Western Area Power Administration

Solar DSM

Profile #29,1992

Executive Summary

Western Area Power Administration (Western) is a federal power marketing agency that was created in 1977 and is responsible for marketing energy to 615 wholesale power customers. These wholesale customers provide retail energy service to millions of customers in the central and western states, an area covering 1.3 million square miles. Western markets power from 50 power plants and sells 15% of the nation's hydroelectric generation.

The Hoover Power Plant Act of 1984, which has been superseded by the 1992 Energy Policy Act, required that all of Western's customers develop conservation and renewable energy programs (C&RE) as a prerequisite for purchasing Western's low-cost, "preference" power. Western estimates that over 3,000 customer C&RE activities are currently under way as a result of this contract requirement. Western assists in customer C&RE programs by providing peer matches, workshops, informational services, customer visits, technology transfer, and equipment loans.

Nearly 50 rural electric cooperatives (RECs) in Western's service area are now investigating the use of photovoltaic (PV) power as both a cost cutting and new service option. To date, 14 rural electric cooperatives in Western's service area have pilot PV programs which account for approximately 80 PV installations. These small utilities recognize that PV power can greatly reduce the cost of service to small outlying or difficult to serve loads. Often, a PV powered system is the least expensive solution for the load requirement due to either the cost of extending the utility line to the site, or the recurrent cost of repairing existing power lines which are damaged by storms. Examples of these loads include water pumps, communications, cathodic protection, battery charging, off grid residential (often summer cabins), sign and security lighting.

Western's involvement with PV applications began in 1989 with a request for technical assistance from K.C. Electric in Hugo, Colorado. K.C. Electric got the notion for remote PV applications in 1989 after a series of winter storms in which the utility lost close to 1,000 power poles. The resulting K.C. Electric program has served as a model for others looking to evaluate and implement PV programs. K.C. Electric identified 511 utility-powered stock well or fence charger services, and 90 miles of distribution line that included approximately 65 well services. Since these 511 services totaled more than a half a million dollars in plant investments (3% of total coop plant investment), and annual revenues of only $78,000 (0.3% of annual revenues), remote PV applications seemed to be a logical solution to the problems confronting K.C. Electric.

This profile introduces the concept of solar demand-side management, explores various opportunities for its application, and also presents the case study of K.C. Electric and its photovoltaic installations. This profile presents the important interface between renewable energy and DSM.

Solar DSM Program

Utility:	Western Area Power Administration
Sector:	Agricultural
Measures:	Photovoltaic systems for small, remote loads.
Mechanism:	Information provided and portable demonstration systems installed for participants who ultimately purchase their own systems.
History:	Pilot program began in 1989 at K.C. Electric Cooperative in eastern Colorado, various pilot programs running presently.
Participation:	14 rural electric cooperatives currently have solar DSM programs.
Installations:	80 P.V. systems
Funding:	Program supported by Western Area Power Administration and installations paid for by individual ranchers.

Conventions

For the entire 1992 profile series all dollar values have been adjusted to 1990 U.S. dollar levels unless otherwise specified. Inflation and exchange rates were derived from the U.S. Department of Labor's Consumer Price Index and the International Monetary Fund's International Financial Statistics Yearbook: 1991.

The Results Center uses three conventions for presenting program savings. **Annual savings** refer to the annualized value of increments of energy and capacity installed in a given year, or what might be best described as the first full-year effect of the measures installed in a given year. **Cumulative savings** represent the savings in a given year for all measures installed to date. **Lifecycle savings** are calculated by multiplying the annual savings by the assumed average measure lifetime. **Caution:** cumulative and lifecycle savings are theoretical values that usually represent only the technical measure lifetimes and are not adjusted for attrition unless specifically stated.

Utility Overview

Western Area Power Administration (referred to throughout this profile as Western) is a federal power marketing agency created in 1977 with the passage of the Department of Energy Organization Act. Western markets energy to 615 wholesale power customers. These wholesale customers provide retail energy service to millions of customers in the central and western states. Western's "service area" covers approximately 1.3 million square miles and includes the states of Arizona, California, Colorado, Iowa, Kansas, Minnesota, Montana, Nebraska, Nevada, New Mexico, North Dakota, South Dakota, Texas, Utah, and Wyoming. Western markets power from 50 power plants run by the U.S. Army Corps of Engineers, the Bureau of Reclamation, and the International Boundary and Water Commission.

Western sells 15% of the nation's hydroelectric generation and 75% of the regional hydroelectric generation. In 1991, Western marketed 33,858 GWh of power which accounted for more than $614 million in gross revenues. Peak demand for the year was 6,872 MW while Western's generating capacity was 10,407 MW. Western operates more than 16,550 miles of transmission lines. Western energy sales for 1991 were as follows: municipalities 10,248 GWh, cooperatives 7,518 GWh, state agencies 4,519 GWh, public utility districts 3,642 GWh, irrigation districts 2,487 GWh, investor owned utilities 2,245 GWh, federal agencies 2,072 GWh, the Bureau of Reclamation 636 GWh, and interdepartmental transfers 487 GWh. Western's electricity rates are very low. Composite wholesale rates for Western's five area offices range from a high of 3.06 cents per kWh for the Sacramento area office to a low of between 0.84 and 0.96 cents per kWh for the Phoenix area office.

Western dealt with many environmental concerns in 1991. The environmental issue having the greatest direct effect on Western was the continued drought that has plagued the west for the past six years. Western was forced to buy over 10,000 GWh of power in large part because of generating restrictions caused by the drought. Hydro generation for Fiscal Year 91 was 23,000 GWh compared with an average generation of 30,100 GWh for the years 1986 to 1990.

WESTERN 1991 STATISTICS

Number of Customers	615	
Energy Sales	33,858	GWh
Energy Sales Revenue	$614.030	million
Peak Demand	6,872	MW
Generating Capacity	10,407	MW
Reserve Margin	51	%
Western Composite Wholesale Rates		
Billings Area	1.05-1.14	¢/kWh
Loveland Area	1.80-1.89	¢/kWh
Phoenix Area	0.84-0.96	¢/kWh
Sacramento Area	3.06	¢/kWh
Salt Lake City Area	1.56	¢/kWh

[R#1,3]

Additional environmental issues led to reductions in power marketed by Western. Central Valley power plants were temporarily bypassed to ensure the correct temperature for spawning winter run salmon in California rivers. Similar water flow adjustments were made to protect endangered species in the Missouri River and Upper Colorado River basins.[R#1,3]

Utility DSM Overview

Western's involvement with DSM programs began in 1981 with the creation of the Conservation and Renewable Energy Program (C&RE Program). The C&RE Program was designed with the intent of encouraging energy conservation, improving electric power efficiency, and making C&RE technologies competitive with traditional power resources for future power needs. The Hoover Power Plant Act of 1984 required all long term Western customers to develop their own C&RE programs in order to purchase power from Western. In addition, the Guidelines and Acceptance Criteria outline customer program components. The 1992 Energy Policy Act has replaced the Hoover Act. Western customers are now required to perform integrated resource planning. Western's 1991 DSM expenditures were equal to 0.6% of gross energy revenues.

Western estimates that over 3,000 customer C&RE activities are currently under way as a result of Western's contract requirement. These program activities focus on areas such as conservation, energy management, cogeneration, wind power, solar power, biomass technology, hydropower, and geothermal power. Western assists in customer C&RE programs by providing peer matches, workshops, informational services, technology transfer, and equipment loans. Western also helps customers with their C&RE projects by providing direct technical assistance and sharing project costs. By effectively sharing C&RE program costs with its customers, Western leverages the implementation of C&RE activities.

A few of the C&RE programs that Western is most proud of are:

Navopache Electric received Western's highest C&RE award in 1989 for programs aimed at reducing demand and increasing load factor. Some interesting aspects of Navopache's programs included geothermal development of the hot dry rock technology, use of ground loop heat pumps, and developing off peak rates in order to shift load.

DSM Overview Table	DSM Expenditure ($1000)
1981	$719
1982	$880
1983	$997
1984	$1,390
1985	$2,845
1986	$3,003
1987	$3,462
1988	$3,415
1989	$3,117
1990	$2,704
1991	$3,493
1992	$3,846
Total	$29,870

[R#3]

Western customers have saved tens of thousands of dollars by borrowing infrared cameras from Western to scan electrical systems, distribution lines, transformers, substations, service drops, and buildings. The cameras reveal energy losses in buildings' hot spots that could cause future outages. The correction of problems revealed by camera use makes energy delivery more reliable and efficient.

The Sacramento Municipal Utility District (SMUD), a Western customer, is noted by Western for its efforts to integrate conservation into its resource mix. In 1992 SMUD has audited, rebated and documented 7.6 MW of demand savings and 32.7 GWH of energy savings in the commercial/ industrial sector. (See Profile #13 for a description of one of SMUD's programs.)[R#3]

COST EFFECTIVE PV APPLICATIONS FOR ELECTRIC UTILITIES

Utility Operations

Transmission Department		Environmental Department
Tower Obstruction Lights		Meteorlogical Monitoring
Dynamic Thermal Rating Sensors		Steam Flow/Level Monitoring
Remote Sectionalizing Switches		Water Quality Monitoring
Distribution Department		Communications Department
Isolated Substation Service		Microwave Repeaters
Remote Sectionalizing Switches		Remote Meter Reading Systems
Feeder Capacity/Energy Support		Emergency Call/Telephone Boxes
Dynamic Thermal Rating Sensors		Fiberoptic Installations
Power Plant Operations		Purchasing Departments
Security/Lighting/Video/Detection		Vehicle Battery Chargers
Nuclear Plant Warning Sirens		Facility Sign Lighting
Tank/Pipeline Cathodic Protection		
Remote Gate/Access Control		

Customer Service

Residential Customer Service		Industrial Customer Service
Dusk/Dawn Security Lights		Oil Well Pumping
Electric Gate Openers		Remote Pipeline Monitoring
Remote Residential Service		Remote Gas Production Metering
Commercial Customer Service		Institutional Customer Service
Gas Pipeline Cathodic Protection		Street and Structure Lighting
Pipeline Value Actuators		Park Area/Lights/Fans/ Water
Parking Lot Lighting		Remote Highway Signs/Signals
Remote Stock Watering Pumps		Remote Irrigation Controls/Meters

In recent years, nearly 50 rural electric cooperatives (RECs) have begun to investigate the use of photovoltaic (PV) power as both a cost cutting and new service option. To date, 14 RECs in Western's service area have pilot PV programs, which account for approximately 80 PV installations. Western's current PV activities are located almost solely in the Loveland, Colorado and Billings, Montana service areas, with additional interest being shown in the Salt Lake City, Utah and Phoenix, Arizona areas.

Small utilities are recognizing that PV power can greatly reduce the cost of service to small outlying or difficult to serve loads. Often, a PV powered system is the least expensive solution for the load requirement due to either the cost of extending the utility line to the site, or the recurrent cost of repairing existing power lines which are damaged. Examples of these remote loads include water pumps, communications, cathodic protection, battery charging, off grid residential (often summer cabins), sign lighting and security lighting. The accompanying table provides an extensive list of cost-effective PV applications.[R#14]

Today, PVs are cost effective for very specific niche markets. They are viewed as a solution for utilities trying to control costs. Future least cost planning strategies will include more nontraditional methods of customer service.

Western's involvement with PV applications began in 1989 with a request for technical assistance from K.C. Electric. Western's technical assistance contractor, NEOS Corporation, was asked to investigate the use of PV power as a customer service option. The resulting K.C. Electric program has served as a model for others looking to evaluate and implement PV programs.

There are many new issues to be dealt with by utilities when evaluating and implementing PV programs. One issue is the ownership of the PV equipment. Should the utility or the customer supply and purchase the PV equipment? Different approaches have been tested. All utilities, however, agree that involvement by local private sector entrepreneurs is needed for supplying equipment, simplifying systems, and providing system design and maintenance support.

Much of Western's involvement with PV applications is customer driven. Because all Western customers must develop their own C&RE programs, they often call upon Western for assistance. Western will advise PV use where it is applicable. Technical assistance is provided by Western through their technical assistance contractors: NEOS Corporation in Lakewood, Colorado and Environmental Research Groups International of Golden, Colorado.

Interest in PV products has also been helped by numerous magazine and newspaper articles about the K.C. Electric experience. Word of mouth has helped spread interest in PV systems. RECs do not actively market PV programs because there are typically only ten to fifteen customer requests per year for line extensions, although some cooperatives do have up to 100 requests for line extensions annually.[R#3,4,5]

Western has many marketing techniques in place which are not customer driven. Western publishes a bimonthly C&RE Bulletin which discusses the experiences of utilities with different C&RE programs. Western's area offices also have one on one meetings with customers to discuss their needs. Customer surveys are also sent out, inquiring about customer interest in programs to potentially be offered by Western at a future date. Western also provides a telephone hotline to answer any customer questions, including technical queries. Workshops covering specific C&RE topics are conducted by Western on a regular basis. A newsletter titled "Photovoltaic Information Exchange" is published by Western and is directed toward both current and potential PV users. Other Western marketing techniques include annual customer meetings, publication of technology transfer packets, and management updates. Western marketed PV applications before K.C. Electric began their PV pilot program.[R#3]

K.C. Electric was one of the first rural electric cooperatives to implement a pilot PV program for remote loads. K.C. Electric got the idea for remote PV applications in 1989, during a winter storm. The service area for K.C. Electric is very susceptible to winter storms. A typical storm begins with fog and drizzle, which build ice on the lines. Strong winds often result in broken poles and downed power lines. In 1989 K.C. Electric lost close to 1,000 poles due to winter storms.[R#7]

During one particular storm, Jim Zabukover, General Manager of K.C. Electric, was in his office answering phone calls and greeting ranchers coming to his office. Everyone wanted to know when their electricity would be turned back on because their livestock needed water. Zabukover saw many ranchers filling their water tanks from town storage to haul back to their ranches. Zabukover realized that these harsh storms often occurred during calving season. It also occurred to Zabukover that such storms were followed by days of bright sunshine. At this time, Zabukover recalled a PV seminar conducted by Western, and considered the possibility of using photovoltaics to solve the problem of getting water to the livestock.[R#7]

A few weeks later, Zabukover telephoned Peggy Plate of Western to discuss PV water pumping. Western was able to provide programs that helped with cost benefit analysis and equipment selection, and NEOS Corporation was contracted to provide a concept. After seeing the preliminary study by NEOS, The Photovoltaic Design Assistance Center at Sandia National Laboratories provided a grant for the purchase of the equipment to be used in the PV study, in exchange for results from the project.[R#7]

MEASURES INSTALLED

The remote PV water pumping systems are comprised of PV modules, a pump and motor, and a controller. Approximately 30% of the systems have a solar tracker. Twelve-volt PV panels are the most popular for livestock watering. Typically, systems have two to four 60 watt panels.

STAFFING REQUIREMENTS

Western provides program options, analysis, and marketing strategies through their C&RE program. The individual utilities are ultimately responsible for their own programs. The PV component of Western's C&RE program has required 8% of one person's annual work load. NEOS Corporation has done much of the work on the monitoring and evaluation of several PV programs. NEOS has four people working on PV programs, and their combined time requirements are the equivalent of one person's annual work load. The staffing requirements for the K.C. Electric pilot program are discussed in the K.C. Electric case study section.

A large body of hard data on remote PV applications simply does not exist for the Western service area. The results from the K.C. Electric pilot program are the most detailed so far. Unfortunately the lack of comprehensive systems or conservation data for remote PV programs hinders the planning process for interested utilities and increases the existing uncertainty presently associated with such an undertaking.

Please remember that the concept of using PV systems for small, difficult to serve loads instead of repairing or installing power lines, is the important lesson to be taken away from this profile. We have provided the limited data that does exist in the hopes that it serves to illustrate the potential for savings if applied on a larger scale to a broader range of applications.

DATA QUALITY

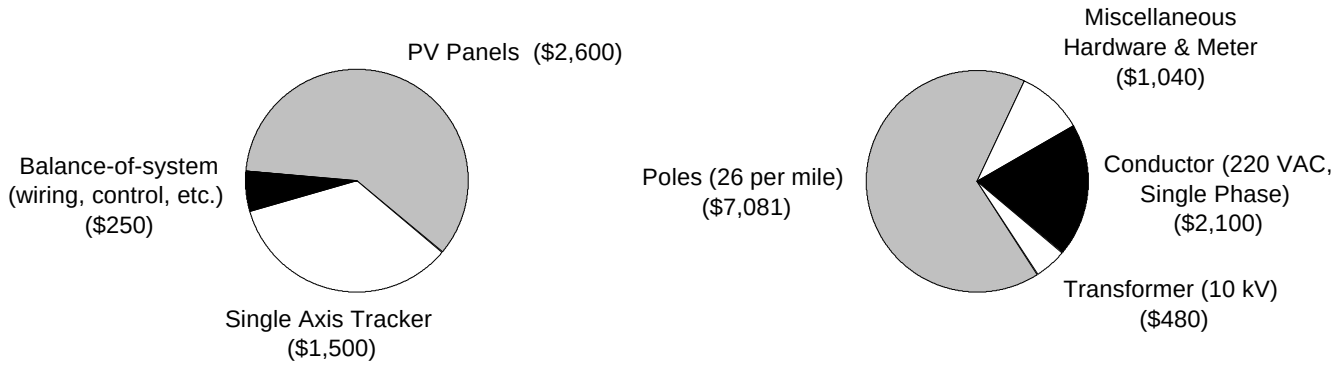
The data concerning K.C. Electric was gathered primarily from reports prepared by Western's contractor, NEOS Corporation. Actual PV system monitoring was performed by the system owners or K.C. Electric personnel. PV owners kept PV pumping system logs which contained: the date and time the data was gathered, a weather description, a water meter reading and flow rate measurement, and comments on operation and maintenance. The monitoring of the PV systems was not incredibly scientific, but K.C. Electric felt that overall customer satisfaction with the system was the most important factor in evaluating the success of the pilot PV program.

The cost overview table shows estimated installation and operation costs for conventional service and a PV system. The service costs given are for a livestock pump one mile from an existing electrical distribution system. Installed costs include materials and labor. The PV panels used represent a PV power supply sized for average pumping requirements. Operating costs are based on a $25 per hour labor rate, costs are amortized over 30 years at 6.5%, and transformer losses are based on no-load energy losses of 400 kWh per year at $0.043 per kWh. Please note that the cost comparison is only valid for the specific example described.

Dollar values in the Agency Overview and Agency DSM Overview sections have been levelized to 1990 U.S. dollars. All dollar values in the other profile sections are unlevelized.

Costs Overview Table*	Installation Costs	Annual Operating Costs	Total Estimated Cost	Lifetime (years)	Levelized Annual Cost Over Lifetime
Conventional Service	$10,701	$1,036	$11,737	30	$910
Photovoltaic Service	$4,350	$355	$4,705	20	$420

[R#11] * Estimated costs for a livestock pump one mile from an existing electrical distribution system. Costs are not levelized.



K.C. Electric Association Case Study

Approximately 80 PV systems have been installed in the Western service area since 1989. NEOS Corporation has written reports on K.C. Electric's PV experiences and has also done PV technical feasibility studies for several utilities including San Isabel Electric Association, LaPlata Electric Association, Inc. and McKenzie Electric Cooperative. Because the K.C. Electric program provides the best available data on existing PV installations, this program will be the focus of this profile.

K.C. Electric is an electric cooperative located in Hugo, Colorado. Its service territory covers over 4,000 square miles in eastern Colorado. K.C. Electric has approximately 5,500 customers, with only 2.1 customers per mile of line on average. Much of the K.C. service area is comprised of ranchland and cropland. Maintaining system reliability during winter storms that damage power lines has been a recurrent problem for K.C. Electric.

The opportunity for PV powered electric service focused on one specific utility load: remote livestock water pumping. A typical livestock pumping system in eastern Colorado consumes only 500 to 1,000 kWh per year. In K.C. Electric's service territory, it is common to run a 220VAC, single-phase feeder several miles to serve a single livestock water pump. These original and secondary feeders were installed when the costs were covered entirely by the Rural Electrification Administration (REA). The REA no longer finances these costs completely. Today, new line extensions are financed largely by the specific customer requiring the line extension, and the remainder of the cost is covered by an increase in the rate base. K.C. Electric is responsible for operating and maintaining the existing distribution system, the cost of which can be overwhelming. Line installation costs are about $10,000 per mile for K.C. Electric.[R#10,11]

IMPLEMENTATION

The actual planning and implementation of K.C. Electric's PV program occurred as follows: During the Phase 1 assistance to K.C. Electric, NEOS identified cost effective PV water pumping sites and provided technical and economic assessments for PV pumping systems at these sites. At this point, several questions arose: When is it cost-effective to provide PV power either to loads presently interconnected or new loads? If service is offered to new loads, which PV system components should the utility provide? Will these PV services provide the reliability required by the utility and its customers? How will a PV service affect the utility operations and how much should the customer be charged for the service?[R#10,11]

To answer these questions, a Phase 2 technical assistance task was implemented. During Phase 2 assistance, NEOS also addressed utility planning and policy considerations that exist when PV power is offered as a customer service; assessed program implementation methods, including customer education, trade ally cooperation, and alternative pricing; and suggested program monitoring and evaluation techniques for customer satisfaction and system reliability.

To assess the number of grid-connected livestock water pumping systems interconnected to their distribution system, K.C. Electric conducted an inventory survey. They identified 511 utility-powered stock well or fence charger services, and 90 miles of distribution line serving approximately 65 well services. These 511 services totaled more than a half a million dollars in plant investments (3% of total coop plant investment), and annual revenues of only $78,000 (0.3% of annual revenues).

By not having to rebuild the 90 miles of distribution lines, construction cost savings were estimated to be almost a million dollars. The individual well units along these 90 miles of line could be replaced by PV systems at a total installed cost of between $1,800 and $6,000 each, depending on the depth of the well and the pump requirements.[R#7,10]

Based on the survey data, K.C. Electric decided to raise the monthly service charge for all rural residential customers from $5.00 to $15.00, while the energy charge remained $0.07/kWh. In addition the first 100 kWh used by customers each month was free. Central Area Data Processing, the consulting company that performs rate analysis studies for K.C. Electric, had recommended an energy rate increase from $0.07/kWh to $0.20/kWh and a monthly service charge increase from $5.00 to $23.00. The actual rate increase was designed to encourage service disconnects by customers who were paying the minimum monthly service charge, but were not consuming any electric energy, so that K.C. would reduce the line distance that potentially would have to be reconstructed. To date, almost 40 customers (most likely those not consuming any energy) have requested service disconnects.[R#7,10]

With assistance from a cost shared grant by Sandia National Laboratories PV Systems Research Project, K.C. initially installed two PV systems for evaluation, in exchange for providing information on the performance of these first

PV PUMPING SYSTEM SPECIFICATIONS

PV Pumping System	#1	#2	#3	#4	#5	#6
Well Description						
Total Depth (ft)	180	180	45	60	18	230
Pump Description						
Type	Jack	Centr-Sub	Micro-Sub	Micro-Sub	Micro-Sub	Micro-Sub
Model	SJB 10-47	180809 DM	SDS-128	SDS-128	SDS-128	Not Available
Manufacturer	Solarjack	A.Y. McDonald	Solarjack	Solarjack	Solarjack	Photocom
PV Array Description						
Manufacturer	Solarex	Solarex	Solarex	Solarex	Solarex	Kyocera
Module Rating (W)	60	60	53	53	53	63
# of Modules	10	10	2	2	2	2
Rated Power (W)	600	600	106	106	106	126
Nominal Operating Voltage (V)	60	60	24	24	24	24
Mounting Configuration						
Type	Tracker	Tracker	Tracker	Tracker	Tracker	Tracker
Manufacturer	Zomework	Zomework	Zomework	Zomework	Zomework	Zomework
System Description						
Installation Date	May '90	Sept '91	Aug '91	July '91	June '91	Aug '91
Design Flow Rate (gal/day)	3,500	2,500	900	850	900	400
Seasonal Use	Sp,Su,F,W	Sp,Su,F,W	Sp,Su,F,W	Sp,F	Sp,Su,F	Sp,Su,F,W
Installed Cost*	$11,000	$11,000	$2,500	$2,500	$2,500	$2,500
Utility Line Extension Information						
Distance (mi.)	2.0	2.0	1.8	0.8	2.0	0.8
Cost*	$22,000	$22,000	$19,250	$8,250	$22,000	$8,250

[R#10]

* Costs are not levelized.

two PV pumping systems. Since May 1990, K.C. Electric has participated in a total of five PV pumping system installations. Remote Power, Inc. of Fort Collins, Colorado was selected to provide and install the PV equipment.

Of the two initial PV systems installed, one was fairly large, requiring a 600 watt PV power supply to yield a maximum 3,500 gallons per day with a well depth of 170 feet. The other system was relatively small, requiring a 106 watt power supply for a maximum output of 500 gallons per day at 50 feet of total well depth. The large PV pilot system was installed May 11, 1990 on Bill Bledsoe's ranch. Mr. Bledsoe eventually purchased the system from K.C. Electric. The total installed cost for the PV system was about $11,000. The average daily water output of the system was 900 gallons per day, well below the capacity of 3,500 gallons. The low average output was due to the system pumping more water than the distribution system could handle. The system's storage tank was often full, and when the tank was full, the pumping system was automatically turned off. Because of the excess pumping capacity, Mr. Bledsoe installed a pipeline from the well site to another holding tank which distributed gravity-fed water to other pastures.[R#8,10,11]

"**We had an existing windmill with a pressure system, and it seemed like when we needed water most — in the summer — we didn't have enough. So when K.C. Electric came to us with the idea of a photovoltaic system, we decided to try it. All in all, we've been pleased with the system. I think the big advantage we've seen is that we get a lot of use, four or five miles of pipeline, off that one well."** *Bill Bledsoe*

The smaller pilot system was a mobile demonstration system that could be moved from ranch to ranch with little trouble. The only difficulty with the mobile pilot system was the pleasant discovery that the ranchers did not want to give up the system after seeing the demonstration. As a result of these demonstrations, Marvin Thaller of K.C. Electric estimates that approximately ten PV systems have been purchased by ranchers.[R#10,11]

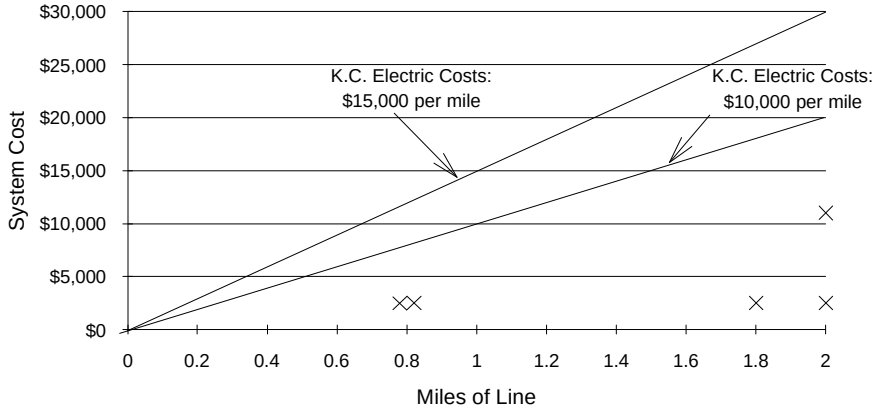
Mr. Thaller has helped with the installation and monitoring of four smaller PV systems, all of which were purchased after seeing a mobile system demonstration. He has also assisted with the installation and monitoring of the system on the Bledsoe ranch. The four smaller systems had a maximum output range of 400 gallons per day to 900 gallons per day. Descriptions of these different pumping systems are contained in the table on the previous page.

All pumping systems were direct-coupled systems that included PV modules, a maximum power controller, and pump and motor. In all instances the PV systems replaced windmills for livestock watering.

The new systems were installed to facilitate both utility and customer understanding of PV systems. They also represented new service opportunities for K.C. Electric, as their locations were too far from the distribution system for economical line extension.

Note: Systems #1 and #2 in this table are actually the same PV system on the Bledsoe ranch. System #1 refers to the original system installed with a jack pump, while system #2 refers to the same system with a centrifugal-submersible

COST COMPARISON CHART



NOTE: The X's in this chart indicate the actual costs and distance from the grid of the five installed PV systems

pump. The second type of pump was installed to provide year round service. All of the systems described in the table are customer owned.

The first cost for all of these pumping systems was a great deal lower than the required line extension cost as shown in the accompanying chart. K.C. Electric has assigned a range of $10,000 to $15,000 per mile for line extension costs. It is also important to note that line extension costs continually rise as the distance of line constructed away from the grid increases, while initial PV costs will remain fairly constant, regardless of the system location. Initial PV costs will vary somewhat as a function of the well depth.[R#5,10]

MEASURES INSTALLED

To date, the 18 PV modules used between the Bledsoe ranch and the four other small PV systems monitored by K.C. Electric have had no failures and required no maintenance since their installation. The pumps, on the other hand, have had several failures but manufacturer warranties have always provided replacements. The several diaphragm pump failures have not deterred ranchers from using them because of their low cost relative to other remote pumps. Four controller failures occurred, and the likely cause was overheating. Two solar tracker failures occurred due primarily to high winds, which destroyed the shock absorber, causing the tracker to flap in the wind. In all cases, the PV pumping system owners felt that PV power was much more reliable and required less maintenance than the windmills that they replaced.[R#10]

PROJECT STAFFING

The pilot PV program at K.C. Electric has not had a significant impact on utility operations. The greatest impact has been on Jim Zabukover and Marvin Thaller, who have been responsible for implementation of the pilot program. During the first two years of the program, ~14% of one person's time has been devoted annually to the program. Almost all of this time was devoted to education and training of utility personnel and customers, system design and installation support, and maintenance support.[R#10]

REGULATORY CONSIDERATIONS

K.C. Electric is currently unregulated by the state Public Utilities Commission (PUC) and they want to remain that way. K.C. Electric was concerned that providing a new service (PV) might necessitate regulation. This concern was not warranted because the PUC encourages regulated utilities to offer a PV service where it is the least cost option. Another concern was the contract with K.C. Electric's wholesale supplier, Tri-State G&T Cooperative, which required K.C. Electric to purchase all of its energy and capacity requirements from Tri-State. Tri-State has since revised the contract to allow for renewable energy projects up to 25 kW per project.

CONCLUSIONS

As reflected in the cost comparison chart, the K.C. Electric experience has shown that in all cases, installed PV system costs have been lower than line extension costs to provide power to the same load. K.C. Electric believes they have successfully addressed the problem of finding an alternative to reconstructed power lines serving remote loads. The combination of PV powered pumping systems and the revised rural residential rate structure have helped to solve this problem. K.C. Electric doubts that traditional utility service will ever be constructed or reconstructed to an individual livestock water pumping load. If existing services are damaged, the utility will pay for the replacement of the customer's grid-connected system with a PV powered system. For new wells that require a line extension, K.C. Electric will not consider line extension an option. K.C. will not provide specific PV services to the customer, but they will recommend PV power and ask the customer to speak with a PV industry representative. K. C. Electric believes that because customers are responsible for new service extension costs, they will likely choose PV power. The reliability of the PV pumping systems monitored by K.C. Electric has been impressive, with the minor exception of some pump difficulties previously mentioned. Finally, the pilot PV program impact on utility operations has been minimal, and the time requirements have already been mentioned.[R#10,15]

LESSONS LEARNED

The most important lesson learned from the existing PV pilot programs with regard to the future of remote PV service is that a catch 22 situation exists. In any given REC service area, there is not a very large demand for remote PV power. As a result, RECs, due to limited resources, are hesitant to spend the money to hire and train someone to become a PV expert (design and installation). Instead, RECs look for local support from the PV industry and the private sector. Unfortunately, the PV industry is in its infancy, and therefore lacks the technological resources to support the utilities. This situation has often led to a scenario of RECs being very interested in the remote PV concept, but losing interest as the realities of design, installation, and service resources come to the fore.[R#5]

Similarly, the PV pilot programs to date have borne the burden of custom designing PV systems for each application. Acceptance of PV systems would be much greater if PV systems could be uniformly packaged. Packaging of PV water pumping systems has been done with some minor difficulty, but uniform packaging for applications such as cathodic protection and residential use is very feasible.[R#5]

Many of these difficulties were experienced by K.C. Electric. Remote Power Inc., was K.C. Electric's contractor, but they are located 150 miles from utility headquarters. It is important to note that Remote Power provided excellent support to K.C. Electric throughout the pilot program, in spite of their great distance from the utility. Having qualified local PV vendors would improve access to equipment and would also replace the utility as the first contact when customer problems or questions arose. To date, the individual support required for each K.C. Electric PV customer has been intensive. There are not, however, enough interested customers to justify a full time PV service position. Because of these difficulties, the K.C. Electric PV program remains in the pilot program stage with no formal PV service guidelines in place.

Currently, Western's Loveland Area Office is proposing an energy services technical support program for its customers on PV applications. This program would provide a PV service expert to participating utilities. This expert would be equipped with transportation, tools, and hardware to provide on site support for photovoltaic assessment, development, and applications. To date, 21 utilities have expressed interest and agreed to pay a nominal fee. Western is now in the process of gaining additional funding.[R#4,5]

TRANSFERABILITY

As there are currently 14 RECs in the Western service area with pilot PV programs, it appears that the pilot PV program implemented by K.C. Electric has been very transferable. The concept that PV power is a cheaper alternative to constructing or reconstructing power lines for small, remote power loads is clearly appealing to rural utilities. Unfortunately, the lack of qualified PV vendors in rural areas has also been a barrier in K.C. Electric's pilot PV program, and for other utilities as well.

References

1. Western Area Power Administration (Western), "Annual Report," 1991.

2. Western, "Annual Report-Statistical Appendix," 1991.

3. Theresa Williams, Western, personal communication, October-December 1992.

4. Peggy Plate, Energy Services Manager, Western, personal communication, November 1992.

5. Kirk Stokes, Senior Analyst, NEOS Corporation, personal communication, October - November 1992.

6. Peggy Plate, Kirk Stokes, and Jim Zabukover, "Integrating Photovoltaics Into Utility Planning,".

7. Jim Zabukover, K.C. Electric, "Photovoltaics Systems for the Rural Consumer," from Photovoltaics: New Opportunities for Utilities, July 1991.

8. Western, Office of Energy Conservation, "Photovoltaic Stock Watering in Colorado," brochure.

9. Roland Skinner, NW Rural Public Power District, personal communication, November 1992.

10. NEOS Corporation, "Photovoltaics As A Utility Service: Lessons Learned from K.C. Electric Association," April 1992.

11. NEOS Corporation, "Photovoltaics: The Economics and Applications for Stock Tank Pumping," January 1991.

12. NEOS Corporation, "Final Report, Phase 1 Technical Assistance for McKenzie Electric Cooperative," July 1991.

13. NEOS Corporation, "Assessment of Photovoltaic Service Options for LaPlata Electric Association, Inc., Final Report," July 1992.

14. NEOS Corporation, " Final Report: Phase 1 Technical Assistance for San Isabel Electric Association, Inc.", May 1991, table from Electric Power Research Institute, J. Bigger and E. Kern, "Early Applications of Photovoltaics in the Electric Utility Industry," 21st IEEE PV Specialists Conference, Kissimmee, Florida, May 1990.

15. Jim Zabukover, K.C. Electric Association, personal communication, October-November 1992.

16. Jason Anderson, Western, personal communication, December 1992.

17. Carrol Hamon, Coordinator, Energy Conservation for Colorado Agriculture, personal communication, September, December 1992.

Special thanks to Kirk Stokes for his patience and help with the development of this profile.