AGRICULTURE: An Often-Overlooked Opportunity For Energy Conservation

Alex H.W. Lee, Ph.D.
Jay W. Zarnikau, Ph.D.
Strategic Planning and Pricing, Planergy Inc.
Austin, Texas

Editor's Note: Agriculture is a major part of our economy, and yet ways to save energy in this sector are rarely examined. This article explores sophisticated conservation measures being taken in the "Panhandle Region" of Texas, New Mexico, and Oklahoma.

The United States can be divided into many additional agricultural regions, each with its own distinctive qualities and opportunities. Many of the improvements discussed here can be applied in them.

One of the most important agricultural regions in the U.S. is the Panhandle region, the Southern region of America's Great Plains. In recent years, there has been renewed interest in agricultural energy efficiency in the Panhandle region which covers Eastern New Mexico, Texas Panhandle, and Oklahoma Panhandle. The declining prices for agricultural products has prompted local farmers and agribusinesses to control costs so as to maintain profitability. In the Panhandle region, electricity is provided primarily by Southwestern Public Service (SPS) Company.

Four different types of agricultural activities or establishments—irrigation pumping, feed lots, grain elevators, and cotton gins—account for over three-quarters of SPS's retail sales of electricity to the agricultural sector. Although the focus of this article is to explore cost-effective energy-efficiency opportunities in the Panhandle agricultural sector, most of the measures can be applied to other agricultural regions in the U.S.

Specific energy efficiency measures are identified and potential energy savings are quantified. In addition, the economic payback periods for these measures are also estimated. Hopefully, this analysis will can help formulate effective energy policies for the agricultural sector, the design of cost-effective demand-side management strategies, improved energy tariffs and economic and environmental benefits not only to the Panhandle region, but also to the total agricultural sector.

Energy efficiency is hailed by many as a cost-effective alternative to constructing additional electricity-generating facilities for addressing some environmental problems, and increasing productivity. Energy efficiency in the agricultural sector can provide a variety of benefits to agribusinesses and society. Reduced spending on energy resources can improve profitability for agribusinesses. Society benefits as reduced energy use curbs production of air-, land-, and water-polluting emissions.

However, efforts to promote energy efficiency in the agricultural sector face many obstacles. There is an extreme diversity of electric end-uses used in agriculture from irrigation to grain drying. In addition, there is also an extreme diversity in the size of agricultural operations. On one hand is the small family farming operation that is particularly interested in electricity use that will save time and cut costs. On the other hand are the large commercial farms and agribusinesses that are also interested in producing the most product with the least inputs. Budget constraints, lack of information about new technologies, uncertainty about future energy costs, and manpower constraints are among other barriers faced in developing an effective energy efficiency program in the agricultural sector.

Despite these barriers, a number of actions can be taken by the agricultural energy consumers. Policy makers, regulators, and utilities can also play a vital role by taking steps to improve energy pricing, offering more effective demand-side management (DSM) programs, ensuring services and tariffs are available to satisfy emerging energy needs, promoting technology transfer between universities and agricultural industry, as well as encouraging education and training on energy issues.

OBJECTIVES

A study of energy-efficiency opportunities in the Panhandle agricultural sector was conducted to:

- Define an upper limit of the technical and economic potential for electrical energy savings and peak demand reduction in the agricultural sector served by SPS.

- Assess the impacts and costs of promising agricultural sector energy efficiency measures.
- Provide input to demand-side management (DSM) screening exercises so as to assess the cost of energy saved relative to the marginal cost of generation on the utility system.
- Satisfy regulatory requirements that SPS sponsor a comprehensive analysis of potential demand-side resources in its service area.

In this study, key agricultural sector end-uses are identified and the costs and impacts of a set of promising energy efficiency measures are quantified. Irrigation systems, grain elevators, cattle feedlots, and cotton gins are examined in detail. Together, these facilities account for over 75 percent of the utility's agricultural sector retail sales.

IRRIGATION

Electricity use for crop irrigation is the most important agricultural sector in the Panhandle region in terms of its contribution to coincident peak demand, energy sales, and numbers of customers. In 1991, SPS reported 3,636 electric motors used for irrigation pumping in the retail service area (SPS, 1991). The High Plains accounts for 68 percent of the irrigated cropland in Texas and 12 percent of the total irrigated cropland in the United States (Ellis, 1985). The primary irrigated crops in the SPS service area are wheat, cotton, corn, sorghum, and vegetables (SPS, 1991). Irrigation costs comprise over one-third of the total production costs of the major irrigated crops produced on the Texas High Plains.

Electric irrigation pumping is expected to increase slightly in the future, while the use of natural gas for irrigation pumping is expected to decline (SPS, 1991). During the 1980s, there was a trend toward increased dry-land crop production (TWDB, 1991). Irrigation wells were becoming less productive as the underground water level declined. However, with the introduction of more efficient irrigation technologies, this trend now appears to be reversing.

Irrigation efficiency has received increased attention in recent years, particularly in the Texas High Plains. The motivation for heightened interest has primarily been the need to conserve water in the

Ogallala aquifer, whose water level has been declining in recent decades. Water conservation measures typically result in energy conservation, as well. Reduced water requirements usually imply lower water pumping needs. Pumping-related motor loads are the primary energy use in crop irrigation. Opportunities for energy efficiency tend to lie in the following areas:

- pumping plant efficiency;
- water application efficiency; and
- load control.

In the Panhandle region, there is a trend toward increased use of low pressure sprinkler systems, many employing Low Precision Energy Application (LEPA) technology.* Following the 1993 harvest, an exceptionally good year for many farmers, many standard furrow and sprinkler systems were replaced with low pressure sprinkler systems. Sixty-six HP is the average rating on new sprinkler system pumps.

Much of the crop land on the Panhandle is farmed by tenant farmers. While the tenant farmer may own the motors and water distribution equipment used for irrigation, pumps may be owned by the landlord. This ownership pattern presents the classic "landlord-tenant problem" where energy and water conservation efforts may be thwarted by divergent economic interests between the two groups.

Base Case Conditions.

Table 1 shows the baseline average electricity consumption per acre for each type of irrigation system.

Load Shape Development

To develop base case hourly load shapes, annual estimates of electricity consumption by jurisdiction and sprinkler system type were segregated into monthly values using billing data. The load curves within each month were assumed to be flat, which is consistent with survey

*LEPA was designed to reduce water losses from wind drift and evaporation, improve yields, and lower energy costs for pumping. LEPA applies water directly to a furrow (between rows) at low pressure through drop tubes and orifice controlled emitters, or spray nozzles. The water is applied from 4 to 8 inches from the soil surface.

Table 1. Base Case Annual Electricity Use per Acre by Type of Irrigation System for Retail Service Area Only (kWh per Acre)

Type of Irrigation System	Texas	New Mexico	Oklahoma
Sprinklers			
High pressure	773	1,181	933
Low pressure	622	950	751
LEPA	486	N/A	N/A
Furrows	738	1,128	891

findings that irrigation pumps are run continuously with few interruptions.

Efficiency Measures

Here are estimates of the potential energy savings and peak demand reduction from five promising types of efficiency measures:

- conversion of existing low pressure sprinkler systems to LEPA;
- conversion of existing high pressure sprinkler systems to LEPA;
- efficiency improvements to existing furrow systems;
- downsizing of motors used for irrigation; and
- pumping plant efficiency.

These measures are described in this section.

Conversion of Existing High Pressure and Low Pressure Sprinkler Systems to Low Energy Precision Application (LEPA)

LEPA is designed to be used in conjunction with microbasin land preparation (e.g., furrow diking, where mounds of soil are placed at selected intervals across the furrow between beds to form small storage basins). Water is often applied in large drops to reduce water surface area and resulting evaporation losses. Water losses for LEPA systems are only 2 to 3 percent, compared to at least 20 to 25 percent from typical impact sprinklers and low pressure drop nozzles. Further, LEPA's lower operating pressure significantly reduces pumping costs.

It should be noted that some analysts hypothesize that LEPA might actually increase rather than decrease, electric loads. In many areas of the Panhandle, irrigation wells were abandoned when their flow rate dropped below 50 gallons per minutes, rendering even low-pressure center pivots uneconomical. However, LEPA systems can operate with such low flow rates. Thus, wells that were previously abandoned may be used once again in the future and contribute to increased irrigation pumping electrical loads (Stark, 1991).

The cost of converting an existing center pivot sprinkler system to LEPA is roughly $72 per acre. Actual costs will depend upon row width, the need for pressure regulators (usually required for unlevel land), and the type of nozzling. On conversions, actual cost will also depend upon the outlet spacing on the original equipment. New quarter-mile center pivots can be equipped with LEPA components for $3,000 to $4,000 more than the cost of a new system equipped with conventional spray nozzles (New and Fipps). According to Hall, Lacewell, and Lyle (1988), the life of LEPA equipment is 15 years.

Efficiency Improvements to Furrow Systems

Improved furrow practices include use of tailwater pits, pipeline transport of water to the field, blocking the ends of the furrows, recirculation pumps, reduced length furrows, and significantly higher levels of management (Masud and Lacewell, 1991). Surge valves may also be used. Fourteen percent potential savings were estimated under the assumptions that all acreage irrigated with conventional furrow technologies were converted to "improved furrow" irrigation.

Downsizing of Irrigation Motors

Data collected from pump tests reveal that a significant fraction of the existing motors used for irrigation pumping in the Panhandle are oversized relative to current requirements. Replacing these existing motors with properly-sized motors will result in some energy savings. A range of 5 to 10% energy and demand savings was estimated.

Pumping Plant Efficiency

Irrigation pumping efficiency tests reveal considerable potential energy savings from improvements in pumping equipment (the water pump and motor). An optimum level of energy conversion efficiency in irrigation pumping operations is considered to be 67.5%. In the South High Plains, the average efficiency has been estimated at 46.2% (Stark, 1995). Higher efficiency levels are quite achievable. For example, a much higher average efficiency of 60.4% was estimated for the Rio Grande Valley, where energy costs are higher and higher value crops are produced.

Much of the inefficiency in pumping operations may actually be attributable to the efficiency improvements in water application equipment (e.g., the introduction of LEPA systems and recent improvements to furrow systems). These conservation retrofits have reduced required pumping pressures, leaving the pumping equipment oversized in relation to the needs of the water application system.

Some further pumping equipment oversizing has resulted from changes in well characteristics over time. If the water level in the vicinity of a well declines over time, pumping equipment that was sized correctly for original well characteristics may later be improperly sized. As a general rule, it will be cost-effective for a farmer to replace existing pumping equipment if the efficiency of existing equipment is found to be less than 33.75% (one half of the optimal level).

FEED LOTS

Energy efficiency opportunities for cattle feed lots were also explored. Thirty feed lots are currently operating in the Panhandle region. Each feed lot consumes an average of 1,500 GWh per year and has an average demand of 300 kW.

A feed lot is a fenced-in feeding area, used to "beef up" or fatten cattle before they are slaughtered. Most feed lots have a modified grain elevator to process grain, and mix it with molasses, hay, and any other nutrients/vitamins that are necessary to produce healthy cattle. The major electrical load in feed lots stems from the large motors that grind the grain, and mix the additives. The motors are typically generalized into the following categories:

- Roller motors; facilities may have up to 10 of these motors (one for each roller), which range from 30 to 100 HP, depending on the number of cattle the facility can hold. These motors account for the bulk of the electrical load, as they are in operation during the entire process.

- Auger motors are used for material handling. These motors range from 5 to 50 HP, depending on the length of the auger required for a particular amount of feed.

- Boiler fans and exhaust fans, which are generally between 2 and 20 HP.

- Airlift motors, which are generally very large, but seldom run. They range between 75 and 150 HP.

Pumps and air compressors, which are between 1/2 and 20 HP. These motors are rarely used.

High Efficiency Motors

COMQUEST II was used to calculate the potential savings from motor efficiency measures at feed lots served by SPS. COMQUEST II is an energy auditing software, developed by Planergy, Inc., which is designed to quickly assess the viability of energy savings retrofits for commercial, industrial, and agricultural facilities. COMQUEST II results were calibrated to monthly billing data provided by SPS to ensure that realistic results were obtained for feed lots in the entire SPS service area.

Adjustable Speed Drive Motors

Adjustable-speed drives (ASDs) can be very cost-effective for applications that have highly variable load profiles. An ASD will reduce the speed of a motor by adjusting the frequency, voltage, or current of the motor input so that the motor performance just matches the present load. Sparrow and McKinzie (1992) presented a summary of potential savings for use of ASDs in 30 process and manufacturing industries. They estimated electricity savings of 2% to 12% for these industries. Due to limited data specific to the agricultural sector industry, the results from their study will be applied to agricultural sector in this study.

EXCEL spreadsheet programs were constructed to calculate the technical potential savings for adjustable speed drive motors. A range of minimum to maximum energy and demand savings were estimated using field data from Sparrow and McKinzie's study. The cost for all ASD motors were obtained from large manufacturers such as General Electric and Baldor. The investment costs for new motors was calculated assuming motor lifetimes of 10 years. Energy savings were calculated for applicability factors of 5 and 10% based on discussions with local motor vendors.

GRAIN ELEVATORS

This study also addressed the electricity energy efficiency potential for grain elevators. Currently, 343 electric meters serve the grain elevators in the Panhandle region. Each grain elevator consumes an average of 700 MWh per year and has an average demand of 630 kW.

A grain elevator is a facility used to dry and store grain. The drying process begins with an elevator transporting grain from a dump pit, where the grain was unloaded from trucks to a wet tank and then to a dryer. The large fans of the dryer's gas drying chamber blow hot dry air across the grain until it reaches a specified moisture level. The grain is then elevated to the top of the silos, the large concrete or tin tanks which store the grain until it can be delivered to the customer. While stored, large fans at the bottom of the silos blow air into the grain to keep it at a certain moisture level and temperature. At the top, another fan is drawing air out, providing a flow of air through the grain.

The typical grain elevator runs approximately 800 hours per year. Operated up to 24 hours a day during the harvest season, the grain elevators are operated at a reduced schedule the rest of the year. The average harvest season lasts 8 to 10 weeks. There are three main types of applications for motors in grain elevators. These classifications are listed below.

- *Elevator leg motors* which elevate the grain to the top of the silo range from 30 to 300 HP, depending on the height of the silo and the speed at which it moves the grain.

- *Auger/drag/belt motors* which range between 5 and 50 HP, depending on the length of the conveyor. These motors are smaller than elevator leg motors since they primarily move the grain in a horizontal direction, and have very little vertical movement.

- *Fan motors* range between 3 and 30 HP depending upon the amount of air flow needed, and the quantity of grain. Generally dust fans are over-sized due to the pressure needed for this process.

The efficiency measures for grain elevators include the conversion to standard motors to high efficiency models and the use of adjustable speed drive motors.

High Efficiency Motors

As with feed lots, COMQUEST II was used to calculate the potential savings from motor efficiency measures at grain elevators served by SPS.

Adjustable Speed Drive Motors

Again, EXCEL spreadsheet programs were constructed to calculate the technical and economic potential savings for adjustable speed drive motors.

COTTON GINS

The electricity energy efficiency potential for cotton gins was also investigated in this study. Seventy-one cotton gins (each gin may have more than one meter) are currently operating in the Panhandle region. Each cotton gin consumes an average of 1,000 MWh per year and has an average demand of 1,000 kW during months of operation.

A cotton gin is a processing facility which separates the fiber from the seed and other impurities in raw cotton. It can require over 100 motors to prepare cotton for the textile industry. Cotton gins have multiple blowers which move the cotton pneumatically throughout the process. These high pressure, high flow rate fans consume large amounts of energy. The next largest energy consumer is the gin stands. Impurities such as bolls, rocks, dirt, stems, and leaves must be removed before the fibers can be removed from the seed.

Cotton gins are mainly operated during harvest season and the months following. Gins are operated from the last week in early October through March. The typical cotton gin operates for 1,200 hours per year, approximately 22 hours per day.

There are many applications for motors in the cotton gins, including fans, module feeds, conveyors, shredders, and grin stands. There are often as many as 75 motors in a cotton gin, and few of them are under 10 HP. The largest consumers of energy are the gin itself and fans used for drying and transporting the cotton. Typically, each gin has a combine motor load of 1,000 HP.

The efficiency measures for cotton gins include the conversion of standard motors to high efficiency models and the use of adjustable speed drive motors.

High Efficiency Motors

COMQUEST II was used to calculate the potential savings of motor efficiency measures at cotton gins served by SPS.

Adjustable Speed Drive Motors

Again, EXCEL spreadsheet programs were constructed to calculate the technical and economic potential savings for adjustable speed drive motors.

METHODOLOGY: ENERGY SAVINGS

Studies from Texas A&M University and other third-party organizations were updated by Planergy and adapted to the characteristics of the SPS retail service area. A number of original engineering calculations were also performed to analyze opportunities for energy efficiency through applications of high efficiency motors and adjustable speed drives, downsizing irrigation pumping motors, and irrigation pump replacement.

For each of the measures examined, the technically-feasible (technical potential) and economic potential electrical energy savings and peak demand reduction have been calculated. The technical potential estimate is the maximum possible savings, assuming the measure is applied everywhere it is feasible to do so. In general, it is estimated as follows:

Energy/Demand Savings = (Baseline Consumption) × (% Savings Potential)

Economic potential is defined here as the demand and energy reduction that can be achieved within 3-year payback period, from the customer's perspective. Each of the savings estimates is of *instantaneous* potential. The concept of *phase-in potential* or *replacement on burnout is* not particularly relevant to the irrigation energy efficiency measures examined here, since each of these measures can be applied to today's existing equipment. However, *phase-in potential* estimates are presented for feed lots, grain elevators, and cotton gins.

For instantaneous potential, the cost of the measure is calculated as:

$$\text{Cost (\$)} = \frac{\text{Cost of Efficient}}{\text{Equipment and Labor (\$)}} - \frac{\text{Remaining Value of}}{\text{Existing Equipment (\$)}}$$

Assuming that the existing stock of equipment has lost about 10% its value, a crude approximation of the remaining value of existing equipment is given as:

$$\frac{\text{Remaining Value of}}{\text{Existing Equipment (\$)}} = \frac{\text{Original Cost of}}{\text{Existing Equipment (\$)}} \times 0.1$$

For phase-in potential, the cost of the measure is determined by:

$$\text{Cost (\$)} = \frac{\text{Cost of Efficient}}{\text{Equipment and Labor (\$)}} - \frac{\text{Cost of Available Equipment}}{\text{of "Standard Efficiency" (\$)}}$$

The aggregate savings and costs for the measure will increase cumulatively over time, as the measure is applied to an increasing number of customers. The incremental number of customers to which the measure might be applied each year is estimated by:

$$\frac{\text{Annual Eligible}}{\text{Potential Participants}} = (1/\text{Equipment Life in Years}) \times \left(\begin{array}{c}\text{Total Number of Sites at which the}\\ \text{Measure could Potentially be Applied}\end{array}\right)$$

RESULTS

Irrigation

Significant energy savings opportunities from conversion of existing irrigation systems to more efficient technologies has consistently been revealed. For these irrigation energy efficiency measures, the total technical potential electrical energy savings is over 51 GWh, or one-third of the total electricity consumed for irrigation purposes. The potential energy savings achievable with a payback period of three years or less is 4 GWh, or about 3%. The areas of greatest potential savings include pumping system improvements and improvements to existing furrow systems.

The technical potential for peak demand reduction from the irrigation system retrofit measures is nearly 13 MW. The measures with the greatest potential peak demand impact include pumping efficiency measures and improvements to furrow systems and the conversion of existing sprinkler systems to LEPA technologies.

None of the measures was found to have a payback period of less than one year. About 3,692 MWh of annual energy savings or 0.87 MW of peak demand reduction could *technically* be achieved with a payback period of less than three years. About 22 percent of the total potential savings from the measures examined could be attained with a payback period of five years or less.

Cattle Feed Lots

For the high efficiency motor measures, the instantaneous technical potential electrical energy savings is about 1,396 MWh, or 3.2% of the total electricity consumed for cattle feed lots. The potential energy savings achievable with a payback period of three years or less is 226 MWh, or about 0.5%.

The technical potential for peak demand reduction from the high efficiency motor replacement measures is about 337 kW. None of the measures was found to have a payback period of less than one year. About 226 MWh of annual energy savings or 0.032 MW of peak demand reduction could *technically* be achieved with a payback period of less than three years.

The phase-in energy and demand savings for high efficiency motors are realized proportionately each year until the EPAct becomes effective in October 1997.

The installation of adjustable speed drive motors in feed lot motor applications would yield instantaneous annual energy savings of 48 to 289 MWh and 96 to 578 MWh, for applicability factors of 5 and 10%, respectively. Similarly, demand savings of 11 to 65 kW and 22 to 130 kW, could be realized for applicability factors of 5 and 10%, respectively. The wide range of savings suggest large variation in applicability of adjustable speed drive motors. These instantaneous energy savings account for 0.1 to 0.6% and 0.2 to 1.2% for applicability factors of 5 and 10%, respectively, of the total electricity energy consumption in the feed lot industry. The demand savings account for 0.1 to 0.7% and 0.2 to 1.2% for applicability factors of 5 and 10%, respectively of the peak demand in the feed lot industry.

Grain Elevators

For the high-efficiency motor measures, the instantaneous technical potential electrical energy savings is about 27165 MWh, or 8.8% of the total electricity consumed for grain elevators. The technical potential for peak demand reduction from the high efficiency motor replacement measures is about 2.9 MW. None of the measures was found to have a payback period of less than five years.

The phase-in energy and demand savings for high efficiency motors are realized proportionately each year until the EPAct becomes effective in October 1997.

The installation of adjustable speed drive motors in grain elevator motor applications would yield instantaneous annual energy savings of 60 to 364 MWh and 121 to 727 MWh, for applicability factors of 5 and 10%, respectively. Similarly, demand savings of 26 to 156 kW and 52 to 312 kW, could be realized for applicability factors of 5 and 10%, respectively. The wide range of savings suggest large variation in applicability of adjustable speed drive motors. These instantaneous energy savings account for 0.1 to 0.6% and 0.2 to 1.2% for applicability factors of 5 and 10%, respectively of the total electricity energy consumption in the grain elevator industry. The demand savings account for 0.1 to 0.6% and 0.2 to 1.2% for applicability factors of 5 and 10%, respectively of the peak demand in the grain elevator industry.

Cotton Gins

The technical potential for peak demand from high efficiency motor replacement in cotton gins is 0 kW. The system peak for SPS occurs in

August and the Cotton Gin peak occurs in November and December; therefore, no potential system peak demand reduction is possible.

For the high efficiency motor measures the instantaneous technical potential electrical energy savings is about 2,590 MWh, or 4.2% of the total electricity consumed for cotton gins. The potential energy savings achievable with a payback period of five years or less is 350 MWh, or about 0.6%. None of the measures was found to have a payback period of less than three years.

The installation of adjustable speed drive motors in cotton gin motor applications would yield instantaneous annual energy savings of 65 to 393 MWh and 131 to 786 MWh, for applicability factors of 5 and 10%, respectively. Similarly, customer demand savings of 65 to 393 kW and 131 to 786 kW, could be realized for applicability factors of 5 and 10%, respectively. However, this potential peak demand reduction is not coincident with the utility's system peak demand. The wide range of savings suggest large variation in applicability of adjustable speed drive motors. These instantaneous energy savings account for 0.1 to 0.6% and 0.2 to 1.2% for applicability factors of 5 and 10%, respectively of the total electricity energy consumption in the cotton gins industry.

CONCLUSION

The four different types of agricultural activities or establishments discussed here—irrigation pumping, feed lots, grain elevators, and cotton gins—account for over three-quarters of SPS's retail sales of electricity to the agricultural sector. Three or four percent of the electricity used (roughly 8,281 MWh) could be conserved with a payback period of three years or less from the energy consumer's perspective (absent any utility incentives and disregarding the "societal value" of conserved water that would accompany many of the irrigation efficiency measures). Measures which were cost-effective on this basis would result in about 2 MW of peak demand reduction if implemented in an "instantaneous" or "overnight" manner.

If all measures examined with a five year or less payback were implemented, technical potential peak demand reduction and energy savings would rise to about 3.4 MW and about 14,940 MWh. Disregarding cost-effectiveness, reductions of 17.5 MW and over 62,500 MWh could be achieved through implementation of the energy efficiency measures examined here. This represents about 20% of SPS's present retail sales to agricultural establishments.

Encouraging the conversion of existing high pressure sprinkler irrigation systems to LEPA (low energy precision application) technologies was identified as one of the most cost-effective efficiency options. However, savings opportunities are limited, since many conversions of high pressure systems to LEPA or low pressure technologies have already occurred. The replacement of select existing motors in cattle feedlots with high efficiency models is also a cost-effective energy efficiency strategy, at least until new motor efficiency standards take effect and limit future savings opportunities.

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ABOUT THE AUTHORS

Alex H.W. Lee, Ph.D., received his B.S.M.E. (high honors), M.S.E., and Ph.D. in 1989, 1991, and 1995, respectively, from The University of Texas at Austin. He is a senior engineer with Planergy, Inc., which is one of the first full-service energy management and consulting firms in the nation. He is a member of the Association of Energy Engineers as well as the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and an associate member of the American Society of Mechanical Engineers (ASME). His publications include articles in *Energy—The International Journal, Energy Conversion and Management, Energy Engineering,* and *The International Journal of Heat and Mass Transfer.*

Jay W. Zarnikau, Ph.D., currently serves as director of strategic planning and pricing at Planergy, Inc. where he is responsible for screening, designing, and evaluating DSM programs, and providing consulting assistance on resource planning, energy pricing, load forecasting, and cogeneration topics. Dr. Zarnikau received his Ph.D. in economics from The University of Texas at Austin. His publications include articles in *The Energy Journal, Resource and Energy Economics, IEEE Transactions on Power Systems, The Electricity Journal,* and *The Energy Policy.*

Table 2. A summary of the technical and economic potential peak demand savings in the agricultural sector in the Panhandle region

Instantaneous Technical and Economic Potential
Potential Peak Demand Reduction at Time of System Peak
(MW)

Efficiency Measures	Payback Less than One Year	Payback Less than Three Years	Payback Less than Five Years	Total Technical Potential
Irrigation:				
Convert High Pressure Sprinkler to LEPA	0	0.87	1.09	1.09
Convert Low Pressure Sprinkler to LEPA	0	0	0	1.8
Improve Furrow Systems	0	0	1.22	3.95
Pump Efficiency Measures	0	0	0	5.7
Motor Downsizing	0	0	0	0.45
Sub Total	0	0.87	2.31	12.99
Feed Lots:				
Install High Efficiency Motors at Feed Lots	0	0.032	0.064	0.337
ASD Motors at Feed Lots	0	0	0	0.114
Misc. Feed Lot Measures	0	1.010	1.010	1.010
Sub Total	0	1.042	1.074	1.461
Grain Elevators:				
Install High Efficiency Motors at Grain Elevators	0	0	0	2.934
ASD Motors at Grain Elevators	0	0	0	0.137
Sub Total	0	0	0	3.071
Cotton Gins:				
Install High Efficiency Motors in Cotton Gins	0	0	0	0
ASD Motors at Cotton Gins	0	0	0	0
Sub Total	0	0	0	0
Total	**0**	**1.912**	**3.384**	**17.522**

Note: Mean values are assumed here for those savings estimates presented as a range in previous sections.

Table 3. A summary of the technical and economic potential energy savings in the agricultural sector in the Panhandle region

Instantaneous Technical and Economic Potential
Energy Savings Potential
(MWh)

Efficiency Measures	Payback Less than One Year	Payback Less than Three Years	Payback Less than Five Years	Total Technical Potential
Irrigation:				
Convert High Pressure Sprinkler to LEPA	0	3,682	4,609	4,609
Convert Low Pressure Sprinkler to LEPA	0	0	0	7,617
Improve Furrow Systems	0	0	5,195	16,446
Pump Efficiency Measures	0	0	0	20,776
Motor Downsizing	0	0	0	1,704
Sub Total	0	3,682	9,804	51,152
Feed Lots:				
Install High Efficiency Motors at Feed Lots	0	226	423	1,396
ASD Motors at Feed Lots	0	0	0	253
Misc. Feed Lots Measures	0	4,363	4,363	4,363
Sub Total	0	4,589	4,786	6,012
Grain Elevators:				
Install High Efficiency Motors at Grain Elevators	0	0	0	2,165
ASD Motors at Grain Elevators	0	0	0	318
Sub Total	0	0	0	2,483
Cotton Gins:				
Install High Efficiency Motors in Cotton Gins	0	0	350	2,590
ASD Motors at Cotton Gins	0	0	0	344
Sub Total	0	0	350	2,934
Total	**0**	**8,271**	**14,940**	**62,581**

Note: Mean values are assumed here for those savings estimates presented as a range in previous sections.