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COMMENTARY

Economic Analysis of Energy-Efficiency Measures: Tribal Case Studies with the Yurok Tribe, the Confederated Salish and Kootenai Tribes of the Flathead Reservation, and the Pascua Yaqui Tribe

THOMAS L. ACKER, WILLIAM M. AUBERLE, JOHN D. EASTWOOD, DAVID R. LAROCHE, AMANDA S. ORMOND, ROBERT P. SLACK, AND DEAN H. SMITH

Energy efficiency (EE) is maximizing the effective utilization of energy while minimizing the costs of that energy. Implementation of energy-efficiency programs by a tribe can have many positive impacts. These include the reduction of energy costs and the associated freeing of significant financial resources for other important uses, improved electrical service, increased energy independence, improved air quality, reduction in environmental impacts, and others. Foremost among these benefits may be the potential for reduced energy costs. By employing EE measures, it is easily possible to save 10 percent on energy costs, and the potential exists to save in excess of 50 percent. Thus, if a tribe spends $100,000 annually on energy, it can expect a

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minimum energy cost savings of $10,000 annually and perhaps significantly more. In 1997 US Indian households spent $757 million on energy supplies.[1] Thus if only 10 percent of that cost were eliminated via EE, then $76 million would be available for other purposes than energy. The magnitude of these savings will increase significantly if other energy end-uses such as commercial and government entities are included. Furthermore, EE can go hand in hand with new electrification, providing a cost-effective means to decrease operating costs while improving the performance of newly electrified homes and other buildings.

This article presents the results of three energy-efficiency case studies conducted with three different Native American tribes in the western United States. The purpose of these case studies was to demonstrate that EE is economically feasible, has the potential to reduce air pollution, and can potentially help tribes meet other important tribal objectives. The article will present a discussion of the motivation for this work, but primarily it will focus on the results of the case studies.

MOTIVATION FOR THIS WORK

With the development of the Western Regional Air Partnership (WRAP) in 1997, tribal governments were recognized as full partners in the development of strategies to address the problem of regional haze in the West.[2] The WRAP formed the Air Pollution Prevention (AP2) forum in part "to examine barriers to use of renewable energy and energy-efficient technologies, identify actions to overcome such barriers, and recommend potential renewable energy and energy-efficiency programs and policies that could result in a reduction of air emissions from energy reduction and energy end-use sectors in the Grand Canyon Visibility Transport Region."[3]

In 1998 the EPA administrator promulgated regulations authorizing eligible tribal governments to implement Clean Air Act programs. These regulations have become known as the "tribal authority rule" and are listed in the Code of Federal Regulations at 40 CFR Part 49. The regional haze rule (RHR), promulgated by the EPA in 1999 and codified at 40 CFR Part 51.300–9, has provisions that apply to all states and tribes in the United States. One specific provision offers western states and tribes options for complying with RHR requirements. The requirements of the RHR are among the air-quality program elements that can be implemented by tribal governments. Energy-efficiency measures are specifically recognized in section 309 of the RHR. Under the Clean Air Act, tribes eligible to implement section 309 (GCVTC) plans are those located in the states of Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon, Utah, and Wyoming. These tribes *may* seek approval from the EPA to implement the RHR through Tribal Implementation Plans (TIPs). The deadlines imposed on states do not apply to tribes, but tribes *may choose*, and are encouraged, to implement programs. Thus tribes may elect to develop a regional haze program pursuant to the RHR. For any tribal lands where the tribal government elects not to take on this responsibility, the EPA must assure air-quality protection. Regional haze program requirements on some tribal lands may therefore be implemented via Federal Implementation Plans. Economic costs and benefits—both direct and indirect—are to be identified and described.

In order to aid tribes in developing TIPs, the AP2 completed two reports: *Recommendations of the Air Pollution Prevention Forum to Increase the Generation of Electricity from Renewable Resources on Native American Lands* and *Reducing Energy Consumption and Improving Air Quality through Energy Efficiency in Indian Country: Recommendations to Tribal Leaders from the Western Regional Air Partnership.*[4] This paper is derived from the latter report.

Many tribes from throughout the WRAP region were consulted as part of the process of devising a set of recommended actions for tribes to consider related to energy efficiency. During the spring of 2002, three of these tribes were also visited with the intention of developing case studies related to specific EE measures and to have in-depth conversations with tribal officials concerning many aspects of tribal energy. The three tribes visited were the Yurok tribe (northern California), the Confederated Salish and Kootenai tribes of the Flathead Reservation (western Montana), and the Pascua Yaqui tribe (southern Arizona). These three tribes each possess a different set of the tribal characteristics that influence the suitability of potential EE measures and programs (these characteristics are discussed below). Thus, a diverse variety of energy perspectives, constraints, and opportunities were revealed during these visits that helped develop the information presented here.

The purpose of this article is to present the results of the case studies initiated during the tribal visits. Since it is the goal of the WRAP to reduce air emission from electricity generation (especially from coal-fired power plants that emit haze-causing sulfur dioxide), the EE measures proposed here focus on reducing electricity consumption. The primary metrics used in evaluating the worthiness of the EE projects proposed in the case studies are the economics indicators net present value (NPV), internal rate of return (IRR), and simple payback period (SPP). These indicators tell whether an efficiency project is a good investment (for example, will it pay for itself?). The focus of this article is the economic analysis of the energy-efficiency case studies since the financial resources freed can be used to address important tribal or personal needs and to relate EE to the potential for reducing haze-causing pollutants via energy efficiency.

The case studies focus on three specific EE measures. There are, however, a number of potential EE measures that could be implemented. Table 1 provides a list of specific energy-efficiency measures, divided into sectors to provide easy reference. This table is provided to give the reader a quick reference guide to the types of energy-efficiency measures available to tribes.[5]

Beyond the project economics, however, there may be other important factors to consider when deciding whether or not to go forward with an EE project. Availability of capital and the impact of the project on the community are two such factors. These other considerations will be unique to each tribe and must be evaluated on a tribal- and project-specific basis. In many cases the final decision may be determined by answering the following question: “Is this project good for the people?”

Table 1

Energy-Efficiency Measures Categorized by Sector and Rated for Cost, Maintenance, Ease of Implementation, and Energy-Savings Potential

Sector	Measure	Cost	Maintenance	Ease of Implementation	Energy-Saving Potential
Residential					
Lighting retrofit with compact fluorescent (CFL) bulbs		Low	Low	Easy	Low to Mod
New construction CFL fixtures (indoors & outdoors)		Low	Low	Moderate	Low to Mod
Heating and cooling – new and replacement evaporative cooling		Moderate	Moderate	Easy	High
Heating- and cooling-duct testing and sealing		Moderate	Low	Difficult	High
Heating and cooling service and repair		Moderate	Moderate	Moderate	Moderate
Purchase energy star equipment (clothes washers, etc.)		Low to Mod	Low	Easy	Moderate
Purchase efficient equipment (high SEER CAC, heat pumps, and AC window units)		Moderate	Low	Easy	Moderate
Retire old refrigerators		Moderate	Low	Easy	Moderate
Weatherization-style program		Low to High	Low	Difficult	High
Shading and landscaping		Low to Mod	Moderate	Moderate	Low
Commercial (including Government, Gaming, and Recreation)					
Purchasing high-efficiency gas boilers space heat		Moderate	Moderate	Easy	Moderate
Gas boiler fuel switching		High	Moderate	Moderate	Low
Install LED exit signs		Low	Low	Easy	Low
Install LED traffic signals		Low	Low	Easy	Low
Fluorescent lighting		Moderate	Low	Easy	High
Heating and cooling, low-cost measures		Low	Moderate	Moderate	Moderate
Heating and cooling, high-cost measures		High	Moderate	Moderate	Moderate
Ground-source heat pump		High	Moderate	Difficult	High
Gas air conditioning		High	High	Moderate	Moderate
Building commissioning and retro-commissioning		Moderate	High	Difficult	High
Building load controls		Moderate	High	Moderate	High
Building envelop enhancements		Moderate	Low	Moderate	Moderate
Building training programs		Moderate	High	Difficult	High
Efficient transformers		High	Low	Low	Low
Cooling tower variable speed drives		Moderate	Moderate	Moderate	Moderate
Water heating heat-pump unit		High	Moderate	Moderate	Moderate
Industrial					
Fan systems measures		Moderate	Moderate	Moderate	Moderate
Air compressor system measures		Moderate	Moderate	Moderate	Moderate
Combined heat and power		High	High	Difficult	High
Motor downsizing		Low	Low	Easy	Moderate
Premium motors		Moderate	Moderate	Easy	Moderate
Policy					
Tribal procurement policy		Low	Low	Moderate	High
Green energy purchasing		Moderate	Low	Moderate	Low
Energy education		Moderate	High	Moderate	High
Rebate purchasing incentives		Moderate	Moderate	Moderate	Moderate
Tribal mandates		Low	Low	Moderate	Moderate
Tribal energy policy		Low	Low	Moderate	High
Public benefits fund		Mod to High	Moderate	Difficult	Moderate
Support federal mandates		Low	Moderate	Easy	Low
Designate energy person		Mod to High	--	Moderate	High
IECC or other building codes		Low	Moderate	Moderate	Moderate

RESULTS OF TRIBAL CASE STUDIES

To obtain a better understanding of the types of EE programs and policies that tribes may be interested in, and which types would be successful, three case studies were conducted through visiting the three tribes. The goal was to gain a firsthand understanding of each tribe's experiences with electricity supply, services, and EE programs and policies and to learn about the types of EE measures in which these tribes were interested. Initially, several tribes were identified that possess a diverse variety of the tribal characteristics that influence the potential for EE and are summarized below:[6]

- Heating climate vs. cooling climate
- Rural vs. urban
- Large vs. small energy consumer
- Level of economic activity
- Political infrastructure related to energy and electricity (i.e., was there a tribal utility authority or similar organization that handles energy/electricity issues for the tribe?)
- Electrification of areas not previously served by electricity

Of the tribes identified, the following three graciously agreed to host a visit by a team of researchers from Northern Arizona University: the Yurok tribe in northern California (heating climate, rural, modest energy consumer, modest economic activity, no tribal energy authority, some areas not served by electricity), the Confederated Salish and Kootenai tribes of the Flathead Reservation in western Montana (heating climate, rural, large energy consumer, significant economic activity, existing and effective tribal utility authority, very few areas not served by electricity), and Pascua Yaqui tribe in southern Arizona (cooling climate, urban, medium-to-large energy consumer, significant economic activity, no tribal utility authority, very few areas not served by electricity). These tribes were selected because of their diversity of characteristics that affect energy consumption and their differing needs. The visits were successful in underscoring the challenges to enacting EE programs, as well as the opportunities available. The tribes shared their experiences with electricity service and EE, as well as their views about what would be useful information to present in this study.

One goal of each tribal visit was to learn about a specific EE measure that each tribe would be interested in having evaluated for its economic merit. Thus the case study examples presented here provide the economic evaluations of each of these proposed EE measures of interest. Background information is provided for each tribe, followed by summaries of each measure.

Case Study 1: The Yurok Tribe—Lighting Retrofit at the Ke'pel Head Start Facility

The Yurok tribe is the largest tribe in California, located in the northern part of the state along the Klamath River. Reservation land includes about a forty-five-mile stretch of the lower Klamath River and one mile on either side of the river. Within the external boundaries of the reservation are fifty-five thousand acres; however, the tribe owns only approximately eleven thousand of these acres. Private parties or the federal government hold the remainder of land within the reservation. The tribe has forty-three hundred members; one thousand of those members live on the reservation, and a majority of all members live within sixty miles of tribal lands. The Klamath River and its waters are of utmost importance to the tribe both culturally and economically. Tribal land is largely unimproved with electricity, telecommunications, or roads, which are available only in the upper and lower ends of the reservation. The tribe has commercial electric loads, including a fishery, a tribal court and police force, a historic preservation office that serves the tribe and two counties, retail stores, a recreational vehicle park, and other commercial ventures. Within the reservation there are also the industrial loads of a timber operation and mill.

A council, made up of representatives from seven districts, governs the Yurok. A chairman and vice chairman are chosen from among the council members. A constitution for the tribe was established in 1993. Since 1993 the tribe has concentrated on building a competent and respected tribal government, which is developing a comprehensive land-use plan to guide future development. The plan includes the development and delivery of a full set of services to new homes as they are built. Services include but are not limited to water, sewer, telephone, and electricity. There are approximately ninety Yurok homes within the reservation. An aggressive housing program is underway to build 70 to 150 houses, largely on the reservation. Thus, a focus of the tribe is to develop infrastructure and housing for the benefit of tribal members. In addition to residential housing, a new thirty-thousand-square-foot building is being constructed to house the tribal government. This office will consolidate some of six tribal office locations.

The tribe has evaluated the potential for energy production on the thirty tributaries of the Klamath River. In addition the tribe has several small photovoltaic installations and is considering efficiency measures for the new tribal and residential buildings. For this case study an off-grid Head Start facility was identified as a candidate site for an EE measure. Buildings with off-grid electricity generation (not supplied by utility company electricity from the electrical grid), such as the Yurok tribe's Ke'pel Head Start facility, can offer opportunities for modest to tremendous savings in electricity costs because of the many factors affecting the price of electricity. The price paid for electricity is often quite high in these buildings, with a significant portion of this cost paid up front when the electrical generating equipment is purchased. Consequently, for off-grid systems the opportunity for savings is greatest at the time of construction, when energy efficiency can be incorporated into the design. Regardless, there may still be many economically feasible efficiency improvements possible even after the generation equipment is paid for. A walk-through of the Head Start facility revealed that the fluorescent lights could be retrofitted with more efficient fixtures and tubes.

Figure 1 is a photograph of the Ke'pel Head Start facility. At this facility electricity is supplied by a twelve-kilowatt propane generator, six hundred watts of photovoltaic cells, batteries, and a Trace 4024 inverter (the inverter turns the electricity output of the batteries and photovoltaics into a form useable in the building). The proposed lighting retrofit would replace old

T12 fluorescent lightbulbs and ballasts within the building with T8 fluorescent bulbs and ballasts (a T12 bulb is 1.33 inches in diameter, whereas a T8 bulb is 1.0 inches in diameter). Retrofitting the entire facility would cost $579 including labor. The cost of electricity delivered by the generator was determined to be 8.2 cents per kWh. Since the cost of the existing generation equipment is sunk, it does not factor into this cost of electricity, which is based on fuel costs only. It was also assumed that maintenance costs of the generator would be the same whether or not the retrofit is carried out (although this assumption is likely to be a conservative one). Using this cost of electricity, the higher efficiency lighting fixtures would save nearly one-third of the energy used, with an annual net savings on fuel costs of $77. Assuming a ten-year life cycle and a discount rate (minimum acceptable rate of return [MARR]) of 5 percent, the simple payback period is seven and a half years, the net present value is $76, and the internal rate of return is 7.5 percent. Thus the lighting retrofit appears to be a good investment. It is worth noting that this example did not account for the effects of inflation. If a modest annual fuel price inflation rate of 2 percent is included in the calculations, then the NPV would be $150 and the IRR 9.7 percent, making the investment appear even more favorable.

This example demonstrates how an EE measure at a reasonably new facility using off-grid electricity is attractive and would be recommended on its economic merit. Since on-grid facilities may pay a higher rate for their

FIGURE 1. *The Ke'pel Head Start facility on the Yurok Reservation in Northern California. Photo by T. Acker.*

electricity than stated here, this EE measure would look promising for many facilities using old T12 fluorescent light fixtures.[7] Had the choice been made to use T8 lighting fixtures instead of T12 at the time the building was designed and constructed, the savings could have been much larger since the size and cost of the electrical generation equipment could possibly have been reduced (the cost of electricity at an off-grid facility can easily exceed 20 cents per kWh when the cost of the generating equipment is included along with the fuel costs).

In performing the economic analysis for this lighting retrofit, the most difficult cash flow to estimate was the net annual fuel savings of $77. This difficulty was due to uncertainty in determining the actual electrical energy usage at the facility, since it is off-grid and no electric bills were available. To gain a better understanding of how this uncertainty affects the NPV, a sensitivity plot was created by graphing the NPV versus percent change in the annual fuel savings (see fig. 2). As evident from the figure, the NPV goes to zero if the annual fuel savings decreases by 20 percent, from $77 to $67. It is the job of the person responsible for overseeing this lighting retrofit to determine how likely it is that the fuel savings will decrease by 20 percent or more; in other words, this person is to assess the risk of implementation. If there is sufficient risk, it would be necessary either to revisit the determination of the net energy savings to see if a more certain estimate can be obtained or possibly to decide not to fund the project. Note that the economic indicators are not the only pieces of information that would be considered in making the decision to implement the project. Environmental benefits (for example, as related to the regional haze rule), system reliability benefits, and so forth, should be factored into the decision. Implementing the retrofit could also be used in the educational programs directed toward the children at the Head Start facility.

Case Study 2: Confederated Salish and Kootenai Tribes–Irrigation System Improvements for Agriculture

The Confederated Salish and Kootenai tribes live on the 1.2 million–acre Flathead Indian Reservation. The reservation, with its combination of valley floor and towering mountains, is located north of Missoula and south of Kalispell, in the western part of Montana. A major geological feature of the reservation is Flathead Lake, the largest freshwater lake in the West. The tribes on the Flathead Reservation are a combination of Salish, Pend d'Oreilles, and Kootenai. There are approximately sixty-eight hundred enrolled tribal members, and approximately thirty-seven hundred members live on or near the reservation. The Confederated Salish and Kootenai are prosperous tribes with a diversified local economy. The tribes harvest timber and own Plum Creek Lumber Company; receive revenues from a hydro generating facility, the Kerr Dam; and own an electronics manufacturing facility, two gasoline service stations, a Dairy Queen, and a Best Western resort hotel located on Flathead Lake.

Within the reservation are parts of four counties and ten incorporated towns. The tribes make up less than one-third of the population on the reservation. Throughout the reservation homestead land creates a checkerboard

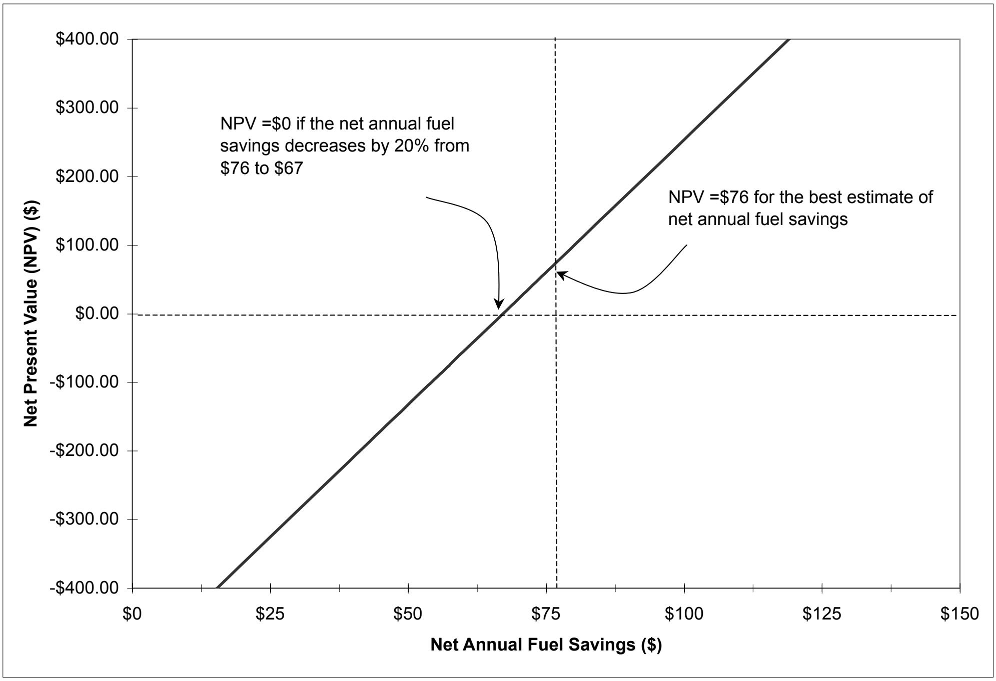

FIGURE 2. *Sensitivity plot of net present value versus net annual fuel savings for the Ke'pel Head Start facility lighting retrofit.*

of land ownership. A tribal council, made up of ten members elected at large, governs the tribe, overseeing all operations. Some of the departments within the tribal government are governed by their own boards, with those boards reporting to the tribal council. This is the case with the housing authority and the utility authority.

Mission Valley Power (MVP) is the tribal utility authority that provides all electrical power on the reservation. MVP has a unique structure for several reasons. First, MVP provides power to both tribal and nontribal customers on the reservation. Second, the utility board reports to the tribal council, yet the tribe earns no profit from MVP, which is an outgrowth of the Bureau of Indian Affairs and became a stand-alone entity in 1990. A utility board of directors, made up of five member appointees by the tribal council, controls MVP. A consumer council works with customers, fields complaints, and presents consumer view to the board.

Approximately 70 percent of the power supplied to the area by MVP comes from the Bonneville Power Administration (BPA) through its hydro generating facilities. The Consolidated Salish and Kootenai have a guaranteed price for electric power until 2011. For changes in customer rates MVP must obtain federal approval. MVP has more than sixteen thousand accounts that were supplied with approximately 330 million kWh of electricity in 2001. Power is offered at the low rate of 4.79 cents per kWh for residential customers, 3.12 cents per kWh for commercial customers, and 3.63 cents per kWh for irrigation customers.

MVP has a sophisticated, effective, and well-funded energy conservation program. In the 2001 annual report MVP states that its program is the “most aggressive conservation program in the Northwest,” offering sixteen different plans. Utility account credits, incentive payments, energy information, weatherization services, and some energy-efficient equipment are offered to customers. Between October 2001 and March 2002 a total of seventeen million kWh were saved through conservation programs. This translates to saving approximately 5 percent in energy use. Funding for conservation programs is provided by BPA and fluctuates depending on BPA’s budget and allocation to its conservation programs.

The Confederated Salish and Kootenai Housing Authority (SKHA) is responsible for construction of housing for tribal members. The SKHA builds energy-efficient “Super Good Cents” all-electric homes. There are approximately 440 rental units managed by SKHA and about 200 units owned by residents. In rental units the utility bills are included in the rental. Neither natural gas nor propane is used in most units because of its lack of availability, expense, or for safety reasons.

Overall, the tribes have a very favorable energy situation. The council and departmental staff recognize the benefits of and support energy-efficiency efforts. Electrical service is available throughout the reservation, and the price for electricity for all customer classes is low. There is an established tribal utility authority that offers residential, small commercial, and some industrial conservation programs. The Kerr Dam produces electrical power on the reservation and will eventually be owned by the tribe.

In terms of the tribal characteristics that can influence which EE programs and measures to consider, the Confederated Salish and Kootenai tribes live in a rural setting, in a heating climate, have a large land base with a substantial energy consumption, and have a significant level of economic activity, and unserved electrical loads are not an issue. Their utility authority, MVP, is a dynamic, and in many senses a model, organization. During the visit with the MVP staff, one of the few EE opportunities that could be identified was related to improving irrigation systems (this is because MVP has done such a good job with its many EE programs serving the residential, commercial, and industrial sectors). A summary of the details of a proposed irrigation system improvement will be presented next.

The external boundaries of Flathead Reservation encompass 1.2 million acres, including thousands of acres of farmland. Some of this land is tribal land, and some of it is privately held. MVP provides electrical service to all of the farms, many of which use irrigation during the summer months. A picture of a typical irrigation system is shown in figure 3, and a picture of the large electric water pumps that might supply such a system are shown in figure 4. Large water pumps that run on electricity are required to draw water from an irrigation canal and feed these irrigation systems. During fiscal year 2001, irrigation customers accounted for approximately 8 percent of the electricity sold by MVP, and MVP is interested in exploring the potential for energy savings for its farming customers through irrigation system improvements.

FIGURE 3. *A typical irrigation system on farmland within the Flathead Reservation in Montana. The haze above the field has been caused by dust blown up from a dirt road, one of the primary sources of haze within the reservation. Photo by T. Acker.*

Low Energy Precision Application (LEPA) irrigation systems are modifications of standard pivot irrigation systems that deliver water directly to the soil. These systems save both energy and water and are one possible irrigation system improvement. Instead of nozzles that shoot water high into the air, LEPA systems employ drop tubes and sprinkler heads that deliver water directly to the soil around crops. This modification allows for lower system pressures and smaller electric motors and cuts evaporative losses of water, reducing the amount of water required to irrigate a given field. For a typical initial cost of $3,000, a farmer can convert an existing medium- or high-pressure pivot system to a LEPA system. Electricity for irrigation provided by MVP costs 3.63 cents per kWh plus $11.05 per horsepower of the pump motor per season. Using these rates, the estimated cost savings in electricity is estimated to be $476 per year (per LEPA modified pivot system). While water costs would typically be included in the analysis of the net present value and internal rate of return, water for irrigation on the Flathead Reservation is charged per acre, independent of how much water is actually used (therefore water savings by a LEPA system will not impact the cost of water, though there will probably be a benefit to the water district as a result of the water saved). Based on the costs for electricity, using a project lifetime of twenty years and a MARR of 5 percent, investment in a LEPA system would pay for itself in just over six years and have an NPV of $2,932 and an IRR of 14.9 percent. Clearly,

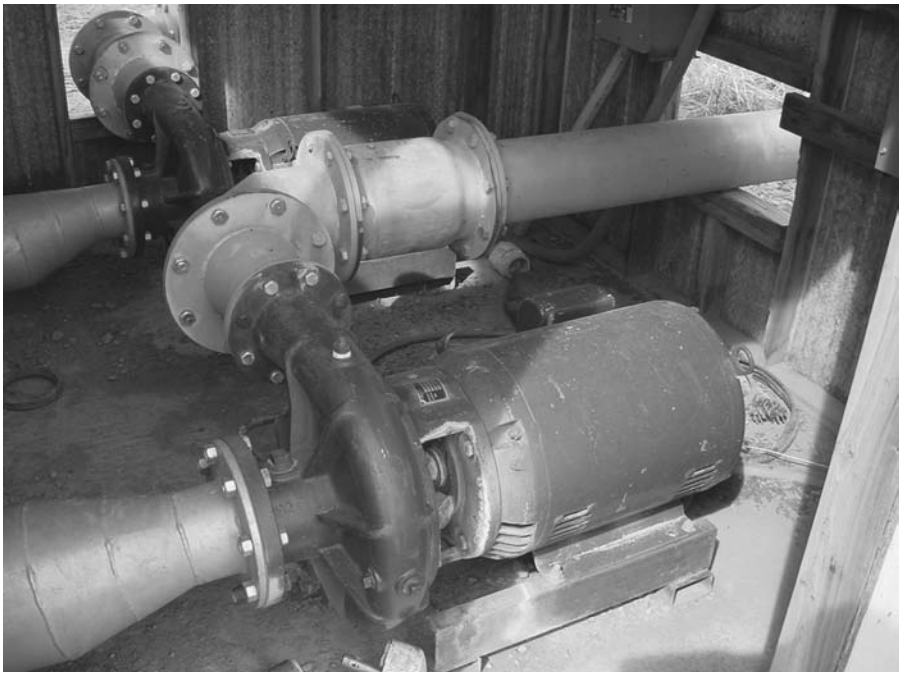

FIGURE 4. *Large electric water pumps used to draw water from a nearby irrigation ditch and supply irrigation equipment. Photo by T. Acker.*

this type of project seems advisable from an economic standpoint. Table 2 summarizes the economic indicators considering different assumptions about the future price of electricity. It is worth mentioning that the electricity saving suggested here would be to the farmer and would not necessarily translate to savings for MVP in the same year (for example, if MVP is contractually bound to pay for the demand charge from its electricity supplier); however, the avoided cost of the reduced demand could be reduced in a future contract.

It is worth noting that the price of electricity delivered by MVP is quite inexpensive. Thus, for farmers on other reservations that pay a higher price for electricity, or are billed per acre-foot of water, that investment in a LEPA system will be even more economically attractive.

Table 2

Net Present Value and Internal Rate of Return for Investment in Installation of a LEPA Irrigation System (shown at various levels of inflation)

Electricity/Water Inflation Rate	Net Present Value	Internal Rate of Return
-4%	$1,232	10.3%
-2%	$1,987	12.6%
0%	$2,932	14.9%
2%	$4,120	17.2%
4%	$5,623	19.5%

Case Study 3: Pascua Yaqui Tribe—Automatic Lighting Sensors

The Pascua Yaqui tribe is located primarily in southern Arizona, with five communities in the state, four of which are located in and around Tucson. It is one of the newest federally recognized tribes in the United States. The Pascua Yaqui received 202 acres of land in 1964 and acquired another 690 acres in 1982. The tribe gained federal recognition in 1978 and adopted a constitution in 1988. Governance of the tribe is by an eleven-member tribal council, for which members are elected at large every four years. A chairman and vice chairman are chosen from among the council members.

The Pascua Yaqui tribe operates two casinos, an amphitheater, and a smoke and gift shop. As of this writing a third casino is under construction. The tribe has approximately thirteen thousand members and is growing. The tribe provides public safety, social services, housing, and vocational training to its members on the reservation and provides limited service to those members located in the four other communities. The tribe is undergoing a tremendous amount of change driven by the increase in tribal membership and an increase in revenues. The tribe identified housing issues as one of the most pressing issues at this time. However, growth is affecting all aspects of tribal development.

The tribal government is made up of eleven departments. The department directors report to the tribal council on matters of policy. Energy issues are handled by the Development Services Department, which is also responsible for land acquisition and land-use planning, planning and attracting or creating economic development opportunities, infrastructure such as roads and parks, providing assistance to the four Yaqui communities not located on the reservation, and nonhousing community development. At the time of the case study visit, the tribe did not have an energy department or employee dedicated to energy efficiency or conservation; however, the tribe has since hired an energy manager.

Development Services staff were interviewed to assess the knowledge of and interest in energy conservation and efficiency and were found to have a working knowledge about the potential benefits of and strategies to implement energy conservation and efficiency programs. Further, the department has a particular interest in developing renewable energy resources for economic development potential and to gain a measure of energy independence.

In terms of the tribal characteristics that may influence which EE programs and measures to consider, the Pascua Yaqui live in an urban, cooling climate, have a small land base, a significant level of economic activity, and unserved electrical loads are not an issue. They are in the process of developing an organizational infrastructure to handle energy issues. During the case study visit with the Development Services staff, motion sensors for lighting in a new Head Start facility were identified as a potential EE measure of interest. A summary of the details of this measure will be presented next.

There are two basic ways to save electricity through lighting. One of these is to upgrade existing lights with fixtures that consume less energy when operated, as suggested to the Yurok tribe. Another method is to install motion

FIGURE 5. *A new Head Start facility under construction on the Pascua Yaqui reservation in southern Arizona. Photo by R. Slack.*

sensors to prevent existing fixtures from being left on when unused, reducing the overall time of use of the fixtures.

The Pascua Yaqui tribe is building a new Head Start facility (see fig. 5). The tribe is using efficient lighting fixtures throughout the building but is also considering the use of motion sensors in the building as a way to further reduce energy consumption. There are six large classrooms in the Head Start facility that could be outfitted with the motion sensors. Of interest to the tribe is determining if the motion sensors are worth the investment. Because motion sensors are fairly simple and inexpensive to install in a retrofit scenario, it is not necessary to install them at the time of construction. The advantage of delaying installation is that the usage patterns for the classrooms can be determined in the first several months of the facility's operation, allowing for a more accurate prediction of the potential for cost savings. The purpose of the economic analysis presented here is to identify the energy cost savings at several different levels of classroom lighting use in order to provide guidance in determining whether or not to install lighting sensors at a later time.

To fully retrofit the Head Start facility with lighting motion-sensors, the Pascua Yaqui would need to purchase twelve light switches and pay someone (tribal member or otherwise) to install them. If wall-mounted motion sensor switches manufactured by espEnergy are employed at $90 each, the equipment cost would be $1,080 for parts and about $108 for installation. Electricity is supplied to the facility by the local co-op (Trico Electric Cooperative, which is not a tribal entity) at a cost of 11 cents per kWh. In performing the energy and economic calculations for this retrofit, it was assumed that under a business-as-usual scenario the classroom lights would be operated eight hours per day on average for 220 days out of the year. There are ninety lighting fixtures in the six classrooms, each rated at ninety watts. Thus the energy cost associated with running the lights over the course of a year is $1,570. The purpose of a lighting sensor is to reduce the amount of time the lights are used by turning them off when a room is not in use. If, for instance, the lighting sensors turn the lights off 10 percent of the time (about fifty minutes per day), there would be an annual savings in the electricity bill of $157. Until the usage patterns of the Head Start facility are established, it is difficult to determine the potential for energy savings each year. In order to handle this uncertainty, the SPP, NPV, and IRR will be computed for several scenarios of reduced electricity consumption. Then, once the usage patterns of the building are known, a staff person can consult the results presented below to determine if retrofitting with the motion sensors is worthwhile. For the results to follow, an MARR of 4 percent was assumed along with a project life cycle of twenty years and an inflation rate of 0 percent. Figure 6 presents plots of the IRR, SPP, and NPV versus percent energy savings (which corresponds directly to the percentage of time the lights are turned off by the motion sensors). In general, if the sensors create at least a 5 percent reduction in the amount of

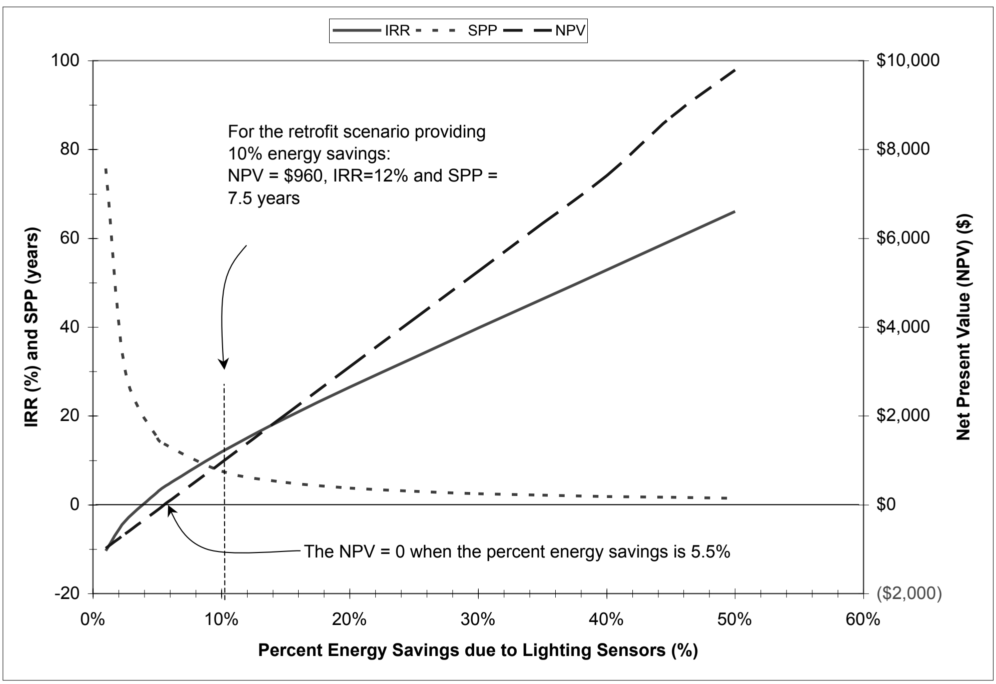

FIGURE 6. *Plot of the SPP, IRR, and NPV versus percent energy savings for the installation of lighting motion sensors at the Pascua Yaqui new Head Start facility.*

time the lights are on, then the NPV is positive, and the project looks acceptable. Furthermore, the project becomes very attractive as the percent of energy savings increases. For example, if the building usage pattern were to indicate an opportunity to save 20 percent on the energy costs, then the SPP would be four years, the NPV would be $3,100, and the IRR would be about 26 percent, each indicating that this is a very worthwhile project.

CONCLUSIONS

The three cases presented here show that tribes can clearly benefit from EE programs. The three tribes participating in this study are diverse in several dimensions and thus face very different energy needs. Members of the research team spent at most one day working with tribal staff, yet in each case it was relatively easy to identify specific projects, and each of the case studies considered yielded a positive net present value. The case studies presented here are project specific and produce modest savings; however, if a full range of projects were implemented on a wide scale by all tribes, the accumulated savings incurred by tribes throughout the United States could be quite significant, on the order of tens of millions of dollars.

In a companion study the authors explain more extensive efficiency practices that tribes can employ at possible savings.[8] Not all possible projects will be beneficial; however, most tribes should find that energy planning will result in net benefits. In that same study the authors, based on Smith's *Modern Tribal Development*,[9] argue that efficiency programs are likely to lead to secondary benefits in addition to the primary savings. For example, energy conservation can contribute to energy independence and improved tribal sovereignty. The money saved may also allow a tribe to address other pressing needs, such as improved health care on the reservation. Energy-efficiency measures also frequently improve the performance and longevity of existing energy systems, which can improve the comfort of working and living spaces and may increase productivity of workers. Benefits such as these may be difficult to quantify but are certainly worth considering. In the companion pieces the authors explain implementation programs for robust energy-efficiency plans. These three cases show the relative ease by which tribes can plan energy-efficiency projects.

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NOTES

1. Energy Information Administration, *Energy Consumption and Renewable Energy Development Potential on Indian Lands*, http://www.eia.doe.gov/cneaf/solar.renewables/ilands/toc.html (accessed 3 January 2005).

2. For more details on the WRAP and the regional haze rule see T. L. Acker, W. M. Auberle, J. D. Eastwood, D. R. LaRoche, A. Ormond, R. P. Slack, and D. H. Smith, *Recommendations for Reducing Energy Consumption and Improving Air Quality through Energy Efficiency in Indian Country*, College of Business Administration Working Paper Series, Northern Arizona University, 2004, ref. 04–04, http://www.cba.nau.edu/faculty/workingpapers/pdf/Smith_Recommendations.pdf (accessed 3 January 2005); or see either of the Air Pollution Prevention (AP2) reports cited in note 4 below.;

3. "About the AP2 Forum; from the WRAP," http://www.wrapair.org/forums/ap2/index.html (accessed 3 January 2005).

4. AP2, *Recommendations of the Air Pollution Prevention Forum to Increase the Generation of Electricity from Renewable Resources on Native American Lands*, http://www.wrapair.org/forums/ap2/projects/tribal_renew/Tribal_Renewables_Report_7-03.pdf (accessed 3 January 2005); AP2, *Reducing Energy Consumption and Improving Air Quality through Energy Efficiency in Indian Country: Recommendations to Tribal Leaders from the Western Regional Air Partnership*, http://www.wrapair.org/forums/ap2/projects/tribal_renew/TribalEEReport_7-03.pdf (accessed 3 January 2005).

5. Many excellent publications for evaluating EE measures are available. See, e.g., W. C. Turner, *Energy Management Handbook*, 3rd ed. (Fairmont Press, Inc., Lilburn, Georgia, 1997); D. R. Wulfinghoff, *Energy Efficiency Manual* (Wheaton, MD: Energy Institute Press, 1999); B. D. Hunn, *Fundamentals of Building Energy Dynamics* (Cambridge, MA: MIT Press, 1996); and B. L. Capehart, W. C. Turner, and W. J. Kennedy, *Guide to Energy Management*, 2nd ed. (Lilburn, GA: Fairmont Press, 1997). The Rebuild America Program website (http://www.rebuild.org/index.asp [accessed 3 January 2005]) also contains suggestions of numerous good EE measures. The AP2 report from which this paper is derived, Reducing Energy Consumption (see note 3) is also a useful resource, available at the WRAP website. For the energy manager who is choosing and implementing EE measures, these resources are valuable tools.

6. For details concerning the importance of these dimensions see T. L. Acker, W. M. Auberle, J. D. Eastwood, D. R. LaRoche, A. Ormond, R. P. Slack, and D. H. Smith, *Identification and Implementation of Potential Energy Efficiency Programs in Indian Country*, College of Business Administration Working Paper Series, Northern Arizona University, 2004, ref. 04–03, . http://www.cba.nau.edu/faculty/workingpapers/pdf/

Smith_Implementation.pdf (accessed 3 January 2005.

7. Indian households on average pay 8.7 cents per kWh for electricity; see Energy Information Administration, *Energy Consumption* (see note 2).

8. Acker et al., *Recommendations for Reducing Energy Consumption.*

9. D. H. Smith, *Modern Tribal Development: Paths to Self-Sufficiency and Cultural Integrity in Indian Country* (Walnut Creek, CA: Altamira Press, 2000).