LBNL–41004

NATIVE POWER

A Handbook on Renewable Energy and Energy Efficiency for Native American Communities

John Busch, John Elliott, Trisha Frank,
Vivian Gratton, Tom Starrs, and Jim Williams

Native American Renewable Energy Education Project;
Energy and Resources Group, University of California, Berkeley
and Environmental Energy Technologies Division,
Lawrence Berkeley National Laboratory

January 1998

To Contact NAREEP:
310 Barrows Hall
U.C. Berkeley
Berkeley CA 94720-3050
Tel: 510.643.1928
Fax: 510.642.1085
Email:
nareep@socrates.berkeley.edu
Website:
eetd.lbl.gov/nareep

ACKNOWLEDGEMENTS

People who contributed significantly to earlier versions of the handbook and helped refine our thinking about what we wanted it to be: Jason Anderson, Sid Bob Dietz, Torri Estrada, Mark Fitzgerald, Chris Greacen, David Howarth, and Leslie Shown.

Graphic Design: John Odam Design Associates

Reviewers: Don Aitken, Marjane Ambler, Tonya Boyd, Nilak Butler, Richard Bad Moccasin, Wyatt Rogers, Steve Sargent, Owen Seumptewa, Jesse Smith, Johnny Weiss, Steve Wiel

Funders: This work was funded by the Office of Energy Research, Chemical Sciences Division, and the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Utility Technologies, U.S. Department of Energy under contract Number DE-AC03-76SF00098. Printing was funded by the Title XXVI Indian Energy Resource Development Program, Denver Regional Support Office, U.S. Department of Energy.

CONTENTS

INTRODUCTION 05

1 HEATING YOUR HOME 07
WEATHERIZATION 08
INSULATION 10
HEATING SYSTEMS 12
COOLING SYSTEMS 14
WOOD HEAT 15
WATER HEATING 16
PASSIVE SOLAR DESIGN 18

2 POWERING YOUR HOME 21
SAVING ELECTRICITY 22
PV SYSTEMS 24
SMALL WIND SYSTEMS 26
SMALL HYDRO SYSTEMS 28
BATTERIES 30
BACK-UP GENERATORS 32
COMMUNITY POWER SYSTEMS 33

3 COMMERCIAL SCALE SUSTAINABLE ENERGY 35
ENERGY EFFICIENCY 36
COMMERCIAL WIND 38
BIOMASS 40
GEOTHERMAL 41
SOLAR THERMAL 42
PHOTOVOLTAICS 43
BUSINESS OPPORTUNITIES 44

4 FINANCING YOUR PROJECT 47
HOME-SCALE PROJECTS 48
COMMUNITY-SCALE PROJECTS 50
SMALL BUSINESS 52
NON-PROFIT PROJECTS 54
COMMERCIAL ENERGY PROJECTS 56

APPENDIX A LEGAL AND REGULATORY ISSUES 58

APPENDIX B RESOURCES 61

INTRODUCTION

Renewable energy relies on the natural flows of wind, running water, sunshine, growing plants, and earth heat. Energy efficiency is doing more with less energy. These concepts have always been part of the traditional ways of native peoples. Today, as tribes grapple with new challenges, they are seeking ways to develop their communities based on sound, long-term sustainable practices. Renewable energy and energy efficiency offer the prospect for a sustainable energy future with important links to the past.

No group of people in the United States is more motivated to pursue sustainable energy development than Native Americans. For one thing, no other group has received fewer benefits from the conventional energy system. Native Americans pay the highest rates for fuel and electricity, have the highest percentage of unelectrified and unweatherized houses, and have the least control over energy services. No group has suffered more from the production of conventional energy, in terms of pollution from power plants, radioactivity from uranium tailings, acid drainage from coal mines, and loss of lands flooded for large hydroelectric dams. In contrast to conventional energy, many Native Americans see renewable energy and energy efficiency as friendly to the environment and compatible with their values.

The technologies available for saving energy and utilizing renewable sources have improved significantly over recent years. Much has been learned about how to develop beneficial and cost-effective projects. It is widely accepted today that energy efficiency and renewable energy go together, that they complement each other. Energy saving opportunities abound at lower costs than conventional fuels. On the other hand, renewable energy is generally more expensive than conventional sources. Together, the package of energy efficiency and renewable energy can provide an affordable, clean path to energy self-reliance. Native Americans have been blazing that path, examples of which are in the pages that follow.

This handbook is a practical introduction to energy efficiency and renewable energy. Each chapter provides basic information about the kinds of sustainable energy projects that may be useful to native communities. Much can be done practically at the residential scale right now, while at the commercial scale, the challenges are greater, but the rewards are potentially high, especially as tribes gain sustainable energy project experience. Chapters 1 and 2 describe household-scale sustainable energy opportunities, organized around heating and electrifying the home. Chapter 3 describes sustainable energy on a larger, commercial scale. Chapter 4 deals with financing projects in tribal communities. The appendices contain information about legal and regulatory issues and where to go next for assistance or more in-depth information.

HEATING YOUR HOME

This chapter provides information to help households stay warm and reduce heating bills. For many tribes already connected to the electricity grid, expensive home heating is the most pressing energy problem. The problem stems from a combination of poor housing quality and design, and limited choice of heating fuels. The good news is, in most cases tribes and individual homeowners can greatly reduce heating and cooling costs through relatively simple, inexpensive improvements.

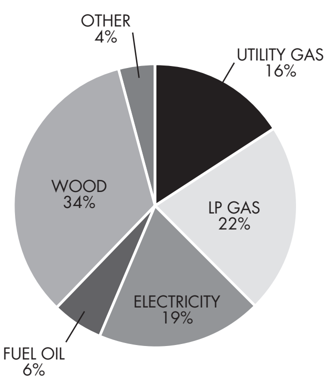
Housing quality and design

Current and reliable statistics about the quality of housing on reservations are hard to find, but the 1990 census does provide some indication. Almost one-fifth of households on reservations lack either piped water, a cooking stove, or a refrigerator, and fourteen percent live in mobile homes or trailers. Much of the reservation housing stock has been built by the federal government. While recent changes at HUD suggest improvement, most of these units were constructed with little thought to energy efficiency or lowering heating bills.

RELATIVE COST OF HOME HEATING ENERGY SOURCES

ENERGY SOURCE	UNIT COST	ENERGY COST($/MILLION BTU)
Hardwood	$100 per cord	$4.65
Natural gas	$0.58 per therm	$5.80
Heating oil	$1.03 per gallon	$7.43
Propane	$0.74 per gallon	$8.10
Electricity	$0.10 per kWh	$29.31

Costs are national averages from 1992. BTUs and therms are units of energy. A 'typical' US home might consume 100 to 200 million BTU/yr. Adapted from Richard Heede *et al*, *Homemade Money*, 1995, p. 11, Rocky Mountain Institute, Snowmass, Colorado.



SOURCES OF HEAT IN RESERVATION HOUSEHOLDS
1990 US CENSUS

Limited fuel choice

Wood, propane, and electricity are the most common sources of heat on American Indian reservations. Propane and electricity are the two most expensive sources of home heat. Relatively inexpensive natural gas is available to only 16 percent of reservation homes. In the U.S. population as a whole, more than half of all households heat with utility natural gas.

Energy improvement priorities for existing homes

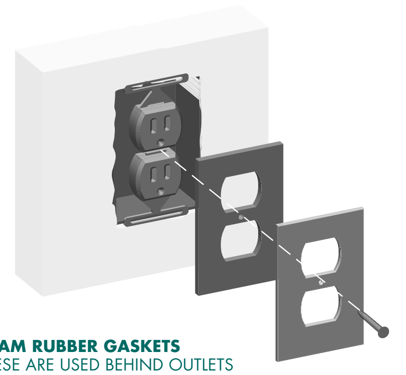
Whether you are a homeowner trying to reduce your heating bills and make your house more comfortable, or a tribal decision-maker developing a housing weatherization program, you will surely want to get the most out of your money. Weatherization and insulation usually provide the biggest bang for the buck in terms of cutting energy consumption and increasing comfort. The next priority is to improve the efficiency of your heating and cooling systems so that you get the most out of whatever fuel you use. These topics are addressed in the next five sections. Following that are tips to reduce costs for water heating, another major home energy expense. The final section presents the basics of passive solar design. Passive solar techniques can be a sensible way to reduce your heating and cooling needs if you are building a new home. However, passive solar retrofits of existing homes are usually the last priority since they can be expensive. Regardless, passive design concepts are a useful way to think about heat in the home and ways to use it wisely.

PRIORITY LIST FOR HEATING AND COOLING IMPROVEMENTS

1. Weatherization
2. Insulation
3. Efficiency improvements to heating and cooling systems
4. Reduction in water heating costs
5. Passive solar retrofits

Weatherization

Most homes lose as much air through holes and cracks as they would through a hole in the wall four feet square! The cost of heating and cooling this lost air generally accounts for about one-third of the total bill for space conditioning. Plugging up a leaky house is usually the most cost-effective way to reduce heating and cooling bills and improve comfort.



FOAM RUBBER GASKETS
THESE ARE USED BEHIND OUTLETS AND SWITCH PLATES LOCATED ON EXTERIOR WALLS.
ADAPTED FROM *HOMEMADE MONEY,* ROCKY MOUNTAIN INSTITUTE, 1995.

Energy audits

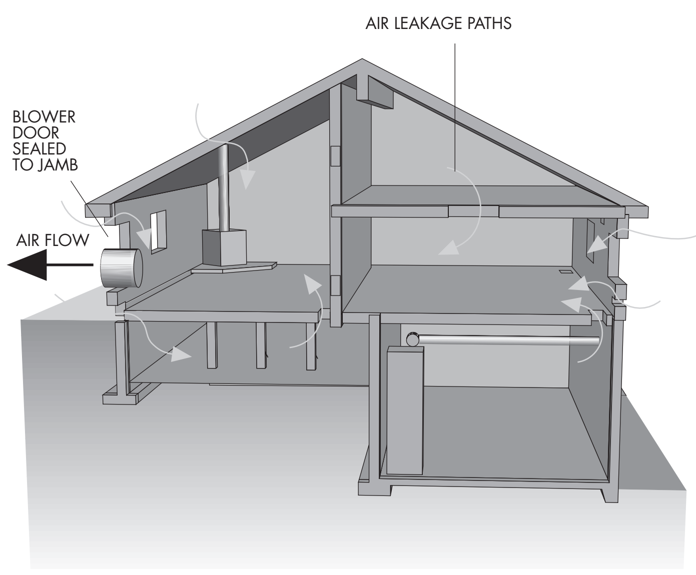
Most holes and cracks can be found with a flashlight and a little patience. But to get the most out of weatherization, you may consider having an energy audit performed by a local utility or home energy conservation contractor. These $50 to $150 audits will show the cheapest places to start saving energy and will also help you decide when to stop. Put another way, an energy audit will identify energy efficiency improvements that will pay for themselves through reduced bills in the shortest period of time. The payback time measures how soon you start saving money from your investment in energy efficiency.

An energy audit should include a "blower door" test which uses a large fan sealed to the front door frame of the house. With the fan running, leaks in the house can be found by feeling air flow at the leak with your hand or by using a smoke pencil. The St. Regis Mohawk tribe of New York began a low-income weatherization program in October 1996 in cooperation with a local energy conservation contractor. Using blower door tests to identify leaks, the program weatherized 18 homes on the reservation during the winter of 1996-1997.

Some utilities offer energy audits free or at low cost. Your state energy office may also be able to refer you to contractors that perform home energy audits. The audit can help you decide if you really want to do the weatherization and insulation work yourself. Contractors can typically do an audit and all the economically-wise weatherization and insulation improvements for about $1,000 to $3,000.

If you do it yourself, the following sections provide guidance. Hardware stores and home improvement centers are increasingly able to provide additional useful advice.

THE BLOWER DOOR TEST
THE BLOWER DOOR IS SEALED TO THE FRAME OF THE HOME'S ENTRY DOOR. WHEN WINDOWS, FIREPLACE DAMPERS, AND VENTILATION OPENINGS ARE CLOSED, THE FAN ON THE BLOWER DOOR CREATES A PARTIAL VACUUM BY SUCKING AIR OUT, AND SOURCES OF AIR LEAKAGE ARE NOTED AND SEALED.
ILLUSTRATION ADAPTED FROM: *BUILDER'S GUIDE TO ENERGY EFFICIENT CONSTRUCTION,* BONNEVILLE POWER ADMINISTRATION, 1992.



Plugging the holes

The biggest holes are not always the easiest to find. Check to make sure your chimney has a damper. Check for holes where the chimney and plumbing stacks go through the roof, attic, and floor. Also check for gaps around plumbing and electrical wire penetrations.

Expanding foam is a good choice to fill cracks up to a couple inches wide. Really big holes can be patched with foil-faced bubble wrap (try Foil-Ray™ or Reflectix™) attached with caulk. You can also use rigid foam insulation glued into place with expanding foam. Don't worry about finding the perfect material to plug a hole. It is more important to get the hole plugged than to do so with fancy materials. Just be careful to use inflammable material near heat sources.

Caulking the cracks

Caulk is the best way to seal cracks thinner than a pencil. While most people are impatient to get on with their caulking, remember that preparation is the secret to making a strong and durable seal. In the long run, you'll be glad you spent some time wire brushing, cleaning, and drying the surfaces to be sealed.

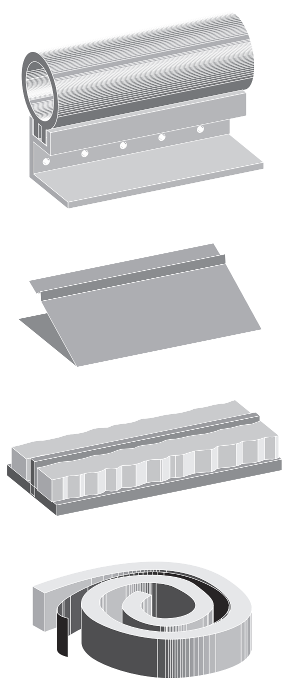
Caulks range in cost and character. Read labels carefully to see if the caulk is suitable for your application and for the particular materials you want to seal. Labels will clearly say whether the caulk is paintable. What they will not tell you is how well the caulk stands up to the elements. If you are applying caulk in exterior areas that will receive direct sunlight, check to make sure the caulk is sun and weather resistant.

Weatherstripping

Weatherstripping comes in all shapes and sizes. Shop around for the weatherstripping that works best for your application. To seal around windows that will be opened in the spring, use rope caulk and/or wide weatherization tape. Rope caulk is a putty-like material that comes in strips or rolls. Reducing heat loss through windows is included in the next section.

HOOPA TRIBAL MEMBER WEATHERSTRIPPING THE FRONT DOOR OF A TRIBAL HOME.

FROM CALIFORNIA ENERGY EXTENSION SERVICE, 1992.



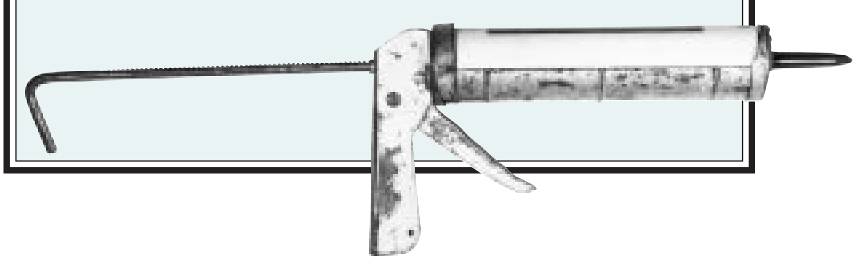
COMMON WEATHERSTRIPPING MATERIALS
FROM TOP: ROLLED VINYL WITH RIGID METAL BACKING, THIN SPRING METAL, FIN SEAL, AND FOAM RUBBER.

ADAPTED FROM AN ILLUSTRATION BY NEW MEXICO STATE UNIVERSITY COOPERATIVE ENERGY EXTENSION SERVICE, *SAVING ENERGY IN YOUR MOBILE HOME*, 1995.

CAULKS AND THEIR CHARACTERISTICS

Silicone	durable (20+ years), easy to apply, excellent sun and weather resistance, not paintable
Siliconized	durable (20 years), easy to apply, acrylic latex good sun and weather resistance, paintable
Polyurethane	durable (20 years), easy to apply, good sun and weather resistance
Acrylic latex	less durable (10 years), easy to apply, not recommended for exterior use
Butyl	less durable (10-15 years), harder to apply, good weather resistance but not suitable for direct sunlight
Oil or latex	not durable (1 to 5 years), not suitable for exterior use

Adapted from Tang and Obst, "Getting a Bead on Caulks: How to Choose the Right Kind," *Home Energy*, March/April 1991, pages 37-43.



Insulation


ONEIDA HOUSING AUTHORITY

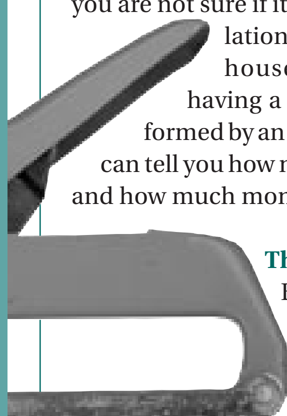
ENERGY EFFICIENT "DREAM HOMES" FOR ONEIDA TRIBE THE ONEIDA HOUSING AUTHORITY IN EASTERN WISCONSIN USED A 1994 DOE TITLE 26 GRANT TO FINANCE THE INSTALLATION OF ENERGY-EFFICIENCY TECHNOLOGY IN THIRTY-FIVE NEW HOMES. EACH HOME HAS R-25 INSULATION IN THE WALLS, R-54 IN THE ATTIC, R-20 IN THE FOUNDATION, AND R-3 WINDOWS. THE HOUSES ARE ALSO ORIENTED TOWARDS THE SOUTH, FEATURE NORTH SIDE EARTHEN BERMS, AND LANDSCAPING TO PROVIDE SUMMER SHADING AND WIND BREAKS. (SEE THE PASSIVE SOLAR DESIGN SECTION.)

Many homes lose more than half their heat through exterior walls, floors and roofs. Insulation is used to reduce heat loss. After weatherization, adding insulation is one of the cheapest ways to reduce heating bills.

How to begin

The first step is to figure out how much insulation you have and how much you need. It is usually easy to find insulation in unfinished attics, basements and beneath floors. In walls covered with drywall, try looking for insulation by taking off the cover to an electrical outlet (after turning off the electricity). If you still can't see any insulation, try drilling a test hole through the wall in an inconspicuous place.

The Energy Efficiency and Renewable Energy Clearinghouse (1-800-DOE-EREC or http://www.eren.doe.gov) can provide a list of minimum insulation levels listed by zip code. Insulation levels are usually expressed as R-values, which are measures of the resistance to heat transfer. The higher the R-value, the greater the resistance to thermal loss. If you are not sure if it is worth installing insulation in a certain part of your house, you might consider having a home energy audit performed by an outside contractor. They can tell you how much insulation will cost and how much money it will save you.



The attic

Before you add insulation to the attic, make sure that you seal up places where air may leak from the heated portion of the house. This would include gaps around the chimney, the attic hatch, or around plumbing stacks and electrical wiring. Make sure you do not cover up attic vents that let in air from the outside. They help keep the attic dry and let hot air escape during the summer. Also make sure you keep insulation away from light fixtures or exhaust flues that may become hot.

In an unfinished attic, it is normally best to use fiberglass batts or blankets laid between or across the floor joists. If your attic has floor boards, you can loosen a few boards and pour in loose cellulose fill. Rigid board or fiberglass batt insulation may be good for insulating between roof rafters in a finished attic. If you are installing the insulation yourself, loose cellulose will cost about half as much as fiberglass. Adding R-22 of loose cellulose in the attic will cost you about 10 cents per square foot.

Exterior walls

Exterior walls are normally insulated by blowing in loose cellulose from the outside through holes in the exterior wall. Blown insulation is best installed by insulation contractors that have the necessary equipment. Expect cellulose insulation to cost about 65 cents per square foot for materials and labor.

Air ducts

Leaky or uninsulated air ducts can be a major source of heat loss. After you have tightened loose joints in the ductwork, seal remaining leaks with latex-based mastic or metal-backed tape. Then wrap the ducts with foil- or paper-faced fiberglass insulation. Duct tape can be used to seal the seams between pieces of insulation.

Mobile homes

After sealing and insulating heating ducts, adding roof insulation is usually the most cost-effective insulation improvement for mobile homes. Blown loose insulation is often the easiest way to go with mobile homes, although this may require hiring an insulation contractor. If the roof is in bad shape, you might try adding a layer of rigid foam insulation and a rubber membrane directly to the existing roof. In cold climates, it is usually worth adding insulation to the floor and walls. It is generally more effective to spend money insulating the floor of the trailer than on insulating the trailer skirting.

The basement

An uninsulated basement can account for one-third of the total heat loss in a home. In unheated basements and crawlspaces, one of the most cost-effective measures is to staple a radiant-barrier bubblepack insulation to the bottom of the floor joists. Another option is to use fiberglass batts between the floor joists. Open ground should be covered with 6- or 10-mil polyethylene sheets to reduce moisture. Rigid board or fiberglass batt insulation can be used to insulate the stem wall. The polyethylene sheet should be laid first so that the wall insulation can hold the plastic in place.

The best option for a finished or heated basement is to frame a 2 by 4 stud wall near the exterior masonry wall. Wall insulation, typically fiberglass, can then be placed between the studs and covered with drywall. To prevent moisture damage to the insulation, leave an air space between the insulation layer and the exterior wall.

Windows

A cheap and attractive way to reduce heat loss out of windows is to install a heat-shrink plastic barrier on the inside of the window. This can cut heat loss through a single-pane window (with an R-value of only 0.9) by 25 to 40 percent at a cost of about 20 to 40 cents a square foot. Adding storm windows is a more expensive but permanent solution. Expect a reduction in heat loss of about 25 to 50 percent for about $8 to $13 a square foot.

Insulating shades can be used to block nighttime heat loss. Many fabric stores sell insulating fabrics with built-in vapor barriers. Another cheap solution is to make covered pop-in panels out of rigid insulation. It is most important to have tight edge seals.

Replacing windows is more expensive. High-performance, low-emissivity (low-e) windows are also available with R values between 4 and 12 for about $16 to $24 a square foot. These windows provide superior insulating performance without window shades. Low-e windows can also help make your home more comfortable by selectively blocking solar heat or light. On west-facing windows in warm climates, a low-e window can be used to block much of the unwanted heat while letting the light through. Consider each window location separately to determine if a high-performance window is worth the investment.

Upgrading to better windows is more cost effective if (1) you live in a cold and windy climate, (2) you have already weatherized and insulated elsewhere (if not, your money is better spent there), or (3) you expect to buy a heating system soon. In the latter case, your investment in better windows may be partially reimbursed by being able to downsize to a smaller heating system.

TYPES OF INSULATION

FORM	TYPE	R-VALUE	COST (PER SQ. FT.)
Batts or blankets	Fiberglass or rock wool	R-3.3 per inch	1.8¢ to 2.0¢
Loose fill	Fiberglass or rock wool	R-2.7 per inch	1.8¢ to 2.0¢
	Cellulose	R-3.7 per inch	1.6¢ to 1.8¢
Rigid board	Expanded polystyrene	R-4 per inch	3.6¢ to 4.8¢
	Extruded polystyrene	R-5 per inch	4.8¢ to 7.2¢
	Polyurethane or polyisocyanurate	R-7 to 8 per inch	4.8¢ to 6.0¢
Radiant barrier	Foil and bubblepack	R-9.8 per 3/8 inch	4.5¢ to 6.0¢

The R-Value measures the material's resistance to heat transfer. Larger R values mean more resistance and better insulation. Adapted from Richard Heede et al, *Homemade Money*, 1995, p. 58, Rocky Mountain Institute, Snowmass, Colorado.

Heating Systems

CAITLIN RIVERS

YUROK SWEATHOUSE, SUMEG VILLAGE

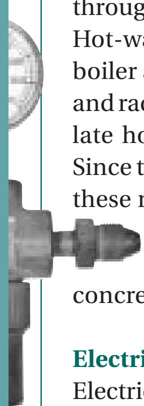
After weatherizing and insulating your home, it is worth making sure that your heating system operates efficiently. This will help you get the most out of whatever heating fuel you use.

TYPES OF HEATING SYSTEMS

There are several types of heating systems which operate using different fuel sources.

Gas, propane, and oil systems

Gas- and oil-fired systems make heat using a furnace or boiler. A warm-air system heats air in a furnace and distributes the heated air through ducts and registers into living spaces. Hot-water systems heat water or steam in a boiler and circulate the water through pipes and radiators. Some hot water systems circulate hot water through tubing in the floor. Since they heat the floor instead of inside air, these radiant floor heating systems are very efficient and comfortable. They are a good choice if you are repouring a concrete slab floor or building a new home.



Electric systems

Electricity can be used with electric resistance baseboards or to power heat pumps. Electric resistance heating is the most expensive source of home heat. Air-source heat pumps transfer heat from outside air into living areas. They are the most common type of heat pump and have the lowest capital cost, but they only work efficiently in warmer climates where outside air does not go below 20 or 30 degrees F. Ground- or water-source heat pumps transfer heat from the ground or water below the frost line. Thousands of ground-source heat pumps have been installed in New England and Canada. They have low lifecycle costs, but can require expensive installation of underground piping.

Wood systems

Wood stoves provide radiant heat or can be used to heat air that may be circulated through living spaces. Wood heat systems are discussed on page 15.

TURNING YOUR HEATER DOWN

As a rough rule of thumb (which depends greatly on climate and building design), you can save about 2 percent on your heating bill for each degree you lower the thermostat. You might try turning back your thermostat before you go to sleep or leave the house. An

EIGHT WAYS TO GET THE MOST OUT OF YOUR HEATING SYSTEM

1 Get a system tune-up done by a qualified technician - usually a worthwhile investment at $50 to $150. Heat pumps should be tuned every three years, gas furnaces and boilers should be tuned every two years, and oil units should be tuned every year.

2 Turn off the pilot light during the summer on gas and propane systems. This will save about $2 to $4 a month. Electronic ignitions can be retrofitted to replace pilot lights on natural gas units.

3 Vacuum or change the air filter on warm-air furnaces and heat pumps. Filters should be vacuumed or changed every month during the heating season. Reusable filters that last a year or two can be bought for about $5.

4 Vacuum out warm air registers and baseboard radiators. Also make sure they are not blocked by furniture, carpets, or curtains.

5 Seal and insulate heating ducts. See "Insulation" on page 10 for tips on saving money by sealing air ducts.

6 Insulate supply and return pipes on steam and hot water boilers. Use high temperature foam or fiberglass insulation.

7 Install reflectors behind hot water radiators. You can make reflectors out of aluminum foil and cardboard or buy them at a building supply store.

8 Bleed trapped air from hot water radiators. Trapped air reduces the efficiency of hot-water radiators. To release the air, buy a valve key at a hardware store. Slowly open the valve on the side of the radiator until only water runs out.

electronic thermostat, available at hardware stores for $25 to $150, will do this for you automatically.

Gas area heaters

In some well-insulated homes, high-efficiency propane or natural gas space heaters can satisfy all heating requirements. The most efficient and safest models draw combustion air from the outside and also exhaust to the exterior. Look for passive systems that do not require electricity to run fans. Expect to pay about $400 to $500 for models which produce between 4,000 and 10,000 Btu/hour, enough to heat a room or home up to 2,000 square feet. Think about "task" heating—like task lighting—only heat when and where you are!

THIS TABLE SHOWS THE RELATIVE COSTS OF OPERATING DIFFERENT HEATING AND COOLING SYSTEMS. COSTS ARE ESTIMATED NATIONAL AVERAGES. ACTUAL COSTS WILL VARY WITH FUEL PRICES, CLIMATE, AND HOUSING CONSTRUCTION. IF YOU HAVE WEB ACCESS, YOU MAY USE AN INTERACTIVE PROGRAM CALLED THE HOME ENERGY SAVER TO ESTIMATE HEATING, COOLING, AND WATER HEATING COSTS FOR HOUSES OF DIFFERENT CONSTRUCTION IN VARYING REGIONS. THIS CAN HELP YOU ESTIMATE COST SAVINGS FROM IMPROVEMENTS TO YOUR OWN HOME (HTTP://EANDE.LBL.GOV/CBS/VH/VH.HTML).

COSTS OF HEATING AND COOLING SYSTEMS

SYSTEM TYPE	INSTALLATION COST	OPERATING COST/YEAR
Advanced gas furnace and high-eff A/C	$7,200	$746
Standard gas furnace and standard A/C	$5,775	$901
Advanced ground-source heat pump	$9,250	$682
Advanced air-source heat pump	$8,940	$822
Standard air-source heat pump	$5,715	$1,232
Advanced oil furnace and high-eff A/C	$6,515	$1,266
Electrical resistance heat and standard A/C	$5,515	$1,769

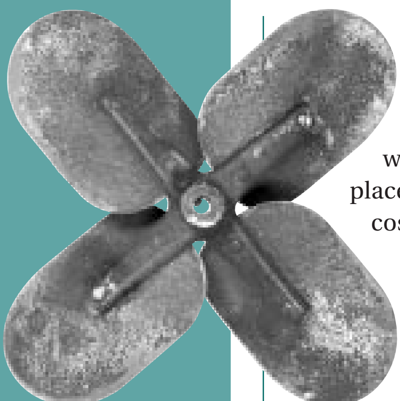
Adapted from Richard Heede *et al*, *Homemade Money*, 1995, p. 96, Rocky Mountain Institute, Snowmass, Colorado.

Buying a new heating system

When buying a new heating system, make sure that your heating contractor carefully explains to you the calculations used to size your system. Weatherization and insulation may allow you to downsize your furnace or boiler.

If you have the opportunity to switch to a cheaper heating fuel when buying a new system, look into it. The long-term cost savings may be significant. If the fuel switch also requires that you replace the whole distribution system, make sure to factor this cost in when you are making your decision. If you use electric resistance heating, live in a mild climate, and also use air conditioning, look into switching to an air-source heat pump. If you have access to natural gas, consider an advanced (condensing-type) furnace.

Cooling Systems



The energy efficiency measures mentioned in this chapter help reduce the need for extra air conditioning as well as heat. With these measures in place, there are also other ways to cut costs on your air conditioning bill.

Reduce cooling loads

The best way to save money on air conditioning is to keep the inside of your house from getting hot. Trees are a good way to shade your home and keep it cool. Remember that deciduous trees can be used in some climates to block summer sun but let winter rays through. Special care should be taken to minimize, shade, or otherwise protect west-facing glass on hot afternoons. Weatherization and insulation, while usually installed to keep heat in, also do a good job of keeping heat out. Another way to reduce the cooling load is to avoid heat buildup in the attic. The cheapest ways to do this include stapling a radiant barrier across the roof rafters, providing adequate controlled ventilation, and choosing a light-colored roofing surface.

Buying a new cooling system

If you are buying a new air conditioning unit, make sure it is relatively efficient. Look for an Energy Efficiency Rating (EER) above 9 for a room A/C unit, or a seasonal energy efficiency ratio (SEER) above 12 for a central A/C system. In hot climates, the extra cost for these units will pay for themselves in a few years. For central systems, make sure that the air conditioning contractor has performed a thorough sizing analysis and explains it to you carefully.

If you live in a climate that requires heating and cooling, an electrical heat pump that provides both may be a cost-effective alternative. See "Heating Systems" on page 12 for more information. In the Southwest and other dry climates, evaporative (or 'swamp') coolers can also be a good alternative to refrigerant systems. They draw house air over damp pads or through a water mist to remove heat.

Cheap ways of cooling

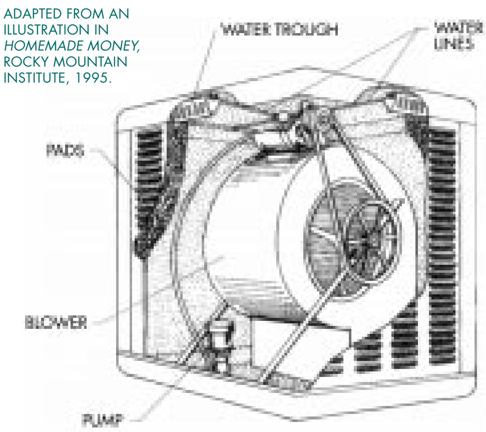
Fans are a cheap alternative to air conditioning. They can extend the comfortable temperature range about 5 degrees F by increasing air movement and evaporative cooling from your skin. Whole-house fans can be installed that draw in air from the outside and exhaust it through the attic. These systems should be installed by a professional. Ceiling fans offer a more out-of-the-box solution. In hot dry areas, make sure to turn off the air conditioning and open up the house during the night. In humid areas, the extra moisture in the evening may create too much extra work for the A/C system.

TEN WAYS TO IMPROVE THE EFFICIENCY OF YOUR COOLING SYSTEM

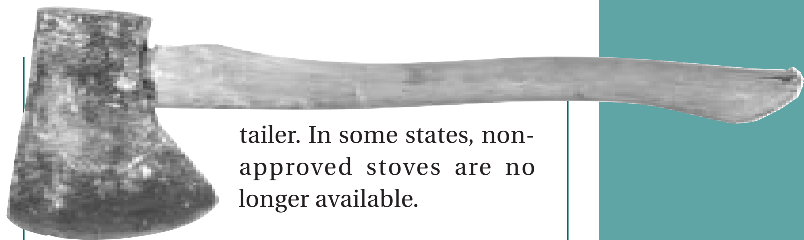
1. Have a technician do a system tune-up.
2. Install a programmable thermostat.
3. Set the thermostat at 78 degrees F or higher if you use fans.
4. Turn your A/C off if you are leaving the house for more than an hour.
5. Close off unused rooms or close registers in unused rooms if you have central A/C.
6. Set your A/C to the recirculating option so that it does not have the extra work of cooling hot, humid outside air.
7. Insulate cool-air ducts that travel through hot spaces in the attic or basement.
8. Shade your condensing unit from direct sunlight.
9. Clean the air filter every month during the cooling season.
10. Clean the coils and fins on the outside compressor unit of a central A/C system.

EVAPORATIVE COOLER.

ADAPTED FROM AN ILLUSTRATION IN *HOMEMADE MONEY*, ROCKY MOUNTAIN INSTITUTE, 1995.



Wood Heat



According to the 1990 Census, 34 percent of Native American households use wood as their primary heating source. This can be a relatively inexpensive source of heat and, if harvested sustainably, can be a renewable form of energy. But wood can also be a major source of pollutants with serious health effects, and wood stoves can be a fire hazard. Most wood stoves emit 200 to 1,000 times as much particulate matter as a gas furnace. The cleanest way to use wood heat is with an EPA-approved wood stove.

High-efficiency wood stoves

High efficiency wood stoves feature air control inlets and separate primary and secondary combustion chambers or use catalytic combustors. These stoves are about 60 to 75 percent efficient, compared with conventional Franklin stoves which are 20 to 30 percent efficient. This means that 60 to 75 percent of the heat available from combustion actually ends up heating your house. Fireplace inserts are wood stoves installed into an existing fireplace. The stove will lose some of its efficiency as an insert and will likely require installation of a chimney pipe within the existing chimney.

With more wood fuel burned inside the stove, less fuel is released as pollution. Wood stoves made after 1992 and certified by the US Environmental Protection Agency are more than 75 percent cleaner than earlier models. With more efficient combustion, the new stoves require less wood which saves on money and effort. EPA-approved stoves (called Phase II wood stoves) cost about $900 to $2,000 dollars. They are available at any wood stove retailer. In some states, non-approved stoves are no longer available.

Fireplaces

Fireplaces can actually have a net cooling effect on the house as a whole. Fireplace fires consume a lot of air, and this air is generally replaced by cold air leaking into the house from outside. Weatherization and insulation can help, both in reducing infiltration of cold air and retaining heated air. But a super-insulated house can seal up sources of fresh air needed for combustion. In this case, the fireplace needs a controlled source of outside combustion air.

You can improve the efficiency of your fireplace by using C-shaped metal tube grates. They draw cool air into the fire and direct the heated air back into the room. Cast-iron firebacks offer another way to improve fireplace efficiency. They radiate heat from the fire back into the room. Another option is to add a wood stove as a fireplace insert as described above.

HIGH-EFFICIENCY WOOD STOVE
THIS HIGH-EFFICIENCY WOOD STOVE HAS AIR CONTROL INLETS AND SEPARATE PRIMARY AND SECONDARY COMBUSTION CHAMBERS

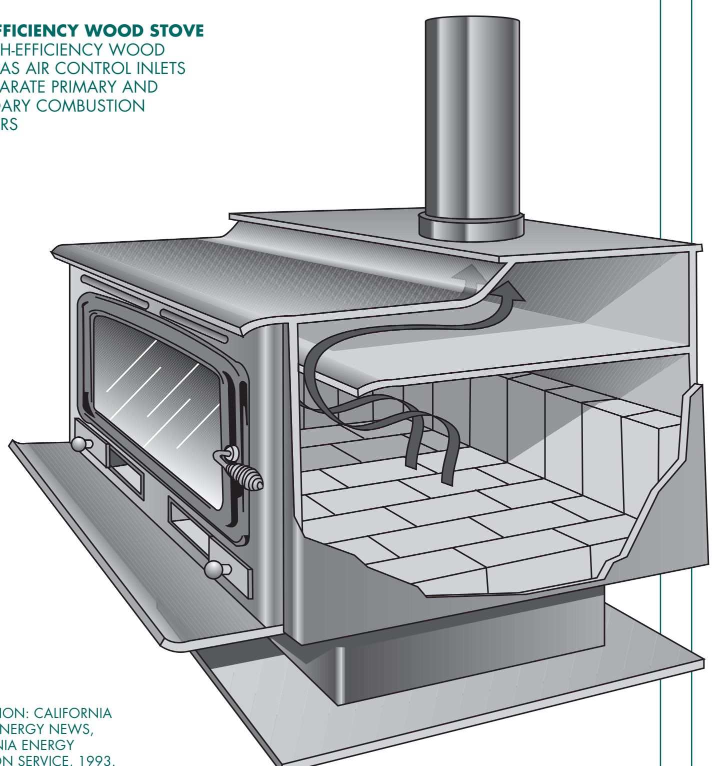


ILLUSTRATION: CALIFORNIA INDIAN ENERGY NEWS, CALIFORNIA ENERGY EXTENSION SERVICE, 1993.

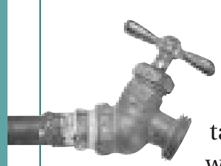
Water Heating

Water heating is often the second largest energy expense after heating and cooling your home. The easiest way to reduce energy used for water heating is to reduce the amount of hot water you use. Then you can work on improving the efficiency of your water heating system.

Saving hot water

The Rocky Mountain Institute estimates that the installation of water-saving shower heads and faucets will save about 17,000 gallons of water each year in the average U.S. home. This means a savings of about $35 per year in water bills and $35 to $85 in energy bills for water heating. This makes the installation of efficient shower heads ($10 to $20) and sink faucet aerators ($4 to $10) well worth the investment. Efficient shower heads should use less than 2.5 gallons per minute. For brushing, washing, and shaving in the bathroom, a faucet that delivers 0.5 gpm works fine. For kitchen sinks where you want to fill pots and do dishes, you may want an aerator that delivers 2.5 gpm.

Another big use for hot water is clothes washing. In most cases, more than 80 percent of the energy used for operating a clothes washer goes towards heating the water. Try to buy machines that let you control the water level and water temperature for the wash and rinse cycles. Then take advantage of that flexibility and wash with cooler water. Front-loading washing machines can be another option, since some models use half the water of a top-loading equivalent.



Insulating your water heater tank

Insulating your water heater tank costs about $10 to $20 and will pay for itself with lower utility bills in three months to a year. Insulate with an R-7 wrap, an R-11 wrap, or two R-5 wraps. Cut the blanket to leave room for the thermostat. On gas water heaters, keep the blanket away from the burner and controls and away from the flue collar on the top. Tape the insulating blanket in place with acrylic tape, which lasts longer than duct tape.

INSULATING A WATER HEATER ON THE HOOPA RESERVATION.

CALIFORNIA ENERGY EXTENSION SERVICE, 1992

Turning the thermostat down

Try setting your water heater thermostat at 120 degrees F. You will save about 3 to 5 percent on your water-heating bill for each 10 degree reduction in the thermostat setting. If your thermostat doesn't list temperatures, try setting it halfway between low and medium.

A water heater timer can be used to turn water heaters off during the day or at night. These cost about $60 to $80 and will pay for themselves in about 6 to 14 months. Also remember to turn the water thermostat down when you are gone from the house for long periods of time.

Solar water heating

Solar hot water systems circulate water through a black collecting surface which absorbs heat from the sun. About 60 to 80 square feet of collector surface is needed to provide hot water for a family of four, and costs between $2,000 and $4,000 including installation. These systems will typically provide all of the needed hot water during the summer and less during the winter. Typically they provide a year-long average of 60 to 80 percent of the total water heating load. Simple batch water heaters can be made for a few hundred dollars using an old water heater stripped of its insulation and painted black. When installed outdoors in a sunny location, the batch water heater acts as an integrated collecting surface and water storage tank.

Solar hot water systems use different methods to circulate water through the collector. Active solar water heaters use pumps to move water through the solar collector back to a storage tank. Passive systems use a storage tank located above the collector surface and natural thermosiphoning to circulate the water. Thermosiphoning takes advantage of the fact that heated water is less dense than cool water. The heated, low density water rises from the collector through pipes to the top of the storage tank where it displaces cool, higher density water. The system will continue to cycle as long as additional heat is available from the sun. Passive systems are usually more reliable than active systems and do not require energy to run a pump. However, a passive system may require mounting the storage tank on the roof to be above the collector, which is not always possible.

Solar water heating systems usually include a backup heating system for use on cloudy days. An existing water heater or an on-demand gas heater can be used for this purpose. During cold spells, water inside the collector must be kept from freezing. The system can either be drained during freezing weather, or an anti-freeze can be added to the circulating water. In anti-freeze systems, the water supply is kept separate from the circulating fluid and is heated using a heat exchanger.

Much has been learned in the last twenty years about making reliable solar water heating systems. Talk to local installers when buying a solar water heating system or making your own so that you will not repeat the same mistakes.

Buying a water heater

Stay away from electric water heating if at all possible. With conventional systems, heating with gas costs half as much as heating with electricity. Heating with propane will cost more than natural gas but will still be cheaper than electric heat. If you already have an electric tank heater, conservation and insulation is the way to go. Another alternative to an electric tank heater is an electric heat pump water heater. These are similar to the heat pumps discussed in "Heating Systems," except some or all of the heat used for space heating is used to heat water.

SOLAR HOT WATER SYSTEM.
FLAT PLATE SOLAR COLLECTORS, CIRCULATING PUMP, SENSOR CIRCUIT, AND HOT WATER STORAGE TANK WITH A HEAT EXCHANGE LOOP.
ADAPTED FROM AN ILLUSTRATION IN *HOMEMADE MONEY*, ROCKY MOUNTAIN INSTITUTE, 1995.

COSTS FOR WATER HEATING

WATER HEATER TYPE	INSTALLATION COST	YEARLY ENERGY COST
Passive solar	$3,000	$30 to $80
Conventional gas	$450	$160
Electric heat pump	$1,200	$160
Propane system	$450	$230
Oil-fired free standing	$1,100	$230
Conventional electric	$450	$390

Assumes 60 gpd of hot water for a family of four. Cost are approximate, include installation, and assume that utility hookups are already present. Passive solar water heating costs assumes that system is sized to displace 80% of conventional gas or electricity heating. Adapted from Alex Wilson and John Morrill, *Consumer Guide to Home Energy Savings*, 4th ed., 1995, p. 163, American Council for an Energy-Efficient Economy, Washington, DC.

POWERING YOUR HOME

This chapter focuses on household renewable energy systems that produce electricity from sun, wind, and water. For homes not connected to the utility grid, or for remote applications such as water pumping for livestock, these proven renewable energy technologies can often provide electricity more cheaply than a utility power line extension. For tribes, off-grid power can also mean independence from outside power companies, keeping money and jobs on the reservation. In locations where grid power is not widespread, design and installation of residential renewable energy systems can also be a business opportunity for tribal enterprises, requiring only modest investments in training and start-up capital.

Renewable energy systems

Renewable energy technologies only produce power when the resource is available—when the sun shines, the wind blows, or the water flows. Also, in most small-scale applications, renewable energy technologies produce direct current electricity. While these characteristics are appropriate for applications such as water pumping, most people want electricity throughout the day and prefer using standard house wiring and appliances. A complete residential renewable energy system uses batteries to store electrical energy for later use and an inverter to convert the DC electricity to conventional AC power. A solar photovoltaic system with battery storage and an inverter is shown on page 25.

Energy conservation comes first

Most household renewable energy systems produce a relatively modest amount of electricity at a cost greater than the price of electricity in a home that is already connected to the grid. The relatively high cost of renewable energy makes conservation the most important part of most renewable energy systems. Most investments in reducing power demand will be more than repaid by savings in system costs. Only in rare cases (with some hydro resources) will renewable energy systems have 'power to burn.'

WHAT APPLIANCES CAN BE RUN ON A RENEWABLE ENERGY SYSTEM?

Microwave ovens, blenders, mixers, stereos, TVs, VCRs, computers, and vacuum cleaners can all be powered with a renewable energy system. Small household appliances with heating elements such as irons, toasters, and hair dryers can also be used, but only for short periods of time since they use up a lot of power. Some electrical loads should not be used at all with renewable energy systems. Standard mass-produced refrigerators consume too much electricity for most systems (see page 22 for alternatives). Electric ranges, electric water heaters, baseboard heaters, and electric dryers can not be used with most renewable energy systems. The same goes for refrigerant air conditioners and forced-air heating systems, which use a lot of power in running condensers, fans, and combustion air blowers.

Home power priorities

The first thing to do if you are interested in an off-grid renewable energy system is to understand how much electricity you now use and plan to use in the future. A sample estimate of the electricity requirements for a small household that does not use electricity for heating or refrigeration is shown on page 23. The next step is to reduce your electricity needs. It will be cheaper to invest in more efficient appliances than to buy an oversized renewable energy system to power the inefficient appliances you have. The third step is to evaluate the available renewable resources and design your remote power system.

The chapter begins with tips to limit your household electrical needs followed by introductions to important elements of home-scale renewable energy systems. For the industrious homeowner, resources listed at the end of the chapter can provide details on resource assessment and system design. For the tribal decision-maker or entrepreneur interested in home-scale renewable energy, this chapter will provide enough information to help you begin exploring your options.

Saving Electricity

In most homes connected to the grid, the largest uses of electricity are for water heating, space conditioning, refrigeration, clothes washing and drying, and lighting. Yet electricity is the most inefficient and expensive way to heat anything. If you plan to power an off-grid home, heating loads should be reduced through weatherization, insulation, and passive solar design. Leftover heating needs should be taken care of with efficient uses of gas, propane, heating oil, or wood.

REFRIGERATOR COMPARISONS

	OLD FRIDGE	NEW FRIDGE	SUNFROST 16 CU. FT	SUNFROST 10 CU. FT.	PROPANE 8 CU. FT.
Cost	Can't give it away!	$500 – $1500	$2,500	$2,000	$1,300
Energy use	5,000 Wh/day	2,000 Wh/day	750 Wh/day	350 Wh/day	1.5 gallons of LP/week
Annual utility bill	$183	$73	$27	$13	$58
Approximate cost for PV panels to power fridge alone	$13,000	$5,000	$2,000	$1,000	$0

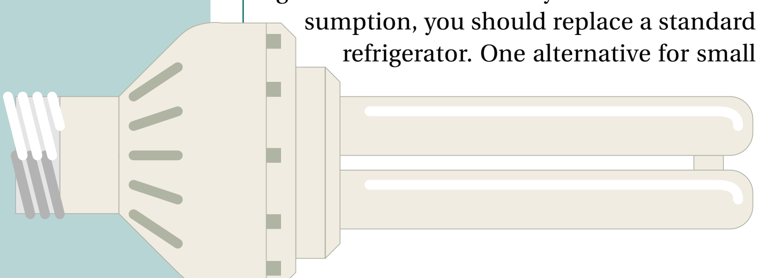
All units are refrigerator/freezers. Utility bills assume $0.10 per kWh electricity and $0.74 per gallon of propane.

The remaining large electricity loads can be powered with renewable energy, but some investment in energy efficiency for these loads is usually cost-effective. This section provides tips to reduce electricity requirements for refrigeration, clothes washing and drying, and lighting. Water pumps are also discussed, since they too can consume large amounts of electricity. By reducing these major electrical loads, you can downsize your renewable energy system and save money.

Even if you do not purchase a renewable energy system, investment in saving electricity can save you money in the long run, especially if your local utility charges high rates.

Refrigeration

Refrigerators are usually the biggest electrical power consumers in the home after space conditioning and water heating. This is because standard, mass-produced refrigerators are very inefficient. If you are off-the-grid and need to reduce your electrical consumption, you should replace a standard refrigerator. One alternative for small households is to use a propane-powered fridge. If you need a larger refrigerator, invest in a super-efficient model like the ones made by Sun Frost. These units use about 20 percent of the energy of most fridges and will be worth the investment if you are using photovoltaic panels. Energy cost comparisons with new refrigerators are made easy with standard black and yellow labels that are now reqired by law. These labels show the estimated yearly energy consumption and energy cost for the unit with reference to all other similar models on the market. Any fridge will run more efficiently if you vacuum off the condenser coils on the back every year and make sure the door gasket seals properly.



Clothes washing and drying

More than 80 percent of the energy used by a clothes washer is typically used for heating water. If you run an electric washer on a renewable system, you may be limited to cooler wash temperatures. In many cases, it is cheaper to downsize your system and run your clothes washer on a backup generator (see "Generators" on page 32).

The cheapest way to dry clothes is on the line. Clothes dryers with electric heat use too much power for most renewable energy systems. If you want to run a clothes dryer on a renewable energy system, use one that uses natural gas or propane as a heat source. These machines draw only about 300 to 400 watts of electricity to tumble the drum.

SAVINGS FROM CFLS

	INCANDESCENT	CFL
Wattage	75W	20W
Lamp life	750 hr.	10,000 hr.
No. of lamps used over 10,000 hrs.	13	1
Electricity cost per kWh	$0.083	$0.083
Electricity cost over 10,000 hrs.	$62.25	$16.60
Cost per bulb	$0.75	$20
Bulb cost over 10,000 hrs.	$9.75	$20
Total life-cycle cost	$72	$37

If you are buying a new washer and dryer and are connected to the grid, remember that removing water from clothes in the washer uses about 70 times less energy than doing so in the dryer. Go for a washer with a high speed spin cycle.

Lighting

Light from the sun is free, but most of the homes we live in were not made to take advantage of daylighting (for alternatives, read about passive solar retrofits on page 19). When you use electric lights, there are several ways to reduce your energy use without sacrificing lighting quality. By concentrating bright light where you need it rather than evenly lighting the entire room, you can lower overall energy demand but still make sure you have light where you need it. This technique is called task lighting. Another way to save money and energy for lighting is to use compact fluorescent lightbulbs (CFLs). These low wattage bulbs are based on fluorescent tube technology but are about the size of a "normal" incandescent bulb. One CFL rated at 20 watts gives the same light output as a 75-watt incandescent bulb. Most CFLs cost about $20. While they aren't cheap, they are cost effective. The table, "Savings from CFLs," shows how one bulb can save you $35 dollars over its entire lifetime when buying regular utility power. For renewable energy systems, the savings can be hundreds or thousands of dollars in reduced equipment costs.

Water pumps

AC pumps perform well, but generally use three times as much power per gallon as a comparable DC pump. There are cases when an AC pump is the best choice, but excellent DC pumps are available for most applications. PV water pumping is often a good option for pumping water to depths of up to 1,000 feet (this will depend on how much water you need). Most renewable energy equipment suppliers can provide assistance in selecting pumps.

SAMPLE HOUSEHOLD ELECTRICAL USE WITH RENEWABLE ENERGY SYSTEM

	NO. ITEMS	WATTS	HOURS/ DAY	DAYS/ WEEK	AVERAGE WATT HOURS/DAY
Compact Fluorescent Lights	4	20	5	7	400
Television set (19″ color)	1	80	4	7	320
Video cassette recorder	1	40	2	2	23
Microwave oven	1	1200	0.1	3	51
Stereo	1	100	1	4	57
Radiotelephone receiving	1	6	18	7	108
Radiotelephone transmitting	1	70	0.5	7	35
Vacuum cleaner	1	700	0.5	1	50
Clothes washing machine	1	1000	1	2	286
				Total electricity use (watt hours/day)	1330

A watt is a measure of the power consumed by an appliance. A watt hour measures energy and refers to one watt delivered for one hour. An 'average' home that does not use electricity for heating in the US might use about 20 thousand watt hours a day. To use the standard unit of electrical energy that appears on your electric bill, a home may use 20 kWh per day. A kilowatt hour is 1000 watt hours. (Adapted from Richard Heade et al, *Homemade Money,* 1995, pages 194-195, Rocky Mountain Institute, Snowmass, Colorado.)

PV Systems

PV systems use photovoltaic cells—thin slices of chemically-treated silicon—that produce direct current electricity when struck by light. Solar cells come wired together in modules that produce 50 to 75 watts in full sun and measure about 4 feet by 1 foot by 1.5 inches. A group of modules mounted on a frame is called a PV array. PV arrays produce direct current, which can power appliances or be stored in batteries for later use.

What is a PV system and how much does it cost?

Native Sun/Hopi Solar Electric Enterprise installs PV systems on the Hopi and Navajo reservations that range in size from one to eight modules. The simplest system that they install has one module, one battery and powers direct current lights without an inverter. This system costs less than $1,000 and, in Arizona, might provide electricity for a few hours of energy efficient light each night.

A diagram of a typical larger system is shown on the next page. This system has all of the basic components of a remote renewable energy power system: storage batteries, a charge controller to regulate battery charging, an inverter to convert direct current electricity to alternating current, and balance of system components including switches and fuses. This system also includes a generator to provide backup power. The cost of two systems installed on California reservations are shown below.

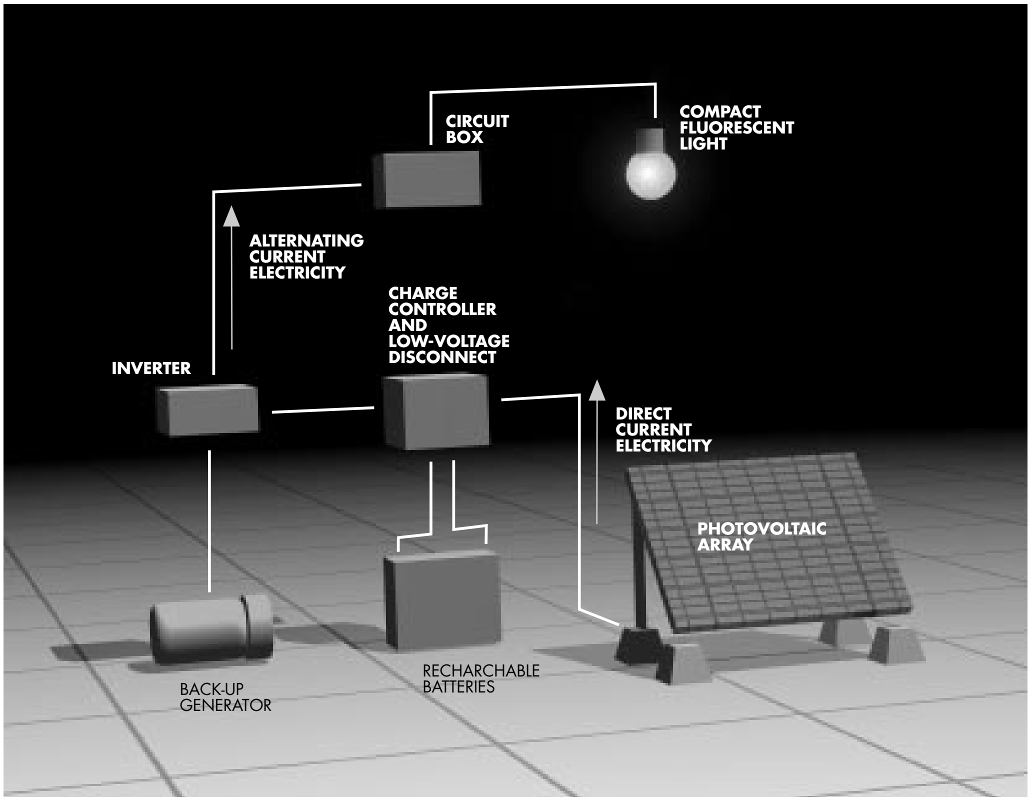
A PV SYSTEM ON THE HOPI RESERVATION WITH 4 MODULES AND AN EXTERIOR BATTERY BANK INSTALLED BY NATIVE SUN.

OWEN SEUMPTEWA

Additional electronic controls are available that can reduce monitoring requirements and make a system more convenient. For example, automatic switches can disconnect batteries to prevent them from becoming too deeply discharged and transfer loads to a generator. These automatic controls are often well worth the price. All systems can be made safe with standard wiring, grounding, and lightning protection practices.

PV SYSTEM COSTS

THE YUROK SYSTEM		THE LOS COYOTES SYSTEM	
Eight 75-watt PV Modules	$3,900	Eight 50-watt PV Modules	$1,700
Eight Deep-Cycle Batteries	$1,700	Six Deep-Cycle Batteries	$500
6.5 kW Generator	$5,000	3.5 kW Generator	$2,100
4 kW Inverter/Controller	$7,100	1.5 kW Inverter/Controller	$1,200
Installation	$700	Installation	$300
TOTAL COST	$18,400	TOTAL COST	$5,800
Estimated Average Output	1350 watt hours/day	Estimated Average Output	700 watt hours/day



A PV SYSTEM WITH STORAGE BATTERIES, A CHARGE CONTROLLER, AN INVERTER, AND BALANCE OF SYSTEM COMPONENTS.

The solar resource

Solar resources are greatest in the Southwest. A PV system located in Montana may produce 30 percent less energy on average than the same system in Arizona. This means that in Montana, you will need more PV modules and a larger battery bank to provide the same level of service. PV arrays must be placed in full sun away from shadows of nearby trees or buildings. Shading of only a small portion of a PV module will reduce its power output to a trickle.

What can I run on my PV system?

Systems can be made to power most any home. But, as discussed on pages 21 and 22, it is generally too expensive to size a remote PV system to power everything in most grid-connected houses. Conservation is the most important part of most renewable energy systems. Refrigerators, one of the largest electrical consumers in the home, are usually cheaper to run on propane than by using PVs. Similarly, it may be cheaper to run very large loads that are used infrequently, such as clothes washers, with a backup generator. See the previous section on conserving electricity.

Maintenance

The PV array and other electronic components of the system have no moving parts and will operate reliably for many years. The biggest maintenance concern for stand-alone PV systems is the battery bank; batteries must be carefully maintained. See "Batteries" (page 30) for more information.

Maintenance costs will vary considerably depending on the system but can be significant. For systems similar to the Yurok system, maintenance and replacement costs could run $13,000 to $18,000 over thirty years, depending on how the systems are maintained. Smaller systems, such as those on the Hopi reservation may require only $1,000 to $4,000 in maintenance and replacement costs over thirty years.

PAT FRANK

LOS COYOTES TRIBAL HALL IS EQUIPPED WITH SOLAR PANELS.

Small Wind Systems

Wind turbines use the kinetic energy of the wind to spin a generator and produce electricity. In areas with a good wind resource, wind turbines are usually a cheaper source of power than PVs. Like PV systems, most residential wind turbines are used with batteries to store energy for when the wind isn't blowing and an inverter to provide AC power. They can also be used without batteries for water pumping and other direct applications.

Turbine output

The size of a wind turbine is often specified by the maximum capacity of the generator, but the actual output of the unit depends mainly on the wind speed and diameter of the turbine rotor. Information about residential-scale wind turbines is shown in the table below, with estimates of power output in typical applications. The cabin size system will power lights, small appliances and hand-held power tools. The home size system will power normal appliances and power tools, but will not power electric ranges, water heaters, space heaters, or central air conditioning. An all-electric size system will power (you guessed it) an all-electric home, a small farm, or commercial shop. This system could also power a cluster of homes with modest electricity needs.

The output of a turbine increases substantially with small increases in wind speed. This is because power is proportional to the cube of the wind speed (meaning that if wind speed doubles, the available power increases eight times). The power output is also related to the swept area of a turbine. If rotor diameter is doubled, the output of the turbine increases about four times.

The following sections will help you figure out how much wind your site has and get the most power out of it. Once you have an idea of the average wind speed that a turbine will experience, you can estimate its yearly power output from published tables or graphs supplied by the turbine manufacturer.

The wind resource

Unlike sunlight, wind resources vary considerably within a single region depending on geographic features. If it *feels* windy in your area, it is probably worth looking into small-scale wind power generation.

How do you figure out if your site is worth the investment in wind power? The first step is to start reading the materials suggested in the *Resources* section. They will show you how to estimate wind speeds at your site based on information reported by nearby airports and weather stations, your site topography, local experience, and even the way trees in your area are shaped by the wind. This level of assessment is sufficient for most home-scale applications. If you want to be more certain of your wind resource, you may do a site-specific wind assessment using simple wind speed indicators, called accumulating anemometers, which are available for a couple hundred dollars. Anemometer data can be collected over an entire year to detect seasonal variations, or over several weeks—just enough time to calibrate your data to the data from a nearby weather station.

If your alternative is a gas or diesel generator, wind systems can be cost effective at an average wind speed as low as 8 mph at the

HOME-SCALE WIND TURBINES

	CABIN SIZE	HOME SIZE	ALL-ELECTRIC SIZE
Rotor diameter (feet)	5 to 10	13 to 20	23 to 28
Rated capacity (kWh)	0.25 to 1.5	3 to 6	10 to 20
Turbine cost ($)	900 to 5,000	5,000 to 10,000	13,000 to 20,000
Typical output (kW/month)	60 to 300	400 to 900	1,000 to 2,000
Typical output (Wh/day)	1,900 to 9,700	12,900 to 29,000	32,000 to 64,000

Source: Mick Sagrillo, Lake Michigan Wind and Sun.

height where the turbine is installed. Since most reporting stations measure wind speeds at 18 to 30 feet, they will report lower speeds than you will find at 50 to 120 feet where your wind turbine will live. If your local monitoring station has similar wind exposure to your site and reports average wind speeds of 7 mph, you may have a good wind resource. Reported averages of 6 mph may even indicate a sufficient resource if the monitoring station is sheltered compared to your site.

Turbine siting

High, well exposed ground is the best location for a wind turbine. Turbines like to be on high towers because wind speed increases with height above the terrain. Depending on the terrain, wind speeds at 100 feet will generally be twenty to sixty percent higher than at 30 feet. In light of the great increases in power that come with small increases in wind speed, investing in a taller tower is almost always a cheaper way to increase your output than buying a larger turbine. Turbulence caused by trees or buildings can drastically reduce the wind available to a turbine. As a general rule, the bottom of a turbine blade should be located at least 30 feet higher than any obstruction within 500 feet.

A typical home system

A typical home-scale turbine is mounted on a tower 50 to 100 feet high. The turbine is usually configured to produce direct current, which is stored in a battery bank, and then converted to alternating current using an inverter.

Approximate costs are shown for two smaller wind turbines mounted at two different heights. These costs give a sense of the increased level of service that comes with investing in a taller tower. The costs are only for the turbine and the tower. Other system components such as batteries, controls, and wiring may cost an additional few thousand dollars.

Your household energy demand and the distribution of windy and calm days will determine the size of the battery bank needed for a complete system. Overall demand may be most cheaply met with a hybrid system that combines a wind turbine and a photovoltaic array.

WIND SYSTEM COSTS AND TOWER HEIGHT

Rotor diameter	8 feet	8 feet	14 feet	14 feet
Tower height	40 feet	100 feet	40 feet	100 feet
Turbine cost	$2,200	$2,200	$4,500	$4,500
Tower cost	$800	$2,300	$1,500	$3,000
Cost of turbine and tower	$3,000	$4,500	$6,000	$7,500
Output (kWh/month)	45	100	240	450
Output (Wh/day)	1,400	3,200	7,700	14,500

Output is based on an average wind speed of 9 mph at a height of 40 feet and 11 mph at 100 feet. This increase in wind with height is typical for a flat rural area with occasional buildings and trees. Costs are author's estimate.

Maintenance

The current generation of wind turbines has been shown to be very reliable. The best small turbines are designed to require little regular maintenance and can operate for 3 to 6 years without attention. However, regular monitoring and occasional maintenance is necessary for long-term reliability. If your system uses batteries, they will be the primary maintenance concern. See "Batteries" (page 30) for more information about battery maintenance.

BERGEY WINDPOWER

Small Hydro Systems

Hydropower uses the kinetic energy of flowing water to turn a generator and produce electricity. Small hydro systems do not use dams. These 'run-of-river' systems use a small weir to divert a portion of a stream or river through a pipe to a turbine located at a lower elevation. The power available from the turbine is determined by the head, or vertical drop from the water source to the turbine, and the flow rate of the water. With a good resource, hydro systems are usually the cheapest renewable energy source for home-scale applications.

A MICRO-HYDRO SYSTEM OWNER PERFORMS THE WEEKLY GREASING OF HIS HYDRO TURBINE (PHOTO: FRONTIER ENERGY, STATE OF ALASKA, 1984).

Types of systems

Traditional water wheels have been used for centuries, but these large and slow-moving wheels are not suitable for generating electricity. Water turbines used for electricity generation are much smaller, rotate at higher speeds, and are much easier to build and install. Over the years, many turbine designs have been developed to work best in different situations. Renewable energy equipment dealers can help you determine which turbine is the best match for your particular combination of head and flow.

At sites with lower flow rates, systems are usually tied to a battery bank and configured to produce direct current. With larger hydro resources, systems may be configured to produce alternating current without the use of a battery bank. These systems must be able to directly power peak loads. Excess power produced is transferred to an alternate load such as a hot water heater.

ESTIMATING YOUR HYDRO RESOURCE

You can get a ballpark estimate of the power available in a stream by knowing the flow rate of water available to your turbine and the vertical drop from the water intake to the turbine (the head). Here goes:

Power (watts) = 0.19 × Flow (gpm) × Head (feet) × Turbine efficiency

A typical efficiency for a home-scale turbine is about 40 percent or 0.4.

If we have a site with 30 gpm at a head of 100 feet we get:

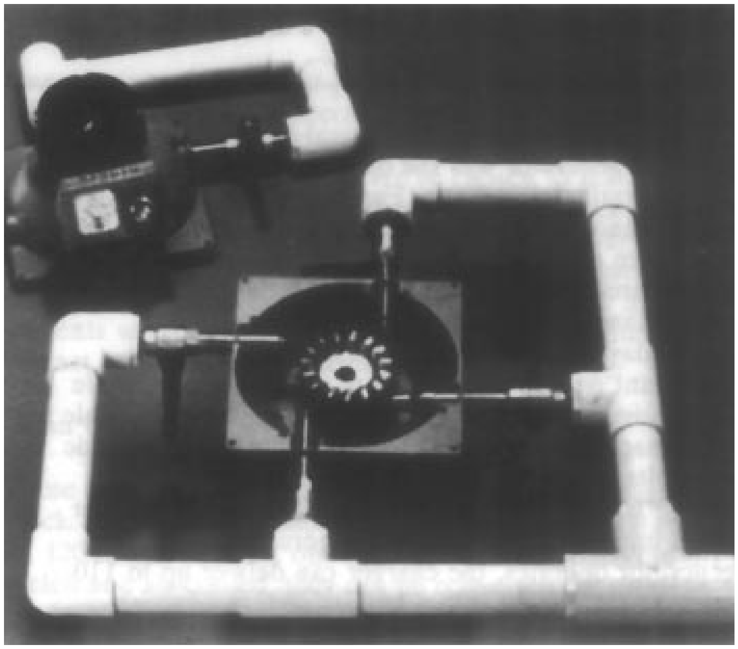
Power = 0.19 × 30 gpm × 100 feet × 0.4 = 228 watts.

Since the stream runs all day, we would estimate that the hydro system could produce about 5,500 watt hours per day (228 watts times 24 hours/day).

A typical home hydro system

A hydropower turbine appropriate for household use can be bought for about $1,000. These simple units are about the size of a breadbox and use a rewired automobile alternator to produce direct current. The direct current is used to charge batteries, then converted to AC power with an inverter.

A typical installation diverts a small portion of stream flow across a screen into a 55-gallon drum. The drum acts as a settling basin and the screen collects debris from the water which may clog the intake to the turbine. The water flows from the drum to the turbine through PVC piping (usually 2 to 4 inches in diameter), and then returns to the stream. Additional costs for piping, controls, batteries, and wiring vary depending on the particular application, but range from $1,000 to $5,000.



REAL GOODS

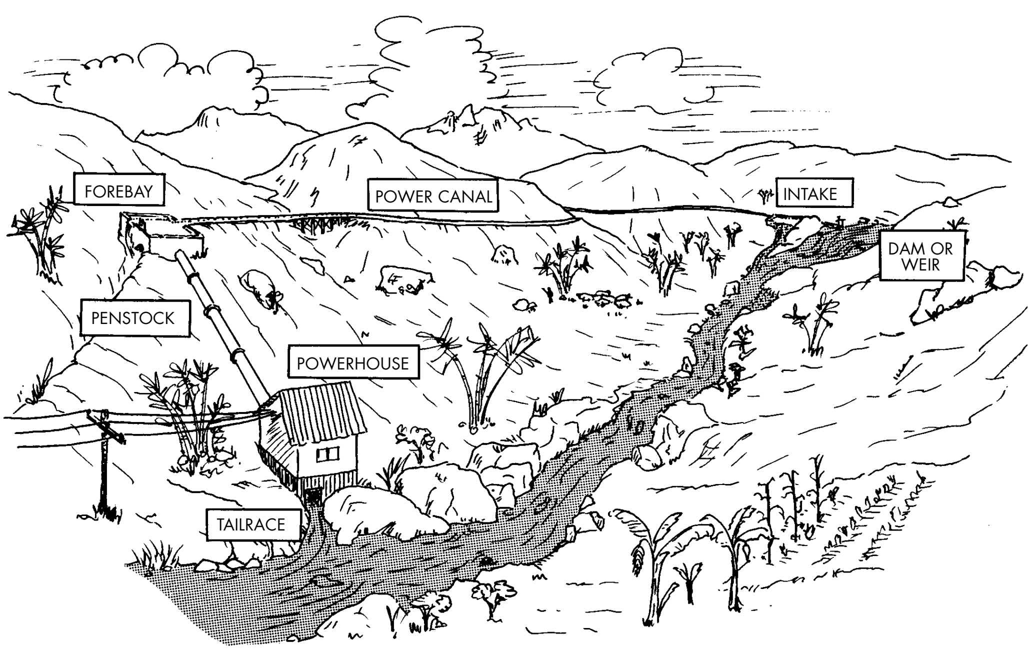
BURKHARDT & HARRIS HYDRO TURBINE

The hydropower resource

Small hydro turbines can be configured to operate efficiently at sites with a wide range of head and flow rates. The greater predictability of hydro resources can help reduce the size of other system components like battery banks. Battery banks for PV systems are usually sized to provide five days of cloudy-day power, while small hydro systems usually need only one or two days of storage. Remember to assess a hydro resource during both wet and dry seasons. It is the responsibility of anyone who uses a hydro resource to evaluate the effects that water diversion may have on the ecology of the waterway and understand any applicable regulatory or legal restrictions. A rule of thumb used by some hydro builders is to divert 10 percent or less of the stream's minimum flow.

Maintenance

Small hydro systems can require more maintenance than comparable wind or PV systems. Construct a reliable screening and settling basin intake that will keep debris out of the turbine through drought and storm. In the turbine itself, only the bearings and brushes will require regular maintenance and replacement. Battery maintenance is also a concern. See "Batteries" (page 30) for more information about battery bank maintenance.



AN ILLUSTRATION OF ALL PRINCIPAL COMPONENTS WHICH MIGHT BE INCLUDED AT A MICRO-HYDROPOWER SITE.

ILLUSTRATION ADAPTED FROM: *MICRO-HLYDROPOWER SOURCEBOOK*, BY ALLEN R. INVERSIN, 1995.

Batteries

Batteries allow you to use renewable energy when the sun is not shining, the wind is not blowing, or the water is not flowing. They also provide storage for powering intermittent, heavy loads. Individual batteries wired together are called battery banks. Battery banks for remote home systems are most often configured to provide power at 12 or 24 volts.

Battery basics

A battery discharge cycle refers to the process of discharging a battery and then charging it back to its original level. The depth of discharge describes how much of the entire battery capacity was used during a cycle. Deep cycle lead acid batteries are designed to be discharged to as low as an 80 percent depth of discharge (leaving 20 percent unused capacity). In a renewable energy system, a battery bank is designed so that the batteries will reach the maximum discharge after a period in which the renewable resource is not available, often assumed to be five days. In general, deep cycle batteries will last longer if they are cycled less deeply.

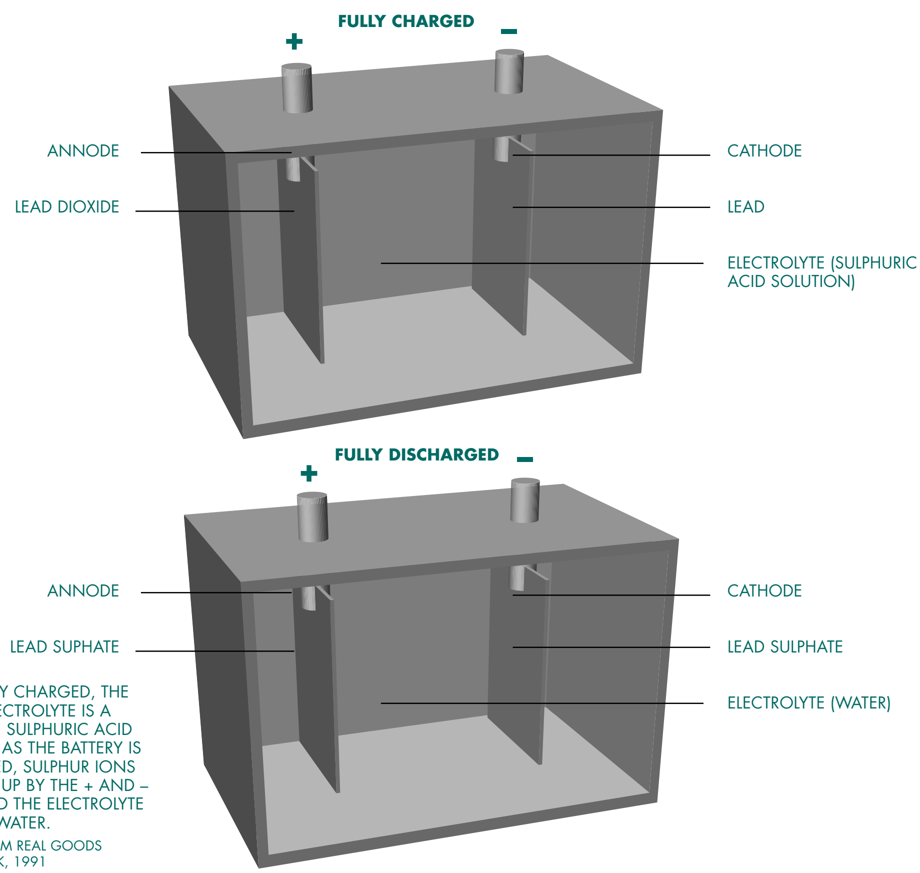
AN EXAMPLE BATTERY BANK

The battery bank for the Yurok PV system (mentioned on page 24) contains eight 6-volt true deep cycle batteries rated at 350 amp hours each. The battery bank is designed to provide an average load of 1350 watt hours per day with a maximum 60 percent depth of discharge during a period of 5 days without sun.

Any renewable energy supplier catalog will contain a worksheet for calculating your battery bank size based on your electricity needs. The battery bank for the Yurok system cost about $1,700.

The Los Coyotes system uses six golf cart (deep cycle) batteries rated at 220 amp hours each. This battery bank costs about $500.

Battery capacity is measured in amp hours. By convention, battery capacity is rated using a 20-hour standard. A 6-volt, lead acid deep cycle battery rated at 220 amp hours will deliver 11 amps at 6 volts for 20 hours. At this point the battery would be completely dead.



WHEN FULLY CHARGED, THE BATTERY ELECTROLYTE IS A CORROSIVE SULPHURIC ACID SOLUTION. AS THE BATTERY IS DISCHARGED, SULPHUR IONS ARE TAKEN UP BY THE + AND – PLATES, AND THE ELECTROLYTE TURNS TO WATER.

ADAPTED FROM REAL GOODS SOURCEBOOK, 1991

Since it is never a good idea to fully discharge a lead acid battery, you should only count on using a portion of the full capacity.

The state of charge tells you how much of the battery capacity you have used up. The approximate state of charge of a battery can be measured using a voltmeter. The voltage measured across the terminals of a fresh 12 volt battery will typically be about 12.7 volts, and will drop to about 12.0 at an 80 percent depth of discharge. A battery's state of charge can be measured more accurately using a hydrometer. The hydrometer allows you to estimate the state of charge based on the change in density of the battery electrolyte that occurs during the charging cycle.

Types of batteries

Lead acid batteries are the most common type of battery used for remote power systems. They are the most established battery technology which makes them relatively inexpensive and well-supported by an extensive manufacturing, distribution, and recycling system.

Lead-acid batteries come in three major types which differ in their ability to provide deep cycle service. Car batteries are designed to deliver high current for short periods with minimal depth of discharge. Car batteries are not recommended for renewable systems as they wear out very quickly. RV or Marine Deep Cycle batteries provide deep cycle service (up to 80 percent depth of discharge), but will only last a few years. They may be a good choice for a small systems that you plan to expand later. These batteries are 12 volt, with capacities ranging from 85 to 105 amp-hours, and costs from $85 to $95. True Deep Cycle batteries are the best way to go for most home systems. They are designed to survive hundreds of cycles with a maximum 80 percent depth of discharge. These batteries are usually 6 volt, with capacities ranging from 220 to 350 amp hours, and costs from $60 to $170. The smaller deep cycle batteries will last at least 3 to 5 years, while the larger ones will typically last for 7 to 10 years.

Lead acid batteries perform poorly in very cold temperatures and should therefore be protected in a box either indoors or in a warm outbuilding. An additional limitation of lead acid batteries is that batteries of different ages should not be used together. A battery bank will perform at the level of its weakest battery.

Regular maintenance

- Checking water level: Batteries lose water during charging. The water level in a lead-acid battery should be checked each month, and if low, refilled with distilled water.
- Cleaning terminals: Corrosion builds up on the terminals of charging batteries. The terminals should be checked monthly and cleaned periodically.
- Hydrometer check: The state of charge of each battery cell should be checked with a hydrometer every six months. If the state of charge differs between the cells, the battery needs equalization.
- Equalization: Batteries should be periodically overcharged in a process called battery equalization. This evens out the charge of the battery bank and helps extend its useful life.

Safety concerns

- Acid burns: The electrolyte inside a lead acid battery is dilute sulfuric acid. This will burn your skin and make holes in your clothing. Be careful with battery acid and always wear goggles, gloves, and old clothes.
- Gassing: Lead acid batteries produce hydrogen and oxygen gas when charging. These gases are potentially explosive and must be vented from the battery area. Make sure that the top of your battery room or enclosure is well vented (since hydrogen is lighter than air) and never smoke or light a match near charging batteries.
- Short-circuits: Even small batteries can create a high short-circuit current that will make a wrench red hot. Tape the handles of metal tools used in the battery area to help prevent dangerous short-circuits.
- Recycling: Batteries are made of toxic metals. They should be recycled and not left to disintegrate in the back yard.

JIM WILLIAMS

DEBBIE TEWA OF HOPI SOLAR/NATIVE SUN EXPLAINING CARE OF BATTERY PV SYSTEMS.

Back-up Generators

Most home power systems use a backup generator to increase reliability. A generator can get you through periods when a renewable resource is not available and it can also power the occasional large load. A generator can also be used to recharge a battery bank to protect it from damage. It is generally most cost effective to design renewable energy systems to provide 80 to 90 percent of a home's electrical power. The last 10 to 20 percent can be more cheaply supplied with a generator.

Choosing a generator

Generators can be powered with gasoline, diesel, propane, or natural gas. Each fuel source has its particular benefits and drawbacks. Think about how much each fuel will cost over time, how available it is over the year, and if its supply will be disrupted in the event of a natural disaster.

Remember that most of the cost of a generator will be for fuel, preventive maintenance, and rebuilds. Think about the long-term costs when you are deciding whether to buy a portable or industrial-grade generator. Lower speed units (1800 rpm instead of 3600) will last longer and require less frequent rebuilds.

Generator sizing

Generators should be sized to power a battery charger and any other loads that you may want to run at the same time. For many full-time remote homes this means a generator of at least 4 to 5 kilowatts. Remember that generators operate very inefficiently when they are under-loaded. For example, a 6.5 kW generator will use as much as half the amount of fuel to power a small 100-watt load than it does at full capacity. Generators will use less fuel and last longer if they are run near full capacity for the shortest amount of time. Oversized generators will waste precious fuel.

Cost

Generators have widely varying costs depending on capacity, durability, and convenience features. A 6.5 kW model that operates at 1800 rpm may cost about $5,000. A 6.0 kW model that operates at 3600 rpm may cost closer to $2,000. Really cheap generators are not designed for continued, reliable use and will generally fail to meet the needs of most renewable energy systems.

Installation

Generators are often installed in power sheds away from the house. Also think about sound proofing, since generators can be pretty noisy. Generators can be installed with additional controls that make them more convenient. They can be made to start automatically when battery levels drop below a set voltage.

A 3.5 KW GENERATOR, V
CAN PROVIDE BACKUP P(
FOR A SMALL HOUSEHOL
RENEWABLE SYSTEM.

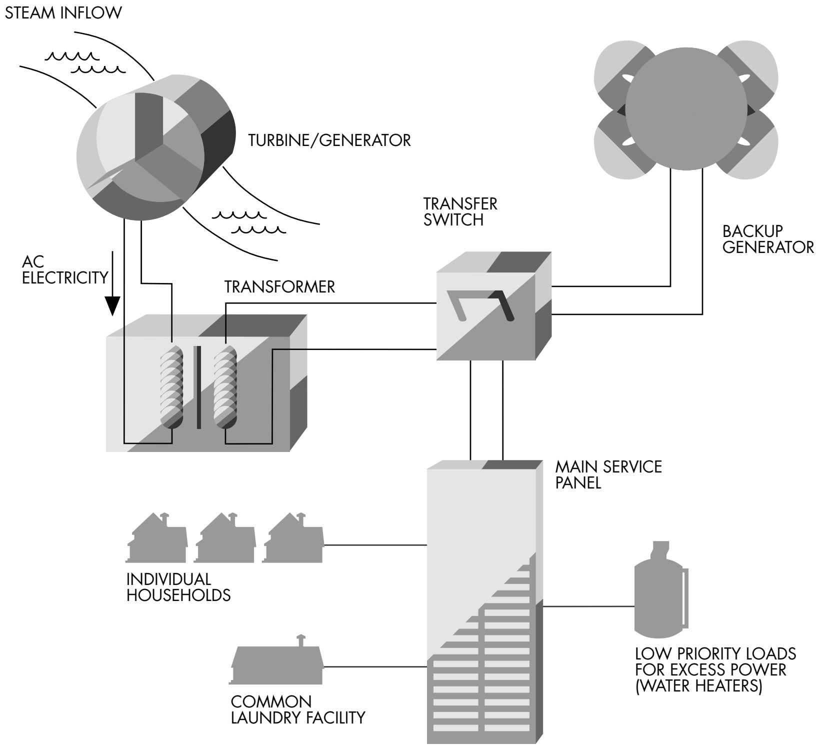
Most of the PV, wind, and hydro systems that have been discussed so far can be bought off-the-shelf and adapted for single home use. But these systems may not respond best to the specific needs and resources of the community. Community energy systems (those that produce power for a cluster of homes or community buildings) can often provide electricity services at a lower cost than several single-family systems.

When are community systems a good idea?

If you are interested in providing electricity to several homes or buildings, it may be a good idea to pursue a community power system. One situation that lends itself to use of a community power system is when there is a sizable local, renewable energy source. A gushing stream or a windy knoll might provide enough energy to warrant investment in larger equipment and community use of the resource. Another is when many members of the community have similar energy demands. A common laundry facility may save money by reducing the size of renewable energy systems needed for individual households in the community. Since equipment is shared, community systems are often less expensive than a number of individual systems. Community systems will, of course, require coordinated control and maintenance. A variety of arrangements for coordinating common operation can be incorporated into the system design.

The Yurok community power system

This system was designed for use by 50 households on the Yurok Reservation in northern California and has not been built as yet. The system is intended to produce 30 to 45 kilowatts of AC power from a diversion of 450 to 1,350 gallons per minute of water. This water is provided from a local creek with a vertical drop of 500 feet. Since AC power cannot be stored, the system is sized large enough to meet peak power demands. The system would provide enough electricity for all household appliances, including TVs, refrigerators, lights, and clothes washers and dryers. When excess power is generated, it is diverted to lower priority loads like water heating.



THE YUROK COMMUNITY POWER SYSTEM

Community Power Systems

COMMERCIAL-SCALE SUSTAINABLE ENERGY

This chapter is an introduction to commercial-scale sustainable energy, which means two things: (1) energy efficiency measures to reduce energy use in commercial or institutional buildings, and (2) the wholesale production of electricity from renewable energy resources for sale to the utility power grid. Commercial-scale projects typically involve more sophisticated technology and higher levels of investment than the household weatherization projects or off-grid electricity systems described in the previous two chapters. Commercial-scale projects have the potential to pay big dividends for some tribes, but also require careful attention to the costs, benefits, and risks involved. For tribes that are considering such projects, this chapter provides some basic information and resources for pursuing the next step.

Most reservations have one or more commercial or institutional buildings that use substantial amounts of energy. Energy efficiency can save energy and money in these buildings by reducing the energy consumption needed for lighting, heating, and cooling without reducing levels of service. Since the early days of energy conservation during the oil crises of the 1970s, the technologies used for commercial and industrial energy efficiency have become sophisticated, reliable, cheaper, and readily available. Tribes are well advised to routinely consider energy efficiency improvements in both existing and planned commercial buildings. Up-front costs of installing energy-efficient equipment can be substantial, and a commitment to maintenance is required. However, the risk is low, and it is a relatively straightforward procedure to determine how great the energy and cost savings will be for a certain kind of investment, and for the tribe to determine if the return justifies the cost. In some cases, the return on investment is so attractive that outside businesses called energy service companies will volunteer to pay the up-front costs and do the work in return for a share of the proceeds from lower energy bills.

The use of renewable energy to generate commercial quantities of electricity is no longer a distant dream. Currently, about two percent of the U.S. electricity supply is generated from renewable sources, not including hydroelectric generation. This amount may seem quite small, but looked at this way: the combined capacity of biomass, geothermal, wind, and solar power plants in the U.S. is about 15,000 megawatts, or the equivalent of 15 large coal or nuclear power plants. While use of renewable energy sources for commercial electricity production is growing and could expand rapidly in the next few years, there is still a long way to go before they overtake conventional energy sources. The technological progress in many areas has been dramatic, and the prices of electricity from renewable sources have fallen tremendously since the late 1970s. Yet even the lowest-cost renewable sources remain more expensive in most areas of the U.S. than cheap conventional sources of electricity, especially natural gas.

The cost of producing electricity with renewables is very dependent on the location, the type of technology, and the quality of the resource. Native American lands are blessed with some of the best renewable energy resources in the United States and tribes have already started producing energy from these sources, including a 50 MW biomass project, and a number of 50 to 100 kW pilot wind projects. Currently, only wind and biomass can generate competitively priced renewable electricity for commercial-scale applications. High temperature geothermal resources are commercially viable, but good sites are extremely rare. Photovoltaics, despite a 20-fold drop in prices in as many years, remain comparatively expensive for grid-connected applications. Solar thermal technologies are still largely experimental.

Occasionally, claims are made regarding other "breakthrough technologies." Beware of such claims, especially if accompanied by a high-pressure sales pitch. The more tribes understand about the technologies and markets for commercial-scale sustainable energy, the better they will be able to determine how they want their resources to be used, and to maximize the benefits to the tribe from their development. Under any circumstances, tribal investment in commercial-scale sustainable energy—to the tune of millions of dollars from the tribe or outside investors—will require the same impartial assessment of feasibility, costs, benefits, and risks as any other major investment.

Energy Efficiency

Significant opportunities exist to save energy and money in many larger buildings on reservations, just as they do for homes. Tribes and businesses on reservations are interested in the services that energy provides—light, comfort, motion—not energy per se, so finding the most cost-effective way of delivering those services makes sense. Improving energy efficiency is often the cheapest solution.

Tribal commercial buildings are used for a myriad of purposes, and can include offices, clinics, schools, community centers, stores, restaurants, casinos, or warehouses. They often have different types of systems for heating and cooling and lighting than homes do, and they can be occupied at different hours of the day, days of the week, or seasons.

Energy consumption in commercial buildings is typically more dependent on what is going on indoors than on the weather. Reflecting these differences, the strategies for increasing energy efficiency in commercial buildings are:

- Increasing the efficiency of the energy-consuming device (such as using a high efficiency boiler or chiller).
- Improving the design of the overall system (such as matching the size of the components to the load)
- Switching to a more efficient system (such as using a heat pump instead of electric resistance heating)
- Improving control of the system (such as using outside air for cooling when appropriate)
- Improving maintenance (such as cleaning coils, sealing ducts, etc.)
- Reducing demand (such as putting in more efficient lights and using daylighting to reduce cooling loads)

Below is a brief overview of the technologies and opportunities available for increasing energy efficiency in commercial buildings. Due to the complexities involved, tribes should consult experts before undertaking retrofit projects in commercial buildings.

Space heating

On average, one-third of all energy in commercial buildings goes into heating space. This is the largest end-use of fuel in commercial buildings. The fraction is much smaller in warm climates, where large commercial buildings require little space heating. These buildings may generate all necessary heat from internal sources such as lights, computers, copiers, etc., and only require energy for moving the heat from the interior spaces to cooler perimeter spaces.

A range of heating systems are used in commercial buildings, including forced-air furnaces, hot water or steam boilers, heat pumps, and resistance heaters. These systems distribute heat around the building by means of fans and ducts or pumps and piping. Central systems sometimes serve domestic hot water needs too. Half of space heating systems use natural gas, with a typical efficiency of around 70 percent. Condensing gas furnaces and boilers are available with efficiencies greater than 90 percent. Heat pumps used in commercial buildings, like their smaller cousins used in homes, are extraordinarily efficient except in the coldest climates, and are almost always a cost-effective alternative to electric resistance heating.

Lighting

The largest end-use for electricity in commercial buildings is lighting, consuming about 41 percent of electricity and 28 percent of total energy. Huge improvements in the efficiencies of lighting equipment have occurred in the last decade, along with falling costs, higher reliabilities, and richer variety of choices.

Fluorescent lighting systems are very common in commercial buildings. These systems are comprised of lamps, ballasts, fixtures, and controls. Each of these components is available in a range of efficiencies. An efficient system might include smaller diameter 32 watt lamps with special phosphors (known as tri-phosphor T8 lamps), electronic ballasts, specular reflector fixtures, and sophisticated controls for scheduling operation or switching on when the room is occupied and off when it is not.

As in the home, replacing incandescent lamps with compact fluorescent lamps (CFLs) is extremely cost-effective. Today, fixtures designed for CFLs are available so aesthetics don't have to be sacrificed in the process of saving energy.

Although generally impractical as a retrofit measure, designing a building to use natu-

COSTS OF COMMERCIAL ELECTRICITY SAVING OPTIONS

	COST OF SAVED ENERGY (¢/KWH)
Lighting Options:	
Delamping	0.1
Reflective Fixtures	1.0
Occupancy Sensors	3.3
Daylighting Controls	4.7
Electronic Ballasts & T8 Fluorescent Lamps	5.8
Space Cooling Options:	
High Efficiency Fan Motors	1.0
VAV Conversion	1.3
Economizer Controls	1.7
High Efficiency Pump Motors	1.8
Variable Speed Drives on Fan Motors	2.1

Adapted from *The Potential for Electricity Conservation in New York State*, by American Council for an Energy Efficient Economy, Washington, DC, September 1989

ral light (also known as daylighting) is an excellent way to save lighting costs. Daylighting also reduces cooling costs by reducing the heat released by electric lighting systems.

Combining high efficiency lighting components into an appropriately designed package can yield cost-effective energy savings in excess of 70 percent over a conventional system, with no degradation in light quantity or quality. Because efficient lighting systems release less heat than inefficient systems, the costs of space cooling are also significantly reduced.

Space cooling

The third largest end-use in commercial buildings is space cooling, consuming 16 percent of total energy. Because of the heat generated in commercial buildings, most are equipped with some type of space cooling system (also known as air-conditioning).

Chillers, which provide cool air or water to the system, are at the heart of any sizeable space cooling system. They are also usually the largest energy consuming component. High efficiency models are available across the range of sizes and types.

In many commercial buildings, the amount of outside air that is brought into the building is a fixed quantity based on minimum air quality standards. If the system is equipped with controls to vary the amount of outside air (known as an "economizer"), then when the outside temperature is cool enough, more outside air can be brought in and the chiller can be turned down or even off, thus saving energy.

Another common situation is for the system to supply a fixed quantity of air to the building at all times. Instead, this amount of air can be varied to meet the minimum space cooling load and air quality requirements at any given time, a strategy known as "variable air volume." This strategy saves energy by reducing the energy used by fans to distribute air around the building. Further fan energy savings can be achieved by using more efficient fan designs and variable speed drives on the motors that power the fans.

The ducts that carry cool (or hot) air around the building are often leaky, so sealing ducts is an inexpensive and effective energy saving measure. If a building is large and complicated enough, a computerized system to control the lighting, heating and cooling systems (known as an energy management system) can also yield significant savings.

BIG LAGOON RANCHERIA: HISTORIC HOTEL LIGHTING RETROFIT SAVES ENERGY

As an economic development project, Big Lagoon Rancheria of northern California assumed ownership of the historic Hotel Arcata in 1990. Built in 1915, the Hotel Arcata had period lamps with glass diffusers and antique brass bases.

A lighting retrofit at the hotel proved that lighting energy consumption can be reduced without sacrificing light levels or appearance. Big Lagoon contracted with an outside firm to take a look at the lighting in the hotel and recommend ways to reduce electricity costs. They came up with a plan to change nearly all of the incandescent lights in antique fixtures in public areas and hallways to energy-efficient, color-corrected, long-lasting compact fluorescent lamps.

Over 120 lamps, fixtures, and exit signs in the hotel were changed to compact fluorescent lamps. These new lights met or exceeded the previous light levels and each will last about 10,000 hours (compared to the 1,000 hours of the incandescent). Most of the lamps that were replaced were operating 24 hours a day. The project cost $4,661, and saved $4,395 in the first year.

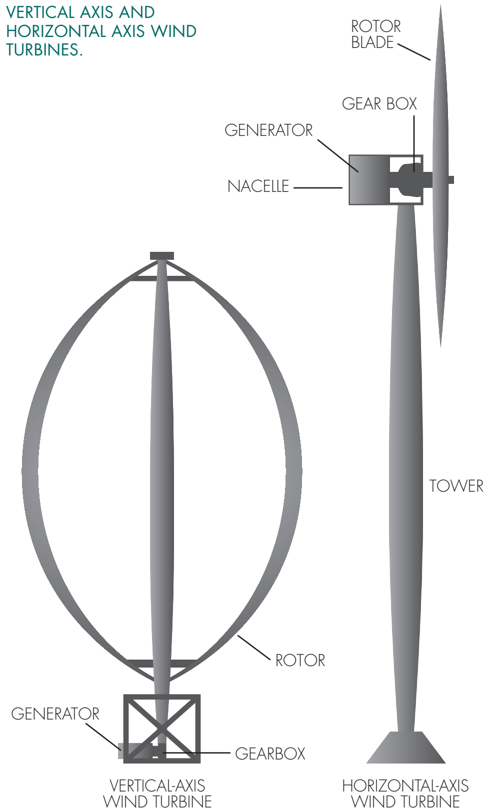
Commercial Wind

In the United States, wind turbines generate about 3.5 billion kilowatt-hours of electricity each year—enough to meet the annual residential electricity needs of 1 million people. Most commercial wind power today is provided by turbines of 100 to 750 kilowatts (kW), most often clustered in wind farms with total array capacities of 1 to 100 megawatts (MW). The latest systems, with installed costs of under $1 per watt, provide power to the grid at less than 5¢/kWh, from sites with minimum average wind speeds of 13 mph. These prices are competitive with fossil fuel electricity in many parts of the country.

The technology

Today's windmills bear little resemblance to their forebears. Some look like huge fans, usually with three long blades. Others look like a giant's eggbeater, sitting straight up. No matter what shape the wind catcher takes, all turbines work essentially the same way. The rotor blades connect to a single shaft which fits into the turbine housing. In most older machines, the rotor spins at a constant

COMPARISON OF VERTICAL AXIS AND HORIZONTAL AXIS WIND TURBINES.



SEA WEST

A COMMERCIAL WIND GENERATION FACIILITY IN PALM SPRINGS, CALIFORNIA.

speed no matter how hard the wind blows, steadily turning a magnet through a coil of wire. This action generates a flow of uniform-frequency electricity. (All turbines, whether they are spun by the wind, rushing water, or steam produced by boiling water, generate electricity the same way—with a magnet and a coil of wire. Rotation through the magnetic field causes a current to flow through the wire.) Electronic equipment "conditions" the power output before it is used to drive a pump or other device, or sent out on cables to the utility grid.

New and better wind machines are being developed all the time with new materials that make them lighter, stronger, and cheaper. One recent innovation is a variable-speed generator with advanced electronics. This new design allows turbines to capture energy more efficiently over a wide range of wind speeds and to stand up to strong gusty winds better than their low-speed cousins while still providing high quality power to the grid.

Wind is pollution and waste free, but it does have a few drawbacks. The whoosh of blades against the wind creates a low, steady drone. From a single, well-maintained turbine this sound is almost inaudible, but the noise from an entire wind farm cannot be missed. The steady winds that make for good windpower sites sometimes coincide with prime habitat for birds of prey or with stop-off points for migrating birds. Spinning turbine blades are hazardous to these birds. Such problems can be avoided through careful site evaluation and system design.

The resource

Maps of average wind speeds reveal the obvious—some areas are very windy and others aren't. But they also show that calm areas may sit right next to windy ones, thanks to variations in local topography. Much of the best U.S. wind energy potential is in the Midwest, including tribal lands, but most states, except those in the Southeast, appear to have some excellent sites. The largest wind projects to date are located in California, where, in 1996, more than 16,000 turbines generated approximately 2.85 billion kWh of electricity.

Wind potential is extraordinarily site specific. Average wind speeds measured at a local airport won't necessarily match the average wind speed a mile away. Prior to planning a wind development, sites must be carefully surveyed and evaluated. Preferably, wind speeds should be measured at different heights and over the course of a year or more before making any large investments in a wind power project.

AMERICAN WIND ENERGY ASSOCIATION

A COMMERCIAL WIND GENERATION FACIILITY IN TEHACHAPI, CALIFORNIA.

Biomass

Biomass is our oldest source of energy, most familiar to us as firewood. In the last two decades, biomass power has become the second largest renewable source of electricity after hydropower. Many commercial-scale biomass energy projects are struggling as they lose their high guaranteed energy prices under federal incentive programs. Nevertheless, there are places and conditions under which biomass energy makes economic sense.

The technology

Biomass is organic material derived from a variety of sources—wood by-products, forest-slash, prunings, nut shells, fruit pits, animal manure, and municipal solid waste. In agricultural regions, orchard and vineyard prunings, almond and rice hulls, poultry and dairy manure, and cheese whey are typical resources. In forested regions, forest residue or wood scraps are the most plentiful resources.

Biomass can be converted to useful energy in two basic ways. It can be burned directly to generate electricity or provide heat, or it can be converted to gaseous or liquid fuels (ethanol or methanol) which are alternatives to gasoline.

Biomass feedstocks are used to generate electricity in the same way as nonrenewable fossil fuels are used. Combustion of biomass heats water to generate steam. This steam drives a turbine generator. Many biomass plants are "cogenerators"—they produce both electricity and useful heat from the same fuel source. The heat from cogenerators is often used for some industrial process; it also may be used to heat a cluster of homes located near to the cogenerator.

The resource

Biomass power plants supply three-quarters of non-hydro renewable electricity with a combined rated capacity of over 10,000 megawatts. Overall, biomass meets 3 percent of the nation's total energy needs.

Today's biomass power plants primarily use residues from the farm and wood-products industries. With increased demand for biomass, care must be taken to manage biomass resources with sustainable forestry and agricultural practices or they will not be replenished for future use. Biomass is often considered a "dirty" fuel because of air pollution problems, although much of this pollution can be reduced with control devices.

Tribes may choose to develop a biomass plant or to incorporate cogeneration into a forest products industry. They may also choose to sell biomass fuels (e.g., wood or agricultural waste) to biomass plant operators or waste brokers.

CABAZON TRIBE CONVERTS WASTE TO ENERGY

In 1986 the Cabazon Tribe negotiated a joint venture agreement with a private company to develop a biomass project on the reservation. The project went on-line in 1992. It generates electricity derived from burning agricultural and wood refuse from Imperial and Coachella Valleys. The project consists of a 49 megawatt power plant with two fluidized bed boilers and one turbine generator. The electricity that is generated is sold to Southern California Edison Company.

The project features advances in plant design. Biomass chips are injected into the plant's twin boilers, which contain circulating fluidized sand heated to 1,750 degrees F. Sand encapsulates the biomass chips, burning them in a very complete combustion process.

Cabazon's biomass project has been a success; in May, 1997 it won the Department of Energy's "Clean Cities" award for its contribution to cleaner air and local recycling activities.

Cabazon CEO, Mark Nichols reflects, "When undertaking any project as large as this plant is, one has to be ready to spend thousands of hours in preparation, which the tribe expects to pay off with 30 years of economic stability. The project has been a crucial stepping stone to realization of the tribe's dream of having an industrial park located on the reservation. All the infrastructure that has been put in place by this project can be used by other industry willing to locate on the reservation."

Funded by Title 26 of the 1992 Energy Policy Act, the Nez Perce and White Mountain Apache tribes are in the process of assessing the feasibility of biomass projects.

Geothermal energy is the natural heat trapped in rocks and fluids beneath the earth. Geothermal resources have been used for ages as naturally occurring hot springs. Geothermal energy may also be used directly to produce electricity. Electricity was first generated from geothermal power in the early 1900s. Today geothermal energy contributes about 16 billion kilowatt-hours per year to U.S. electrical production and 4 billion kWh/yr in direct use heat.

The technology

Geothermal resources come in five forms: hydrothermal fluids, hot dry rock, geopressured brines, magma, and ambient ground heat. Of these five, only hydrothermal fluids (steam and hot water) have been developed commercially for power generation.

Steam resources are the easiest to use because the steam can directly drive a turbine. Commercial steam resources are quite rare, however. The Geysers, in northern California, is the only steam field in the United States that is commercially developed. It is also the largest single source of geothermal power in the world, generating up to approximately 5 billion kWh/yr.

Hot water plants, using high- or moderate-temperature geothermal fluids, are a relatively recent development. These plants are now the major source of geothermal power in both the United States and the world. In the United States, hot water plants are operating in California, Hawaii, Nevada, and Utah.

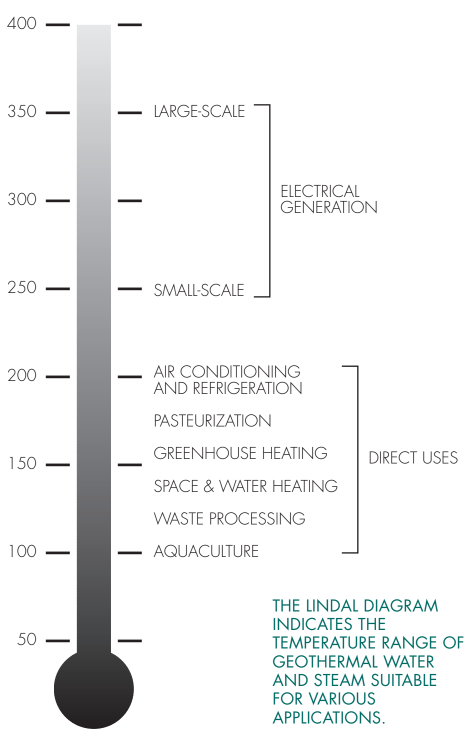
The technology for direct use is simple—conventional hot-water and steam equipment. Over 21 communities in the U.S. use geothermal energy in district heating systems, circulating hot water through pipes to homes and other buildings.

Other direct use applications include produce drying, aquaculture, and industrial processing.

The resource

There exist more than 2,800 megawatts of geothermal electric power capacity in the United States. It is anticipated that as technology improves, the cost of generating geothermal energy will decrease from current costs of 5¢ to 8¢/kWh.

Geothermal electricity is relatively clean compared with electricity generation from fossil fuels. However, some geothermal plants do emit noxious gases, such as hydrogen sulfide. The mineral and salt content of the steam and hot water can also contaminate ground and surface water if not contained. The U.S. contains over 600 direct use facilities—with an equivalent capacity of about 2,000 MW (thermal).



THE LINDAL DIAGRAM INDICATES THE TEMPERATURE RANGE OF GEOTHERMAL WATER AND STEAM SUITABLE FOR VARIOUS APPLICATIONS.

FORT BIDWELL USES HEAT FROM THE EARTH

In 1980 an assessment of the geothermal resource at Fort Bidwell was funded by a grant from the California Energy Commission (CEC).

The first well was drilled in September, 1981, and in1982 HUD funded a project to provide geothermal space heating to a gymnasium and a tribal office, and to retrofit with piping a small medical clinic and staff house, and a five-unit apartment complex.

Tribal Chairman Ralph DeGarmo comments, "Throughout the winter months, most households pay $150 to $200 per month for utilities (wood and electricity). The apartments/clinic pays $25 per month for utilities. It's quite a savings."

Solar Thermal

Solar thermal electric systems produce electric power by using solar radiation to generate enough heat in a working fluid to flush water through a heat exchanger to steam, which then drives a generator. Today there are more than 350 megawatts of solar thermal electric systems in the United States.

The technology

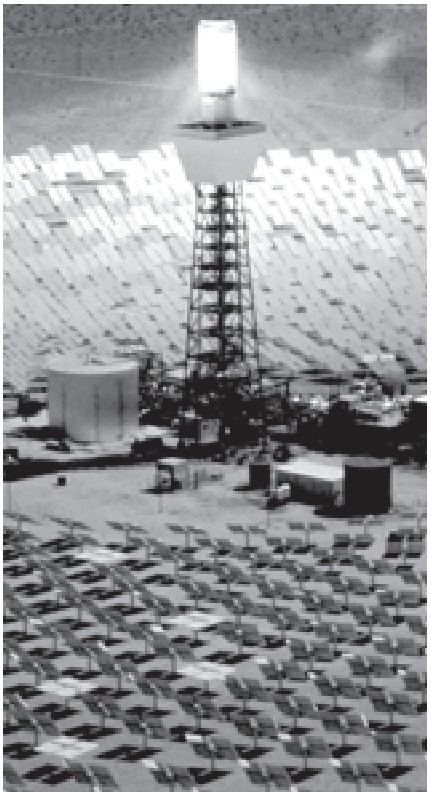
There are several ways that the sun's heat can be employed to drive a generator. One method is to use linear concentrators. These long rows of curved mirrors direct and concentrate sunlight onto an oil-filled pipe running along the center of the mirrors. This system, also known as the Luz System, was commercially viable while tax credits were available during the 1980s.

Another technology involves fields of mirrors aimed at the top of tall towers. These "power towers" circulate and heat fluids that then flash water to steam through a heat exchanger to drive a generator. Solar Two, an experimental power tower currently under development, focuses the sunlight reflected from 435 mirrors onto an opening at the top of a 300-foot tower. Here the brilliant light falls on exposed pipes carrying melted sodium, heating it well above 1,000 °C. This molten mass is then used to boil water and drive a steam turbine. Three hours of thermal energy for electricity production after sunset can also be stored in a tank of the heated molten salt.

A third method involves the use of parabolic dish concentrators. These experimental systems are modular, typically in the size range of 10 kilowatts each. They look like inverted ice cream cones, with mirrors on the curved base that concentrate light onto a Stirling engine at the peak. These engines generate electricity by using the expansion of the working fluid to turn a turbine.

The resource

Solar thermal electricity technologies are more expensive to develop and maintain than most other renewable or conventional energy sources. Currently solar thermal electric provides only 350 MW to the grid, most of it from the Luz linear collector plant in southern California, now operated by KSC Operating Company. To stand a chance economically, solar thermal electric systems must be located in places with a great solar resource, very clear air, and low land costs.



ABOVE: A SOLAR THERMAL LINE-CONCENTRATOR SYSTEM OPERATED BY KSC OPERATING CO. PROVIDES POWER TO SOUTHERN CALIFORNIA EDISON COMPANY. (PHOTO: ELECTRIC POWER RESEARCH INSTITUTE)
RIGHT: THE CENTRAL RECEIVER CONCEPT WAS SUCCESSFULLY DEMONSTRATED AT THIS DOE-SPONSORED 10-MW PILOT PROJECT, CALLED SOLAR ONE, LOCATED IN BARSTOW, CALIFORNIA. (PHOTO: MCDONNELL DOUGLAS)

Photovoltaics

Photovoltaics are a cost-effective option for many applications: off-the-grid homes, water-pumping, highway emergency phones, even calculators. They are not yet, however, cost-competitive with other renewables or with conventional energy sources for grid-connected applications. Commercial photovoltaic power development costs are three to five times those of wind, biomass, and geothermal power. There are currently several experimental utility-scale photovoltaic programs in place, all of which require large subsidies to develop and maintain.

The technology

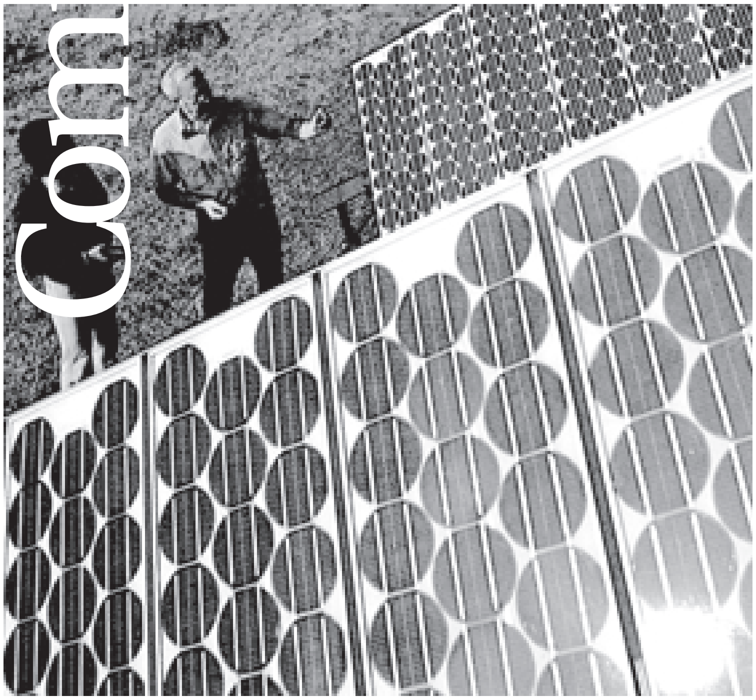
Photovoltaic (PV) cells produce electricity when struck by light. Made from silicon, photovoltaic cells were originally developed to power spacecraft and space stations, where cost per watt was not an important factor.

Photovoltaics are the quintessential modular energy supply. You can start with one or two panels to establish an array, and additional panels can be added when you can afford them, or as you need more electricity. They work soundlessly, emit no pollutants, require no water, and have no moving parts to maintain. Tests show that photovoltaic panels can be easily and safely integrated with the electrical grid, providing clean, renewable electricity for homeowners and helping utilities reduce their peak demand during the daytime.

The resource

Photovoltaic systems are attracting the attention of some utilities. The Sacramento (California) Municipal Utilities District currently operates the world's largest PV power plant, a 2-megawatt system built in 1986 right next to the closed Rancho Seco nuclear power plant. Electricity generated during the day is used in the homes or businesses, and any left over goes into the utility grid, turning the customer's meter backward (a practice known as net metering). At night, the buildings draw power from the grid, which acts like a huge battery backup system.

Like solar thermal energy, PV applications are limited not by the size of the resource but by cost. Since the first photovoltaic cells accompanied satellites into space in the late 1950s, their cost has dropped dramatically from $44 to about $10 per peak watt of output. (The cost actually ranges from $6 to $15 per peak watt depending on the size and type of system. A peak watt rating reflects the maximum power output of a PV module under optimum solar conditions.) It is expected that the cost of photovoltaic modules will eventually drop to between $3 and $5 per peak watt.



PACIFIC GAS & ELECTRIC

A SOLAR ARRAY NEAR SAN LUIS OBISPO IS SELLING POWER TO PACIFIC GAS AND ELECTRIC COMPANY.

Business Opportunities

Many commerical building energy efficiency inprovements offer an immediate opportunity for profitable or cost-saving tribal investment. The need to reduce air pollution and the threat of global climate change due to emissions from fossil fuel power plants may compel the federal government to expand incentives for investment in energy efficiency and renewable energy. These incentives would make marginal investments more attractive due to rebates, tax advantages and other cost breaks.

In addition, the electric utility industry of the U.S. is now undergoing major changes, called *restructuring*, designed to make it more competitive. While some people fear that competition will cause utilities to purchase only the cheapest power available and abandon efforts to develop renewable energy, there is also the prospect that competition will allow millions of individual consumers to support environmentally-beneficial "green electricity" by choosing to pay a little more for it on their electricity bills. Similarly, some states are trying to support renewables and energy efficiency in their restructuring schemes through surcharges in rates.

Opportunities for tribes

What prospects do tribes have for participating in commercial-scale sustainable energy projects? For energy efficiency projects there are many immediate possibilities for reducing overhead of businesses, clinics, and schools through investment in more efficient lighting systems and space heating and cooling systems, and through improving system maintenance and control. In the case of commercial-scale renewable energy projects, the prospects are good in the long term, if approached with sound planning.

For most tribes, the availability of financing for tribal investments in energy efficiency and renewable energy is a key issue. The terms and conditions under which projects are financed often determine the economic feasibility of such investments. Financing issues, including financing for commercial-scale projects, is discussed separately in Chapter 4.

Many tribes are blessed with excellent renewable resources—some of the sunniest and windiest spots in North America are on tribal lands. All things being equal, the better the resource, the cheaper it is to produce power, and the more profitable its development will be. In the newly restructured utility industry, utilities will no longer have a monopoly on generating, transmitting, or selling power, thereby opening the door to independent power producers, including tribes. Tribes have an advantage in being able to use sovereign powers to provide additional incentives, such as low-cost financing and tax incentives for renewable energy investments. With the natural resources to produce electricity, and the legal capacity to sell it commercially, many tribes have an opportunity to use renewable energy as a means of economic development.

This opportunity may come in one or more of several new doors that are opening through the utility restructuring process and the global climate change response. They are:

1. The creation of renewable energy portfolio standards, on a state by state basis. Such standards—already adopted in Arizona, Iowa, Maine, Michigan, Minnesota, and Nevada—require the procurement of a certain amount or a certain percentage of electricity generating capacity from renewable energy. Some portfolio standards also require the renewable generating capacity to be located in the state. In Nevada, for example, the state legislature enacted a Domestic Energy Portfolio Standard that requires all retail sellers of electricity in the state to purchase or generate a small percentage of their electricity from renewable resources. The electricity must come from new rather than existing systems. Also, at least half the electricity must come from solar resources, and half must come from systems located in Nevada. The Portfolio Standard is set at 0.2 percent in 2001, increasing to 1.0 percent by 2010. Tribes located in states with portfolio standards may be well-positioned to capture the benefits of some of the investment that will be required to comply with these standards. This is particularly true for tribes that have abundant renewable resources, offer good access to the transmission system, and provide additional tax or other financial incentives to encourage development on tribal lands.

2. The specific targeting of state and federal financial incentives at energy efficiency and renewable energy investments. These incentives can take the form of rebates, buydowns, low-interest loans, tax credits or tax exemptions, and other mechanisms. Tax credits and tax exemptions have long been used to encourage investment in certain energy technologies. Today, the federal government offers tax credits for commercial wind and solar systems. Many states also offer incentives, including tax credits, property tax exemptions, or sales tax exemptions for investments in renewable energy equipment. Tribes can use their sovereign powers to provide similar tax benefits for energy-related investments on tribal lands. A new type of incentive that has emerged as part of the restructuring process is a system benefits charge, consisting of a small additional charge per kilowatt-hour that is imposed on all customers regardless of their choice of power providers. The funds collected through this charge are then used to support a variety of public benefit programs, including energy efficiency and renewable energy programs. Under California's new restructuring law, for example, utility customers will pay an additional $540 million over five years that will be used to support renewable energy projects, including existing technologies, emerging technologies, and new technologies. The emerging technologies program alone will provide $54 million in the form of rebates for customers who invest in new small-scale, grid-connected solar and wind generating systems.

3. The creation of "green-energy" marketing initiatives and pricing programs, under which customers choose to pay a premium for less polluting energy. These programs have developed in response to overwhelming survey and polling evidence suggesting that customers strongly support renewable energy and are willing to pay more for their electricity if it comes from renewable sources. For instance, a comprehensive deliberative poll conducted recently by Central and Southwest Utilities revealed that 17 percent of customers said they would be willing to pay an additional $20 or more per month for cleaner energy, while 80 percent said they would be willing to pay a smaller additional amount. Based on these and other studies, it appears that green pricing programs may capture as much as a 10 to 15 percent share of electricity customers. In Michigan, for example, Traverse City Light & Power Company (a municipal utility) sought support from its customers for the installation of a 600 kW wind turbine. The utility estimated that it needed 200 customers willing to pay an 18 percent premium on their electricity bills (an average of about $8 a month for residential customers and $20 a month for commercial customers) in order to cover the cost of buying and operating the wind turbine. Over 270 customers signed up—almost four percent of the utility's customer base—and an additional 80 are on a waiting list.

4. In states with retail electricity competition, the ability of customers to choose power providers that will tailor their prices and policies to the customer's own needs. Customers that band together to negotiate jointly with power providers have more leverage to demand concessions. Tribal governments acting on behalf of tribal members to negotiate with power providers could, for example, condition their power purchase agreements on employment of tribal members, investment in on-site renewable generation, or investment in energy conservation for tribal households. Inter-tribal coalitions would have even more leverage to negotiate with power providers for favorable terms and conditions.

5. Expansion of energy savings performance contracting as the means of developing energy efficiency projects. Energy savings performance contracting is an arrangement where an energy service company (ESCO) offers to develop, install, and finance energy efficiency measures in a facility in exchange for a share of the energy cost savings. The energy savings are always measured in order to meet the performance-based standard. ESCOs have been around for almost 20 years, but are now, as part of the utility industry restructuring process, merging and partnering with other entities (including power providers mentioned above) to offer what is known as retail energy services. Tribes with large buildings or industrial facilities may be able to take advantage of the technical and financial assistance in energy savings performance contracting.

FINANCING YOUR PROJECT

You've got a great idea for a renewable energy or energy efficiency project. But where are you going to get the capital to get the project off the ground and running? Historically, Native communities have had little access to credit or other investment funds, and, currently, grants from federal agencies are declining. There are, nevertheless, a number of funding options available to you and your tribe, whether your interest is in housing retrofits, small business development, community programs, or a commercial-scale energy project.

Strategies for capital acquisition vary with the size and type of project, the credit history or business experience of the project developers, the policies of the tribal government, and the existing relationships between outside funders and the tribe. This chapter is designed to provide an overview of the different financing options for the various projects and enterprises that relate to energy efficiency and renewable energy on Native lands.

When looking for funding, you become acutely aware of what you don't have—enough money. Funders, whether they are foundations, banks, or private corporations, are not so interested in what you don't have. They want to know what you *do* already have—a track record, community resources, support from other sources, a well-thought-out plan, physical resources. These are your assets, and before you undertake any economic development project, it is important to look at what you have. You already have a lot going for your project—land, resources, people, knowledge, community. You need what every project developer needs—investment capital, access to credit, and technical assistance.

In this chapter, funding sources are outlined for each of five different types of energy efficiency and renewable economic development projects: home-scale projects; village or community scale projects; small business development; non-profit projects or programs; and commercial-scale energy projects. For each category of development, the preparatory steps needed to lay the ground for securing funding are briefly detailed.

Home-Scale Projects

Home-scale projects include construction of a home with energy efficiency or renewable features and retrofitting an existing home to add energy efficiency or renewable features. It also includes installation of renewable systems on a farm, ranch, or small business. These projects may run between $1,000 to $30,000 in initial investment, and may generate savings of $100 to $2,000 per year. This section discusses how to finance a single home project, or a project for a "family group" of homes.

FUNDING SOURCES

Home-scale projects are generally funded through a combination of savings and loans. Following are several avenues for acquiring home or home improvement loans.

Home mortgage loans

The most common way to acquire a house on tribal lands is to apply to the tribe and be placed on a waiting list to qualify for tribal housing, which is commonly built with funds from the federal government. In some cases, the tribe itself offers home loans to tribal members. Federal government and tribal funds often are not adequate to meet housing needs.

Increasingly tribal members and tribes are pursuing home loans through programs that are designed for Native American communities. Four programs—HUD Section 184, HUD Section 248, the Rural Housing Native American Pilot, and the Native American Conventional Lending Initiative—preserve the trust status of land, restrict resale to tribal members, and preserve sovereignty. Before individual tribal members or tribal entities apply for these loans, the tribes themselves must qualify by guaranteeing that the tribal judicial system will provide the legal protections needed for mortgage lending. Once this requirement is met, then home loans go through the same qualification process as any home mortgage loan. These four programs offer low down payments and market rate interest.

PREPARATION

Before seeking funds for a home-scale energy efficiency or renewable project, you will need to answer several questions for yourself and for your funder. Among these questions are:

Technical Feasibility

You will need to prove to yourself, through study of your homesite and of the technology, that the energy efficiency or renewable project will work in your setting. This may require some research. If the energy efficiency or renewable system accounts for a significant portion of your loan, you will need to educate your lender that this system is reliable, proven, and a financial asset to the home.

Economical Feasibility

Will the reduction in "conventional" energy costs be great enough to offset the cost of the system installation, maintenance, and replacement of parts? How long will this take? You will need to make a conservative estimate of how long it will take before the capital investment in energy efficiency or renewable applications will pay off in reduced energy bills. For example, consider a solar electric system that costs $5,000 initially, plus $1,000 in maintenance and repairs over 10 years. It saves an average of $50/month in generator and related costs. At the simplest figuring, it would take about 10 years to pay back the investment in the system. More complex figuring, which takes into account the interest and other costs of the loan as well as inflation, would probably give a longer payback period (unless the cost of generator fuel skyrockets).

Cashflow

Do you have the cashflow to cover the monthly loan payments, and are you committed to maintaining that cashflow through the duration of the loan period?

Revolving loan funds

A revolving loan account has a fixed amount of funds available for a particular use. When loans are repaid, the funds then become available to other borrowers. The capital for such loans can be raised through various means, including fundraising campaigns or through profit from a successful renewable business. There also may be government funds targeted at reduction of energy costs on the reservation that may become available to support a revolving loan account.

VAL BARBER

VAL BARBER WITH THE LOW-COST, ENERGY-EFFICIENT HOUSE THAT SHE BUILT FROM A GARAGE KIT.

The Native Sun/Hopi Solar Electric Enterprise established a revolving loan fund with $125,000 in private foundation grants. Customers wishing to borrow funds for purchase of a solar electric system can draw up to $10,000 from this account, paying 12 percent interest on their loans. Over half of Native Sun's customers make use of this loan fund. Without it they would not be able to purchase a solar system due to the high up-front costs of these systems.

Personal loans

Personal loans generally have a higher interest rate than home equity loans because there is no collateral for the lender to seize if the borrower fails to pay back the loan. Still, for a home-scale project that has strong economics, including a quick payback period, personal loans may be worth the cost.

Personal savings and private loans and gifts

Many retrofit projects are relatively inexpensive, and can be at least partly funded out of personal savings. Many energy efficiency measures, in particular, fall into this category. You may also appeal to a foundation or private donor to fund retrofits that serve the goal of reducing overhead for projects that they are interested in, be they schools, elder housing, day care, or other community buildings.

Creative financing

Creative financing is a combination of persistence and invention. After being turned down for home financing by the Bureau of Indian Affairs and the Veterans Administration, Val Barber, an Ojibwa from the Lac Courtes Oreilles Reservation in Wisconsin, put creative financing to work.

Using a $4,000 line of credit from the local building supply company, a $5,000 debt consolidation loan from the V.A., and $8,000 of savings, she built an energy efficient thermal slab heated home that uses one quarter of the propane used by her old trailer, saving upwards of $1,000 per year in fuel costs. But how do you build a home for $17,000? Val's creativity didn't stop with financing. She saved a lot of money by turning a pre-fab 4-door garage kit into a spacious home (and occasional dance hall), and by doing a lot of work herself and with the help of friends and family.

A business within the tribe, a community development corporation, or the tribe itself, may choose to seek funding for a medium- to large-scale energy efficiency building construction or retrofit project or for the installation of a village or town-size renewable energy system. Such a project may run from the tens of thousands to several million dollars in initial investment.

FUNDING OPPORTUNITIES

Funds for larger scale housing projects can be found through commercial banks, bond measures, and private investors. There are also federal and state grants and loans that may partially fund these large projects.

Mortgage loan programs

A tribe itself may apply for some of the federally guaranteed loans. After building homes, using these loan programs, tribes may sell or rent these homes to tribal members.

Commercial loans

A tribe, tribal business, or organization may apply for a commercial loan to fund the development of energy efficient housing or a renewable energy installation.

Bonds

A tribe or large tribal business may issue a bond to finance a project. When a bond is sold, the seller must make regular interest and principle payments to the bondholders for the term of the bond. For public works projects, such as renewable projects, tribes may sell tax-exempt bonds, which makes these bonds more appealing to investors wanting tax shelter.

Private investors/venture capital

Wealthy individuals, banks, insurance companies, and other institutions involved in investing money are always interested in ventures that have the potential to pay a high return on their investment. By making an investment in the project, these individuals or institutions are buying part of the project, and therefore have a right to a proportional share of the profit. However, if more than half of the share in the project is sold to outside investors, the tribe may lose control over how the project is run.

Federal programs for energy assistance or housing assistance

The Office of Native American Programs (ONAP) within the Department of Housing and Urban Development (HUD) administers a number of housing programs targeted specifically at Native Americans. These funds are generally competitive, based on comparative need and other factors. All of these programs operate within a complex regulatory framework. In addition, some Indian Housing Authorities (IHA) also operate tenant-based Section 8 programs. (See “Home Loans” and “Federal Loan and Grant Programs” in the *Resources* section.)

The Native American Housing Assistance and Self-Determination Act (NAHASDA), passed in 1996, makes these programs more amenable to energy efficiency or renewable design features in HUD-financed homes. Under this legislation, tribes no longer have to conform to standard federal requirements in order to qualify for low and medium income housing money.

Other federal agencies that have a history of offering grants for Native American housing energy efficiency or renewable projects include:

- The Department of Health and Human Services (HHS)
- The Department of Energy (DOE)
- The Bureau of Indian Affairs
- Indian Health Services
- Environmental Protection Agency
- Rural Utilities Service
- Economic Development Administration

State funds

States may provide funds through energy rebate programs, pilot programs, technical assistance from state offices or colleges, or other assistance that can be used to support tribal energy efficiency or renewable programs.

THE COMMUNITY REINVESTMENT ACT

Originally passed by Congress in 1977, and revised in 1995, the Community Reinvestment Act (CRA) directs banks and savings and loans (S&L) to help meet the credit needs of the local communities in which they are chartered. The “teeth” of the act are in the CRA examination process, by which federal agencies (Federal Reserve Bank System, Federal Deposit Insurance Corporation, Office of Thrift Supervision), determine whether a bank or S&L has met its responsibilities to lend to low and moderate income people within its "assessment area"—the geographic area the bank or S&L is chartered to serve. These examinations are held every two years, and, under the new rules, community members are alerted prior to these examinations so that they may offer comments on how well the lending institution has served the community. If the bank or S&L receives a "needs to improve," or a "substantial non-compliance" score, it may experience delays in or denials of mergers, acquisitions, or "expansions of service." The unfavorable score would also generate bad will among a bank's current and prospective customers.

PREPARATION

Tribal Policies

In order to access home mortgage funds or commercial lending for building projects, the tribe must have negotiated an agreement with Fannie Mae or other lender to provide legal protection for the lenders through the tribal judicial system. The project itself must also go through the tribal approval process.

Feasibility Study

The entire project will need to undergo technical and economic feasibility studies, as well as a marketing study to determine whether the income from the homes or energy services is great enough to meet the costs of developing and financing the project.

Budget and Project Plan

A detailed budget and project plan must be drawn up, and binding agreements must be made with building or system installation contractors. It is important that maintenance, repairs, and replacements be included in the budget for the project.

Relationship Development

To ensure an economically successful project, you will need to know that your contractors have the experience and skills necessary to perform their work on time and within budget. You will also need to develop a relationship with tribal leaders and members as well as with funders, so that all support, understand, and have a vested interest in the project.

How the CRA translates into an opportunity for tribes considering energy efficiency or renewable activities and enterprises is in the incentive for border town banks to provide credit for economic development on the reservation. Community development loans eligible for CRA credit "include, but are not limited to …"

- loans for affordable housing rehabilitation and construction;
- loans for non-profit organizations serving primarily low and moderate income housing or other community development needs;
- loans for construction or rehabilitation of community facilities that serve primarily low and moderate income individuals;
- loans to financial intermediaries such as community development financial institutions, community development corporations, community loan funds, and community development credit unions that primarily lend or facilitate lending for community development;
- loans to tribal governments for community development activities;
- loans to finance revitalization of a low or moderate income community.

The Community Reinvestment Act can serve as a powerful tool for accessing credit for energy efficiency or renewable projects of all kinds in Native communities.

As a result of a CRA compliance investigation, a bank in Gordon, Nebraska was found to be unfairly charging higher interest rates to Indian clients than to others. This finding led to a $275,000 settlement, under which the bank will provide to the residents of the Pine Ridge reservation in South Dakota: a compensation fund for Native customers allegedly victimized by discriminatory interest rates; a subsidy for fees associated with loan applications by reservation residents; an education program for managing personal money and establishing credit; and recruitment of Native Americans into the banking profession.

Small Business

You may have an idea for a company that would manufacture and dis tribute solar and wind powered equipment for ranches and farms, or perhaps you want to expand your contracting business to include energy efficiency and renewable energy retrofits. There are a number of funding sources available to you, whatever your business endeavor.

FUNDING OPPORTUNITIES

Banks are the main source for business loans, but there are also other potential sources—from venture capitalists to tribal microenterprise loan funds.

Small business loans

Small business loans are available through your local banks. These loans may be guaranteed by federal or state programs, by your tribe, or by your own equity (house, savings, etc.). Be sure to take advantage of the Community Reinvestment Act as it directly applies to most energy efficiency- or renewable energy-related business activities on Native lands.

Other sources of small business loans include tribal, federal, state, and other public sector direct loan programs. Pertinent federal programs include:

- Bureau of Indian Affairs
- Indian Business Development Association
- Economic Development Administration
- Small Business Administration

Microenterprise loans

These are small loans (on the order of $250 to $10,000) that may be set up through a bank, a community development organization, or other tribal entity.

The Oregon Native American Business Enterprise Network (ONABEN), a multi-tribe, not-for-profit corporation is working to create a private sector in Northwestern Indian Country. One activity of ONABEN is the operation of a micro-lending program for graduates of its business education programs. In four years ONABEN has had 349 graduates who have started 118 businesses, which have experienced a 90 percent success rate to date.

Home equity loans

The most common source of funds for small business loans in the nation is a second

PREPARATION

Before approaching a lender, or even asking your brother or mother for a loan, you'll need to do a lot of research and planning. See the small business references in the *Resources* section to access guidebooks and assistance to Native American small business developers.

Feasibility Study

A feasibility study includes business concept formation, resource identification, information gathering, sales forecasting, financial analysis, and risk assessment. In addition to considering economic feasibility, it's important to consider the managerial and technical feasibility of the business.

Business Plan

Findings and conclusions from feasibility studies are used to develop a detailed business plan. The business plan serves as the organizational guide to your business as well as the primary document for approaching lenders and suppliers from which you wish to borrow money.

Marketing Plan

The marketing plan is often part of the business plan and is important for both retail and service businesses. It defines your customers, your competition, the environment within which your business will operate, and your sales strategy.

Financial Projections

A part of a complete business plan, financial projections are essential for obtaining credit. They include projections (for 2 to 5 years) of: operating (or income) statement, with explanations for sales, expenses, and profits; balance sheet; reconciliation of net worth; cash flow (with explanation); and breakeven analysis. There are many resources available to assist you in developing these financial documents. (See "Small Business" in the *Resources* section.)

mortgage on a home. The requirements for this type of loan are the same as for any home mortgage loan. Though this rarely has been an option in Indian County, it may become more available as tribes work out loan guarantee agreements with lending agencies.

Savings and private loans

Personal savings and gifts from family and friends are a common source of funds for small business start-up. This contribution is often needed to meet equity requirements for conventional loans.

Venture capital and private investment

You may identify venture capital firms or private investors to become financial partners in your business if it promises to have a good rate of return on investment and acceptable risk.

ASSESSING BUSINESS OPPORTUNITIES ON TRIBAL LANDS

In addition to considering whether a business makes economic sense to the business operator, it is important to determine whether the business makes sense for the tribe. The following questions, developed by the Native American Rights Fund, can help you assess whether the business is a good fit for the tribe.

1. Does the proposed business opportunity fit with the tribe's cultural, physical, and social setting?
2. Does the business opportunity seem to follow from the interests, skills, and experience of tribal members? If not, is the tribal government or other tribal group willing to enter into a new activity and underwrite the training and development costs?
3. Can the business opportunity be integrated into the development goals of the tribe?
4. Does it lead to the development of the tribal capacity to undertake increasing economic development responsibilities?
5. Does it ensure increasing tribal control over the use of development resources and resulting benefits and income?
6. Does it identify new investment opportunities or new linkages with existing tribal or tribal member businesses?
7. Does it attract outside debt or equity capital?
8. Does it provide enough income to tribal members and/or government to compensate for the development and infrastructure costs?
9. Does it improve tribal member employment?
10. Will it create a favorable impression among outside business interests and financial institutions?
11. Is there a demonstrated, dependable market for its goods and services?
12. Are there real opportunities for tribal members to assume management and supervisory responsibilities?
13. What will be its effects on the environment?

OWEN SEUMPTEWA

KEVIN BEGAY CHECKING THE INCLINATION OF PV PANELS FOR THE HOPI SOLAR ELECTRIC ENTERPRISE PROJECT

Non-Profit Projects

Many energy efficiency and renewable energy projects and programs, from the establishment of revolving loan funds to the training of community members in renewable technologies are developed and managed by not-for-profit organizations. Although these programs are not expected to be profit-generating, they must remain financially solvent. Following are some opportunities for providing income for your non-profit program, along with the preparation needed to secure this income.

FUNDING OPPORTUNITIES

Funding possibilities for non-profit projects are very diverse—from product sales to governmental grants to private gifts.

Donations and gifts

Individuals provide over 80 percent of the funds for community based organizations (CBOs). Approaches to raising donations and gifts include:

- Direct mail appeals.
- Planned gifts
- Memberships
- Events
- Individual sponsorships
- Corporate gifts and in-kind support

Fee for service

You may charge for services that you provide, such as research, technical assistance, energy efficiency and renewable energy installation, and maintenance and training services.

Product sales

You may sell products, anything from hats to solar panels, and use the revenue from these sales to support the non-profit organization. Tribes can use the tax-free advantage to realize greater income from product sales. It is possible to set your organization up as a broker for a company that supplies products used in energy efficiency and renewable energy applications—be it super-insulated windows or deep-cycle batteries.

Federal and state government grants

Native communities historically have received most of their funding for energy and housing from federal government grants. Though currently diminishing, these funds are still worth exploring. You may tap into money for housing, energy, community development, or even health or education. Sources include:

- Department of Energy (DOE)
- Bureau of Indian Affairs (BIA)

JOHN BURTON

- Department of Health and Human Services (HHS)
- Indian Health Services (IHS)

(See "Federal Loan and Grant Programs" in the *Resources* section.)

Tribal governments

Tribes are a major source of funding for tribally-based organizations.

Foundation grants

Private foundations are increasingly interested in Indian Country. In recent years the percentage of money contributed to Native communities by foundations has grown from 0.16 percent to 0.66 percent of total giving. Applying for foundation grants requires organization, thoroughness, and patience, as many funding cycles take up to a year from the date of first inquiry. (See "Non-profit Organization Development" in the *Resources* section.)

Remember, from the funder's standpoint, your organization does not have needs. The people in your community have needs. Your job is to show the funder how your organization helps to create a positive change in the community—and how the funder can play a role in making this change happen.

Zuni Conservation Project

The Zuni Conservation Project's solar program is in the process of beginning a tribal renewable energy service to offer sales, installation, financing, etc. As a tribal service, it can apply for foundation grants through the tribe (which has status similar to 501.c.3) or through another tribal non-profit to get started. As a tribal service using foundation grant money there are fewer barriers and less pressure from the very beginning. There are other advantages as well. Most energy efficiency and renewable energy businesses are forced by the market to try to oversell equipment, and to seek out wealthy customers who want to do big systems. Starting out as a non-profit offers the freedom to reach out to other constituencies and to set other criteria for success: written appraisals of the project, numbers of people helped, numbers of small systems installed, etc. It also allows the energy efficiency or renewable energy service to be integrated into other tribal services, in the Zuni case, range management and sustainable agriculture, but also housing, energy assistance, etc. If there is enough demand in the future, it can spin off and become a tribal enterprise—a for-profit business.

This is basically the way that Hopi Native Sun started out, as a division of the Hopi Foundation (which does other things besides solar) with funding from foundations. They were a non-profit for 10 years. Now they're putting together a business plan and soon will be free enterprise.

From what many foundations say about their funding interests, this is a very possible route for many tribes to take, especially if they do their homework from the beginning and articulate a focused, realistic plan for who they would serve.

PREPARATION

Mission Statement, Articles and Bylaws, Board of Directors

These are primary steps in the formation of any community based non-profit organization, and are key to securing funding. Your mission statement should clearly state what your vision is, how you will achieve it, and why you can achieve it. Your Articles and Bylaws (or other organizational framework) state the rules by which your organization functions. The Directors are responsible for the functions and direction of the organization (though they may hire people to carry out these functions).

Budget and Finance

Foundations, government granting agencies, and corporations will need to see a budget for the project or program they are funding. This budget should include all sources of income (including in-kind and volunteer contributions and all expenses (including overhead). You will also need to create a balance sheet for the organization, including assets (cash, equipment, etc.) and liabilities (loans, etc.).

Program Plan

Included in a program plan are activities or services that you will provide, descriptions of the people or groups you will serve, and a timeline for project activities. This plan is usually expected to be fairly quantitative (how many trainings, how many participants, etc.), and is often accompanied by an account of "expected outcomes." For example, "trees will be planted and other landscape alterations will be made to 50 elderly housing units, resulting in an average reduction of peak summer day time indoor temperatures of at least 10°F."

Relationship with Funders

Whether looking for corporation gifts, foundation grants, federal funding, or even individual donations, it is important to give time and thought to the development of a relationship with funders.

"Working with private foundations and other sources of funds has been a source of empowerment for us. It also alllowed us to move faster and take advantage of more opportunities than if we were working under government direction."

—Owen Seumptewa
Former director of Native Sun/Hopi Solar Electric Enterprise, 1993–1996

Commercial Energy Projects

Consider a town center with clinic, school, stores, laundromat, community center, and administrative buildings all hooked up to a group of windmills. Perhaps nearby houses also would be served by windpower. This windpower system could be backed up by solar power systems and generators. Outlying homesteads may run on some combination of solar, wind, or micro-hydro systems. All power systems could be installed, repaired, and even financed through a tribal utility company. For remote reservations or Native lands which are not already tied into the commercial electricity grid, such a utility company could make a lot of sense. It also could be developed incrementally, reducing the amount of capital needed at any one time.

At a larger scale, a tribal utility may be formed to sell power (be it renewable or conventional) to the commercial power grid, or a tribal utility may transmit and distribute power throughout the reservation. These larger scale operations, would require investment capital, in addition to tribal funds and commercial bank loans, in order to be capitalized enough to become a viable business for the tribe.

MARK POUSON/SANDIA NATIONAL LABORATORIES

SOLAR ELECTRICITY PROVIDES POWER TO AN OUTLYING HOMESTEAD ON THE NAVAJO RESERVATION

PREPARATION

Tribal Government and Community Support

Formation of a tribal utility requires the understanding and strong support of the community and tribal leadership. This support will need to be strong and widespread enough to survive changes in tribal administration.

Feasibility study and business and marketing plans

All of the plans and studies needed for any business are essential elements in preparing to undertake tribal utility formation.

The Agdaagux Tribe and the City of King Cove, Alaska completed a 800kW run-of-the-river hydropower facility in December 1994. Planning for this project, which replaces a centralized diesel system, began in 1981, with a study of the feasibility of various renewable and conventional power systems. Additional feasibility studies were conducted in 1985 and 1991. These feasibility studies supported grant applications that resulted in $3,800,000 from the State of Alaska, the U.S. Department of Energy, the Aleutians East Borough, and the City of King Cove, as well as a loan of $1,800,000 from the Farmers Home Administration (now known as USDA Rural Development).

FUNDING OPPORTUNITIES

You will need to put together a finance package, blending contributions from tribal funds, government funds, and private sources. These sources, outlined below, are described in greater detail in earlier sections of this chapter.

Venture capital, bonds and commercial loans

For capitalization of construction and early operation of the project.

Federal loans and grants and private foundations

For technical and feasibility studies, for pilot programs.

Tribal funds

For early studies and pilot programs, and for capitalization of the project.

RELATIONSHIP WITH FUNDERS

The large-scale financing required by tribal utility projects will require extensive involvement of and reporting to major funders. These funders are interested in protecting and gaining a market rate of return on their investment.

POLITICAL ACTION

One important way to ensure long term availability of financing for tribal and tribal member projects and business endeavors is to take political action to protect and further fair lending, grant funding, and the inclusion of Native Americans in national and regional energy and utilities debates. Following are some avenues through which Native Americans can take political action in the finance arena.

- Become involved in the Community Reinvestment Act bank examination process. Register with the examining federal agency as a community organization or member, and organize your tribe to interact with the bank and with the examining agency before and during the examination process.
- Establish tribal or intertribal enterprise organizations that work as players and partners in the commercial lending world.
- Develop tribal credit unions, community development corporations, and tribal banks.
- Take an active role, through the tribe, or through intertribal organizations, in the utility deregulation debate in your state.
- Lobby for support of energy efficiency and renewable energy pilot programs, feasibility studies, and capacity building for American Indians and Alaska and Hawaiian Natives through the Department of Energy (refunding of Title 26), and through other federal agencies.

JAY HALEY

TURTLE MOUNTAIN CHIPPEWA—INSTALLATION OF DEMONSTRATION TURBINE, BELCOURT, NORTH DAKOTA

Appendix A

LEGAL AND REGULATORY ISSUES

This appendix provides an overview of some key legal and regulatory issues facing tribes that wish to become providers of energy efficiency and renewable energy services. These legal requirements serve a number of different purposes. Some are designed to promote safety, or to protect the environment. Others are intended to encourage the development of renewable energy projects, or to prevent utilities from acting anticompetitively. Whether these rules are a benefit or a burden, tribes bear the responsibility for ensuring that their projects comply with applicable laws and regulations.

For most home-scale projects, these rules are minor and have little effect on project design. For commercial projects, however, these issues are very important, and may even determine whether a project is economically or environmentally feasible. In general, the larger, more complex, and more expensive the project, the more complicated the legal and regulatory issues.

The legal rules affecting renewable projects may come from tribal governments, from local or state governments, or from the federal government. The jurisdiction, or legal oversight authority, for renewable energy projects usually expands with the scale of the project. For example, small projects usually are subject only to local laws, such as building codes and zoning regulations. Large projects are also subject to these local laws, but are subject to state and federal laws as well. This means that no single government agency will know all the requirements for your project, and that for larger projects many different agencies may be responsible for regulating different aspects of your project.

This appendix is divided into three parts. Part 1 describes the issues that affect home-scale projects, off the grid. Part 2 describes the rules for home-scale or village-scale projects that generate electricity and are connected to the local utility, but are designed primarily to provide power for use on tribal lands. Part 3 summarizes the rules for large, commercial-scale power projects that are designed primarily to generate power for sale to the utility grid, where it can be resold to other customers.

Stand-Alone Projects

This part describes the rules for stand-alone, grid-independent projects that are also called 'remote' projects. These are projects that have no connection to the local utility's power lines. Examples include: (1) energy conservation projects, such as purchasing and installing ceiling insulation, low-flow faucet or showerheads, or a new energy efficient refrigerator; (2) non-electrical renewable energy projects, including solar hot water systems and wind-powered mechanical water pumping systems; and (3) small electrical projects—such as solar photovoltaic systems and wind generator systems, that are not connected to the utility grid and instead use batteries or combustion generators to provide backup power.

Most of the regulations applying to remote projects are local laws designed to ensure that projects meet minimum safety standards. These rules will be written into local codes, including building, electric, and/or zoning codes. Most non-Indian municipalities (including cities and counties) maintain and enforce such codes, but these codes are not binding on tribal lands. Some tribes have developed their own codes, and these codes will be binding for all projects built on tribal lands.

If your project is on tribal land, and your tribal government has not enacted its own building, electric, or zoning codes, then your project is likely to be unregulated. If, however, you want to see examples of other codes to provide some guidance for your project design, then you should contact another municipality and ask for a copy of their applicable codes. Although non-local rules will not be binding on your project, they may provide useful hints for improving the design of your project.

Local health and safety requirements include code specifications that specify standards for the design, quality, and/or materials used in your project; and zoning regulations that restrict the use of land in certain respects. For example, an energy code may require that new homes be built with specified amounts of insulation in the ceiling or walls, or that solar water heaters meet certain performance standards in order to be permitted. Zoning regulations may restrict the height of a tower used for a wind generator, or may prevent neighbors from building in a way that blocks the sunlight falling on your solar panels.

One set of rules that you may be pleased to find applicable to your remote project are the financial incentives for renewable energy investment. Although some of these incentives are limited to larger, commercial projects, some may apply to remote projects as well. For example, the federal government offers an energy investment tax credit equal to 10 percent of the cost of solar energy equipment that is used to generate electricity, to heat or cool a structure, to provide hot water for use in a structure, or to provide process heat. This means, for example, that a customer investing $4,000 in a solar hot water heating system will be eligible to receive a $400 reduction in the amount of federal tax due for that year. The federal government also offers a renewable energy production credit equal to 1.5¢ per kilowatt-hour of electricity produced from wind energy. The credit is adjusted for inflation, and paid for 10 years after the facility is placed in operation.

Finally, before investing in a remote renewable energy project, check with your insurance provider to ensure that your property insurance will cover losses associated with the project, such as property losses arising from a leak in a solar hot water system or liability losses from a lawsuit brought by a neighbor who slips on the wet floor under the leak.

Small, Grid-Connected Projects

This part describes the rules governing projects that are connected to the utility grid, but are designed primarily to generate electricity for your own use. These projects may produce excess electricity that is sold back to the utility, but the sale of excess power is incidental to the project. In effect, these projects use the local utility as a large 'battery' to be drawn down when additional power is needed and charged up when excess power is generated. Examples of small grid-connected systems include solar photovoltaic systems, wind generators, and "micro" hydroelectric plants. These projects may provide power for a single home or tribal building, or a cluster of homes or buildings.

These grid-connected projects are subject to the rules for remote projects, described in the previous section, plus some additional requirements. The additional requirements mostly are related to interconnection with the utility, which raises engineering, safety, and policy concerns that do not arise with stand-alone projects.

Many people are unaware that a federal law called the Public Utility Regulatory Policies Act of 1978 (PURPA) requires utilities to purchase electricity generated by certain independent power producers, called 'Qualifying Facilities' or QFs. These QFs include cogeneration systems, and renewable energy systems (using solar, wind, geothermal, hydroelectric, or biomass power) with up to 80 megawatts of generating capacity. Most grid-connected renewable energy projects will be considered QFs.

PURPA imposes three requirements on utilities. First, utilities must agree to interconnect QFs, although the QFs may be required to pay for the costs of interconnection. Second, utilities must agree to provide QFs with backup or standby power at non-discriminatory rates. Third, utilities must purchase the excess power produced by QFs (that is, the power that is not immediately used on-site) at their "avoided cost" rate, which is the price each utility would have paid to generate the equivalent amount of power using its own generating facilities.

The calculation of avoided cost rates is particularly important, and may well determine the economic feasibility of your renewable energy project. Avoided costs rates differ from one utility to the next, but they are usually well below the retail rates that the utilities charge their customers. Nationally, avoided cost rates average about 2¢ per kWh, while retail rates average about 6¢ per kWh. The rates for your electric utility may be higher or lower.

Some states make it easy to capture the higher, retail value of the energy produced by making 'net metering' available to owners of small renewable energy projects. 'Net metering' means using excess electricity generation to run the meter backwards, so that the excess electricity offsets retail electricity purchases rather than being sold at the lower avoided cost price.

Another set of laws that can significantly affect the economic feasibility of renewable energy projects are those providing financial incentives for renewable energy investment. These laws, which usually take the form of tax incentives, were described in the previous section.

Another set of issues that will affect grid-connected renewable energy projects are safety and interconnection issues. Because utilities are responsible for maintaining the safety and reliability of the utility grid, they are concerned about the operating characteristics of generating equipment that will be connected to their power lines. Although PURPA requires utilities to interconnect with private power producers, utilities are allowed to impose reasonable safety and interconnection requirements on these power producers. Although these requirements are based on widely-accepted standards such as the National Electrical Code, they vary from one utility to the next. If your project will be connected to the grid, contact your local utility and ask for a copy of their standards for interconnection of parallel generation equipment. Be prepared to provide a detailed description of your project, including its rated generating capacity, the type of generating equipment to be used, and the type of interconnection equipment to be used.

Large, Utility-Scale Projects

Utility-scale projects will be subject to many of the rules for remote projects and for small grid-connected projects, described in the previous sections, as well as additional requirements that are unique to these larger projects. Most of the additional requirements arise from the scale of these projects, which tend to place them in the category of commercial or industrial development projects. For example, most local governments will have one set of building codes for residential projects, and an entirely different set of building codes for industrial projects.

Utility-scale projects are very complex, and development of utility-scale projects will require expert assistance with a variety of issues, including financial, technical and legal issues. The following description is designed to provide an overview of some legal and regulatory issues you must know, and to provide some guidance to help you decide what other assistance you will need. The tribe should expect to retain consultants experienced in the development of private power projects to see it through this process.

Code requirements governing utility-scale projects often restrict the location of large commercial or industrial project to certain areas, typically away from residences and away from environmentally sensitive lands. In addition, zoning codes often include height restrictions, which may affect tower heights for wind energy projects. Building codes and facility siting laws may affect the design of your project and the location of project facilities on the property. Utility-scale projects that employ large numbers of people, whether for construction or for ongoing operation, also will be subject to federal worker safety regulations, such as those developed by the Occupational Safety and Health Administration (OSHA).

Utility-scale projects also are more likely to trigger the application of environmental laws than smaller grid-connected or remote projects. For example, a utility-scale "wind farm" may require the preparation of an Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA). An EIS is required for "major federal actions significantly affecting the quality of the human environment." Federal actions include those taken directly by the federal government, as well as those financed, assisted, regulated, or approved by federal agencies. Therefore private projects that require federal permits, or involve the leasing or use of federal lands or facilities, are likely to trigger environmental review under NEPA.

Another federal environmental law that may apply to utility-scale projects is the Endangered Species Act (ESA). The ESA is designed to halt and reverse the trend toward extinction of endangered species of plants and animals. It prohibits conduct that may be harmful to species that are designated as 'threatened' or 'endangered' under the law. Harmful conduct includes not only direct injury to the species, but also modification or degradation of habitat that significantly impairs breeding, feeding, or sheltering of the species. The Migratory Bird Treaty Act provides similar protection for migratory birds that fly between nations, whether endangered or not, by prohibiting the 'taking' or killing of migratory birds by any means, direct or indirect.

Other federal environmental laws that usually apply to power projects, such as the Clean Air Act (CAA) and Federal Water Pollution Control Act (FWPCA), are not applicable to renewable energy projects that do not produce any emissions or pollutants under routine operation, such as solar and wind energy projects. However, other renewable energy projects—including biomass and hydroelectric projects—may be subject to these laws.

Biomass-fueled power plants emit many of the same air pollutants as fossil-fueled plants, and are similarly subject to regulation under the CAA. Biomass projects may be prohibited altogether by visibility impairment regulations that prohibit degradation of areas designated as "Class 1" for air quality preservation purposes. These "Class 1" areas include national parks larger than 5,000 acres. Otherwise, biomass projects may be subject to regulation for emissions of sulfur dioxide, nitrogen oxides, particulates, and air toxics, depending on what type of biomass material is being used. The Environmental Protection Agency is responsible for regulating air quality, and can provide more information regarding the applicable air quality standards and permitting requirements. Biomass-fueled power plants also may require access to cooling water for their steam-turbine generating systems. The discharge of cooling water to a river or stream at an elevated temperature may be subject to water quality certification requirements under the FWPCA.

Hydroelectric power projects are regulated by the Federal Energy Regulatory Commission (FERC). Developing a new project requires obtaining a license from the FERC, although exemptions may be available for facilities with a peak generating capacity of 5 megawatts or less. Where an exemption is not granted, developers apply to FERC for either a minor or major project license. Minor projects (1.5 megawatts or less) require an environmental report (more limited than a full EIS), basic project information, and water quality certification under Section 401 of the FWPCA. Major projects (over 1.5 megawatts) usually require a full EIS, along with all information and studies requested by FERC, and consultation with other potentially affected government agencies.

Both minor and major hydroelectric project licenses also are subject to the requirements of the FWPCA. Section 404 requires that a permit be obtained from the federal Corps of Engineers for the "discharge of dredged or fill material" into any waters of the United States. The definition of a discharge includes the construction of a dam, so hydroelectric projects that include new dam construction will require a Section 404 permit. The permit application requires a detailed environmental analysis of the project, including its effects on water quality and fishery resources.

Other environmental laws that may apply to renewable energy projects include the Coastal Zone Management Act, the Fish and Wildlife Coordination Act, the Wild and Scenic Rivers Act, and the Wilderness Act.

Just as the application of environmental laws becomes much more complicated for utility-scale projects, the application of financial regulations and technical requirements becomes much more complicated for larger projects as well. Developers of these projects should note that financial and tax filings are subject to careful scrutiny by the Securities and Exchange Commission (SEC) and the Internal Revenue Service (IRS).

PURPA, which was described in the previous section, also applies to larger utility-scale projects. However, the terms and conditions of power purchase agreements (including buyback rates and interconnection requirements) are much more complicated for large projects.

RESOURCES

GENERAL

Center for Renewable Energy and Sustainable Technology (CREST), Solstice Internet Information Service, website: www.crest.org

Lawrence Berkeley National Laboratory Energy Crossroads Website: eande.lbl.gov/CBS/eXroads

U.S. Department of Energy, Energy Efficiency and Renewable Energy Network; website: www.eren.doe.gov

Western Area Power Administration Energy Services Website: www.energy.wsu.edu/org/western/

Energy Efficiency and Renewable Energy Clearinghouse. Free government publications on energy efficiency and renewable energy technology. P.O. Box 3048, Merrifield, VA 22116; (800) 363-3732.

RESIDENTIAL ENERGY EFFICIENCY

Homemade Money by Richard Heede and the staff of Rocky Mountain Institute, Brick House Publishing, 1995. Guide to home energy conservation, with many simple, clear illustrations. Available from Rocky Mountain Institute in Snowmass, Colorado at (970) 927-3851; website: www.rmi.org/.

Consumer Guide to Home Energy Savings (4th ed.) by Alex Wilson and John Morrill, American Council for an Energy-Efficient Economy, 1995. A detailed guide to home energy efficiency with extensive listings of the most energy-efficient home appliances. Available from ACEEE at (202) 429-8873.

Your Mobile Home Energy and Repair Guide by John T. Krigger, 1991. Available from Saturn Source Management in Helena, Montana at (406) 443-3433.

The New Woodburners Handbook: Information about stove selection, operation, maintenance and installation. Available from Storey Communications in Pownal, Vermont at (800) 827-8673.

The Fuel Savers by Bruce Anderson. A simple guide to solar retrofit, solar water heating, and low cost window improvement options. Available from Morning Sun Press at (415) 934-8277.

Our Home—Buildings of the Land: Energy Efficiency Design Guide for Indian Housing by Dr. J. Douglas Balcomb, 1994. A guide to incorporating energy efficiency into Indian housing. A great source of information about passive solar design. Can be used in conjunction with a PC program called BuilderGuide available from the Passive Solar Industries Council, 1511 K St. NM, Suite 600, Washington, DC 20005. The Design Guide is available for $21.50 from the National Technical Information Service at (800) 553-6847 (order number PB95-254322).

Home Energy Magazine. A practical magazine published every two months about residential energy conservation, (800) 707-6585.

State energy offices are often an excellent source of free information about residential energy conservation.

SMALL-SCALE RENEWABLES

Solar Living Source Book, 9th edition, by John Schaeffer and the Real Goods staff, Chelsea Green Publishing Company, 1996. Contains prices and concise descriptions of renewable energy equipment for homes. Call them at (800) 762-7325 or visit their website at www.realgoods.com.

Renewables Are Ready by Nancy Cole and P.J. Skerett, Chelsea Green Publishing Company, 1995. Inspiring stories of community-led renewable energy projects around the U.S. Available from Union of Concerned Scientists in Cambridge, Massachusetts; (617) 547-5552; website: www.ucsusa.org/. An accompanying slide show and teaching guide for junior and senior high school is also available.

The New Solar Electric Home by Joel Davidson, AATEC Publishing, 1987. An excellent place to start for the do-it-your-selfer who wants to put together a photovoltaic system. Available from Real Goods at (800) 762-7325.

The Solar Electric Home by Steven Strong, 1993. Another good starter book for PV systems. Available from Real Goods at (800) 762-7325.

Wind Power for Home and Business by Paul Gipe, Chelsea Green Publishing Company, 1993. An authoritative source on small and medium sized wind systems. Available from Real Goods at (800) 762-7325.

The Homebuild Wind Generated Electricity Handbook by Michael Hackleman, Peace Press, 1975. An excellent source of information about wind turbine towers. Available from Lake Michigan Wind and Sun at (414) 837-2267.

Micro-Hydropower Sourcebook by Allen R. Inversin, NRECA International Foundation, 1986. A practical field guide to home and community-scale hydropower.

Battery Book for Your PV Home, Fowler Solar Electric, 1991. Everything you need to know about caring for lead-acid batteries. Available from Fowler Solar Electric in Worthington, Massachusetts at (413) 238-5974.

Sandia Photovoltaic Systems Assistance Center. The center is a non-commercial source of expertise on photovoltaic systems available to tribal governments, that has worked on projects with a number of tribes. Sandia National Laboratories, Albuquerque, NM 87185; (505) 844-3698. Extensive information about PV systems is available at www.sandia.gov/pv.

Water Pumping: The Solar Alternative by Michael G. Thomas, Sandia National Laboratories, 1996. Available from the National Technical Information Service at (800) 553-6847 (order number SAND87-0804).

Home Power Magazine. “Hands-on” magazine for people building home power systems using solar electricity, wind, and microhydro. P.O. Box 520, Ashland OR, 97520; (800) 707-6585. Back issues are available on the web at www.homepower.com/hp/.

Native SUN/Hopi Solar Electric Enterprise. Native SUN installs solar and wind electric systems on the Hopi and Navajo Reservations and also leads workshops in renewable energy. Native SUN, P.O. Box 705, Hotevilla, AZ 86030; (520) 734-2380.

Solar Energy International. Hands-on training for home power systems and solar building. P.O. Box 715, Carbondale, CO 81623; (970) 967-8855; website: www.solarenergy.org/.

Alternative Energy Engineering Design Guide and Catalog. A source for solar, wind, and hydro electric systems equipment. P.O. Box 339, Redway, California; (800) 777-6609; website: www.asis.com/aee.

COMMERCIAL-SCALE ENERGY EFFICIENCY AND RENEWABLES

Power Plays: Profiles of America’s Independent Renewable Electricity Developers. Investor Responsibility Research Center, Washington, DC, (202) 833-0700. Comprehensive report on the commercial-scale renewable energy industry, with market data, trend analysis, and detailed company profiles.

Solar Energy Industries Association, 122 C Street N.W., 4th Floor, Washington, DC 20001; (202) 383-2600; website: www.seia.org. Trade association representing the solar industry.

Energy Efficiency

C. Eley and T.M. Tolen. “Advanced Lighting Guidelines: 1993.” U.S. Department of Energy Report No. DOE/EE-0008. Washington, DC Available from National Technical Information Service (NTIS), Renewable Energy: Sources for Fuels and Electricity by Thomas Johansson, Henry Kelly, Amulya Reddy, and Robert H. Williams (eds). A technical, comprehensive guide to the state-of-the-art in renewable energy technology. Available from Island Press at (800) 828-1302.

Technology Administration, U.S. Department of Commerce, Springfield, VA 22161; (703) 487-4650; website: www.ntis.gov.

Western Area Power Administration. DSM Pocket Guidebook: Volume 2 Commercial Technologies. April 1991. Available from WAPA at (800) 769-3756; (Website listed under General). Quick reference source on specific technologies in the areas of building structure, HVAC, lighting, hot water, refrigeration, cooking, and motors are compared in the following categories: cost per square foot, energy use (kWh per square foot per year), cost savings per square foot per year, simple payback, peak watts per square foot, life expectancy, and confidence.

Pietsch, J. 1992. TAG Technical Assessment Guide, Volume 2: Electricity End Use, Part 2: Commercial Electricity Use. CU-7222, Vol 2, Part 2, Research Project 3138-08. Electric Power Research Institute. To order, contact EPRI Distribution Center, 207 Coggins Drive, P.O. Box 23205, Pleasant Hill, CA 94523; (510) 934-4212. Includes information on building loads, equipment performance, installed costs, peak demand, and energy consumption.

Koomey, J. et. al. “Building Sector Demand-Side Efficiency Technology Summaries.” Lawrence Berkeley National Laboratory Report No. 33887. March 1994. Available from NTIS. Overviews energy efficiency technologies in residential and commerical buildings.

Frank Kreith and Ronald E. West. CRC Handbook of Energy Efficiency. 1997. CRC Press, 2000 Corporate Blvd., N.W. Boca Raton, FL 33431; (800) 272-7737; website: www.crcpress.com. Textbook covering energy conservation, renewable energy, and general principles including economic methods, resource planning, thermodynamics, and other contextual topics.

Richard D. Cudahy and Thomas K. Dreessen, March 1996. A Review of the Energy Service Company (ESCO) Industry in the United States. National Association of Energy Service Companies, 1615 M. St. N.W., Suite 800, Washington, DC 20036; (202) 822-0950; website: www.naesco.org.

American Council for an Energy Efficient Economy, 1001 Connecticut Ave, N.W. Suite 801, Washington, DC 20036; (202) 429-8873; website: aceee.org. Advocacy and research non-profit organization promoting energy efficiency.

Alliance to Save Energy, 1200 18th St. N.W., Suite 900, Washington D.C. 20036; (202) 857-0666; website: www.ase.org. Public interest organization promoting energy efficiency.

Wind

American Wind Energy Association (AWEA), 122 C Street, NW, Fourth Floor, Washington, DC 20001 USA; (202) 383-2500; email: windmail@mcimail.com; website: www.econet.org/awea/. AWEA publishes Wind Energy Weekly/Windletter.

Landowner's Guide to Wind Energy in the Upper Midwest, Izaak Walton League of America, 5701 Normandale Rd., Suite 317, Minneapolis, MN 55424; (612) 922-1608.

Powering the Midwest: Renewable Electricity for the Economy and the Environment by Michael C. Brower, Michael W. Tennis, Eric W. Denzler, and Mark M. Kaplan, Union of Concerned Scientists, 1993. Discussions of policies to encourage renewables, institutional barriers, and the economics of renewables in the Midwest.

Wind Energy Comes of Age by Paul Gipe, 1995. Gipe argues that wind energy has come of age as a commercial generating technology—citing improvements in performance, reliability, and cost-effectiveness.

Biomass

DOE's Biomass Power Program website, www.eren.doe.gov/biopower/ provides access to information on biomass power, ranging from a general explanation of the technology, to technical reports, to the latest developments and photos of biopower projects.

Western Regional Biomass Program (WRBEP). The U.S. is divided into five Regional Biomass Energy Programs (RBEP). Thirteen states (Arizona, California, Colorado, Kansas, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming) make up the Western Regional Biomass Program (WRBEP). The overall mission of WRBEP is to increase the production and use of biomass energy resources for economic development and environmental sustainability. Contact: Dave Waltzman, WRBEP Program Manager, c/o WAPA, Environmental Affairs, A3400, P.O. Box, Golden, CO 80401; (303) 275-1727.

United BioEnergy Commercialization Association (UBECA), UBECA was established to help commercialize sustainable biomass energy in all forms. Contact: Robert Mauro, Deputy Director, 1800 M Street, NW, Suite 300, Washington, DC 20036; (202) 296-8663; email: ubeca@ttcomp.com.

Geothermal

Geo-Heat Center, Oregon Institute of Technology, 3201 Campus Dr., Klamath Falls, OR 97601; (541) 885-1750; website: www.oit.edu/~geoheat. Information developed through research and experience with hundreds of projects is provided to those involved in geothermal development. Publishes the Geo-Heat Center Quarterly Bulletin.

Geothermal Resources Council, P.O. Box 1350, Davis, CA 95617; (916) 758-2360; email: earth307@concentric.net. Geothermal Resources Council is a membership organization for the geothermal industry.

PROJECT FINANCING

Home Loans

For information about any of the four Fannie Mae Native American Housing Initiatives, contact Ken Goosens, Fannie Mae's Native American Housing Specialist at (202) 752-7407.

General Information and Index

GrantsNet, www.dhhs.gov/progorg/grantsnet) is an online guide to federal grants. It includes information about applying for funding, managing, and reporting on grants.

The Catalog of Federal Domestic Assistance (CFDA) profiles all federal grant programs. It is published annually and updated mid-year. You may search this catalog online (http://gsacentral.gsa.gov/cgi-bin/waisgate). This is an excellent source for information about grants available from all federal agencies.

Federal Loan and Grant Programs

Bureau of Indian Affairs (BIA); (202) 208-3711; website: www.doi.gov/bureau-indian-affairs.html.

- BIA administers the Indian Education Program, which provides grants for Indian schools and educational programs at all levels. Federal Office Bldg. 6, Room 3530, Washington, D.C., 20202; (202) 208-6123.
- BIA administers the Office of Economic Development, which provides seed money for developing Indian owned businesses.

Department of Energy (DOE) 1000 Independence Avenue SW, Washington, DC 20585.

- DOE administers the Office of Conservation and Renewable Energy, Forrestal Bldg., Mail Stop EE-532, Washington, DC 20585. Many Native American renewable energy pilot projects were funded by Title 26 of the 1992 Energy Policy Act. Though funding for this act was cut in 1996, there may be funding for Native American projects through other DOE programs. (202) 586-1851 or (202) 426-1698; website: eia.doe.gov/.

Department of Agriculture (USDA) administers the Rural Utility Service.

- Rural Utility Services (formerly the Rural Electrification Administration) makes loans to Rural Electrification Cooperatives to finance electrification projects. Contact your local Cooperative to find out whether these loan funds can support your tribal electrification project.

Health and Human Services (HHS), Humphrey Bldg., 2000 Independence Avenue SW, Washington, DC 20201; (202) 619-0257.

• HHS administers LIHEAP (Low Income Home Energy Assistance Program). This program helps eligible families pay for fuel and weatherization to insulate homes.

• HHS administers the Administration for Native Americans (ANA); 370 L'Enfant Promenade, SW, Washington, DC 20447; (202) 401-9215. ANA promotes the economic and social self-sufficiency of Native Americans through the provision of competitive grants funding, training and technical assistance.

Housing and Urban Development (HUD), 451 Seventh Street SW, Washington, DC 20410; (202) 708-1422.

• The Office of Native American Programs (ONAP), under HUD, funds housing programs through the Comprehensive Improvement Assistance Program, the Comprehensive Grant Program, the Indian HOME Program, and an Indian set-aside in the McKinney Act Emergency Shelter Grant Program.

CRA: Community Reinvestment Act

The best guide for Native Americans working with the Community Reinvestment Act, *Capital Decisions: Native America and the Community Reinvestment Act*. Contact FNDI at The Stores Bldg., 11917 Main Street, Fredericksburg, VA 22408; (540) 371-5615; email: fndi@firstnations.org.

The National Community Reinvestment Coalition manual *Models of Community Lending: Neighborhood Revitalization Through Community/Lender Partnerships* offers an essential guide to partnerships. You can also get information sheets and articles about the new CRA regulations from NCRC. Contact NCRC at 733 15th Street NW, Suite 540, Washington, DC 20005; (202) 628-8866; email: HN1748@handsnet.org; website: www.essential.org/ncrc.

Small Business

The Indian Business Owner's Guides put out by North Coast Small Business Development Center provide excellent guidance in business plan development, including feasibility, marketing studies, and accounting. Contact NCSBDC at 779 9th Street, Crescent City, CA 95531; (707)464-2168.

The National Center for American Indian Enterprise Development offers a number of helpful publications. Contact NCAIED at 953 E. Juanita Avenue, Mesa, AZ 85204.

The Aspen Institute has published guides and directories for microenterprise development. Contact the Aspen Institute at 1333 New Hampshire Avenue, NW, Suite 1070, Washington, DC 20036.

The Woodstock Institute has published guides on community development financial institutions, loan funds, and credit unions. Contact the Woodstock Institute at 407 S. Dearborn, Suite 550, Chicago, IL 60605; (312) 427-8070; email woodstock@wwa.com; website: www.nonprofit.net/woodstock/.

The Minority Business Development Agency serves as a national network of technical assistance resource providers. Contact MBDA at (202) 482-4713.

The Small Business Administration is the source of many helpful publications, administers grant and loan programs and operates regional small business development centers. Contact: SBA Office of Public Communications at 409 3rd Street, SW, Room 7600, Washington, D.C. 20416; (202) 205-6740.

Non-profit Organization Development

First Nations Development Institute's manual, *Capitalization Strategies for Community-Based Non-profit Organizations* is an excellent guide for non-profit fundraising. Contact FNDI at The Stores Bldg., 11917 Main Street, Fredericksburg, VA 22408; (540) 371-5615; email fndi@firstnations.org.

Nolo Press puts out an excellent and frequently updated guide on non-profit formation, *How to Form a Non-profit Corporation* by A. Mancuso. Contact Nolo Press at 950 Parker Street, Berkeley, CA 94710.

The Foundation Center puts out the definitive directories to foundations and corporate giving in the U.S. Contact the Foundation Center and request their publication catalog. 79 5th Avenue, New York, NY 10003; (212) 620-4230.