCE region in 2017 (contains Delaware)
  - 10.17 kg CO_2 per gal for diesel in the US (via the Climate Registry)
- Since electricity does not have an equivalent volume measure to gallons of diesel for emissions analysis, the basis for electric usage will be annual kilowatt-hours. The basis diesel usage will remain the same — in gallons — since there is no emissions factor for diesel based on horsepower-hours. ■

Comparison of Electric and Diesel Motor Emissions

Motor Type	Motor Efficiency	Emissions Factor (kg CO_2/kWh)	Emissions Factor (kg CO_2/gal)	Annual Usage (kWh)	Annual Usage (hr)	Fuel Consumption Rate (gal/hr)	Annual Emissions (kg CO_2)
Electric	92.15%	0.3508	N/A	22,371	N/A	N/A	8,516
Diesel	40%	N/A	10.17	N/A	750	4.6	35,087

Savings due to conversion of 150 diesel engines to electric: 3,985,534 kg CO_2 per year (75.7% emissions kept out of the atmosphere)
Electric Motor: ((22,371 kWh/year)/92.15%)*(0.3508 kg CO2/kWh) = 8516 kg CO_2/year
Diesel Engine: (750hrs/year)*(4.6 gal/hr)*(10.17 kg CO_2/gal) = 35,087 kg CO_2/year

FLORIDA DIESEL-TO-ELECTRIC CONVERSION PROGRAM BENEFITS AGRICULTURAL PRODUCERS

Under a 2-year program, agricultural producers in Florida — including electric cooperative farm customers — have reduced greenhouse gas emissions and energy costs by converting from diesel-driven irrigation pumps to electricity-driven ones.

The program, which ran from 2015 to 2017, was funded by the Florida Department of Agriculture and Consumer Services, and delivered in partnership with Suwannee County Conservation District and EnSave, Inc. — which provides services for agricultural producers as well as government and utility clients. The Florida Energy and Water Efficiency Realization Program (FEWER) offered free energy audits and cash incentives to Florida agricultural producers.

The program delivered 190 audits to agricultural producers throughout Florida, and 132 of these farms implemented energy-saving projects through the program. Among the agricultural producers were 134 electric cooperative customers representing four rural electric cooperatives. These co-op customers replaced diesel powered irrigation pumps with electric powered pumps. Audits analyzed up to five center pivots or five pumps for irrigation, and the program provided incentives that covered 75 percent of the cost, up to $25,000.

Farmers worked in collaboration with their local electric cooperative to run new electric lines to the farm, while the FEWER program incentivized the cost of the pumps and their connection to the electric grid.

Practices like converting diesel irrigation pumps to electric ones is a component of what has come to be known as “environmentally beneficial electrification,” which favors electrification of applications that typically use on-site fossil fuels (such as space and water heating and vehicles). The environmental benefit comes from the reduced emissions generated by electricity compared with other fuels. The environmental benefit increases when the electricity is generated with low-carbon methods, which are only expected to grow as the electric grid incorporates more renewable energy and low-carbon generation.

Electric pumps have several advantages over diesel in addition to the environmental benefits. Most immediately, the farmer reaps cost savings due to the lower cost of electricity use and reduced maintenance cost. A diesel engine requires frequent monitoring and replacement of the engine oil and filters. Electric motors are also quieter to run and easier to control through automated systems.

Together, these farms added 790,000 kWh to the grid annually by displacing 181,661 gallons of diesel fuel, for a net savings of more than 22,000 MMBtu of energy.

These diesel-to-electric conversions resulted in the reduction of more than 3 million pounds of CO_2, and 1.45 metric tons of CO_2 equivalent.

These installations also delivered $292,537 in annual cost savings to the producers.

Table of Energy Savings and Greenhouse Gas Reductions

Farms	kWh	Diesel (gal)	MMBtu	CO_2 (lb)	N_2O(lb)	CH_4(lb)	SO_2(lb)	NOx(lb)	$mtCO_2e$
34	(790,405)	181,661	22,259.9	3,178,277	37.2	(32.9)	(632.4)	2,746.6	1,446.4
Source: EnSave, Inc.									

Continued

FLORIDA DIESEL-TO-ELECTRIC CONVERSION PROGRAM BENEFITS AGRICULTURAL PRODUCERS (CONT.)

A program like that in Florida can be pursued by electric cooperatives in other parts of the country to incentivize switching from diesel to electric pumps. Such a program builds load for the electric cooperative, saves money for the farmer, and contributes to reducing greenhouse gas emissions.

EnSave has worked with farmers and their electricity providers for 25 years, helping farms reduce costs through energy efficiency. The firm provides energy audits, specialized consulting, and energy efficiency program design and implementation services. ■

About the Author

Alice Clamp is a technology writer for the Cooperative Research Network, a service of the Arlington, Virginia-based National Rural Electric Cooperative Association. With more than two decades of experience in the energy field, she has researched and written articles on renewable energy, nuclear energy, fossil fuels, grid reliability, environmental issues, energy efficiency, demand response, and emerging technologies.

Questions or Comments

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