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SUSTAINABLE ENERGY: POWER SOLUTIONS FOR LOCAL GOVERNMENTS

Rolling brownouts and sky-rocketing energy prices have captured headlines in the United States. The news from energy-conscious California is grim and may well be a portent of energy calamities around the country.

Almost daily, local governments are confronted with questions about energy. Should we tap our landfill for methane? How and when do we replace our municipal buildings' ancient heating, ventilating, and air-conditioning systems? Should we use natural gas or diesel buses? Can we make the air cleaner by choosing a different energy source? If we change our system, when do the savings begin?

This report establishes a context in which to examine renewable energy resources and suggests a wide range of strategies for modernizing local government energy systems. It discusses how local governments can use renewable energy (i.e., solar, wind, small hydro, bioenergy, and geothermal power), addresses program development, and outlines ways to get citizens to support municipal energy projects. The report concludes with a list of resource organizations and selected readings.

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These reports are intended primarily to provide timely information on subjects of practical interest to local government administrators, department heads, budget and research analysts, administrative assistants, and others responsible for and concerned with operational aspects of local government.

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Sustainable Energy: Power Solutions for Local Governments

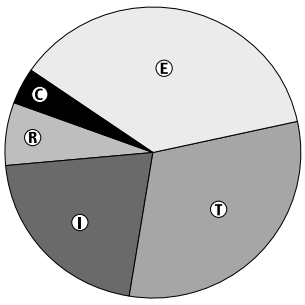
The authors of this report, Mary Walsh and Beverly Salas, are codirectors of the Climate Change Learning and Information Center (CCLIC), which provides training and research for local governments on the issue of global climate change (www.cclic.com). Both are local government professionals with broad-based experience in local government administration, training, and sustainable development programs. Mary Walsh is currently developing sustainable energy and climate change workshops for the Waquoit Bay National Estuarine Research Reserve in Cape Cod, Massachusetts. Beverly Salas is a certified energy auditor with the California Energy Commission. They have also written ICMA's May 1998 IQ Report, *"Climate Change: Strategies for Local Governments."*

Local governments are concerned about the potential for an energy crisis in the near future. They are troubled by the price of energy to power public buildings; run their fleets; and deliver critical services such as police and fire protection, refuse collection, and road maintenance. At the same time, local elected and appointed officials must respond to citizen demands for reliable and affordable energy.

Currently, the major source of power in the United States is the burning of fossil fuels, mainly coal and oil. This country spends $13 billion on home heating annually, which amounts to roughly 11.4 barrels of oil per household. However, reliance alone on fossil fuels is now ending. The most notable reasons are the known and quantified environmental problems caused by the burning of fossil fuels, such as air pollution, acid rain, groundwater pollution from storage and transport facility leakage, and the build-up of greenhouse gases. Moreover, easily tapped and reasonably affordable domestic oil and coal reserves are limited, while oil importation leaves us vulnerable to disruptions in energy supply. Nuclear power provides some of our energy, but this too creates safety hazards and produces radioactive wastes.

Hope for the future is grounded in harnessing natural renewable energy that will never run out and will be cleaner and more efficient to run. But all sources of energy come with costs as well as benefits, and local government managers and leaders must take these into account when making energy-related decisions.

Figure 1: Sources of Carbon Dioxide Emissions in the United States



Ⓒ	**Commercial**	**4%**
Ⓔ	**Electricity generation**	**37%**
Ⓣ	**Transportation**	**31%**
Ⓘ	**Industrial**	**21%**
Ⓡ	**Residential**	**7%**

Source: Environmental Protection Agency, Inventory of US Greenhouse Gas Emissions and Sinks 1990–1997, Washington, D.C., 1999.

THE NEW ENERGY AGE

Modern technology gave sustainable energy a real foothold in the worldwide economy in the early 1970s. Spurred on by oil shortages and accompanying tax incentives, the sustainable energy industry began in earnest to develop, produce, and distribute products designed to collect energy from renewable sources, including solar, wind, geothermal, small hydro, biomass, wave, and tidal power.

Developing sustainable energy practices means tapping renewable energy sources close to home, thus creating greater local self-reliance. In the summer of 2000, California businesses and residents paid $10.9 billion more for electricity than they did the year before. This is significant on many levels, not the least of which being that much of that money flowed to out-of-state energy firms. Yet a few of California's cities—such as Los Angeles, Glendale, Burbank, and Sacramento—were unaffected by last summer's high prices. This is because they own their own power systems.

Now local and state governments are piloting programs that use renewable sources of power, and in

some cases they are devising incentives for their citizens to install renewable energy systems in their homes and businesses. The city of Austin, Texas, for example, offers its citizens the opportunity to purchase "green power" through the city's GreenChoice Program, which is sponsored by the municipal utility, Austin Energy. In 1999 the Austin city council passed a resolution requiring 5 percent of the city's electricity to come from renewable sources by 2005. To generate the electricity, the program includes twelve wind turbines (constructed by Texas Wind Power Corporation of Austin) and six landfill methane projects. Through the GreenChoice program, citizens of Austin who join the program pay 2.85 cents for each kilowatt hour (kWh) of green power, which will remain fixed for ten years. The current standard fuel charge is 2.68 cents/kWh, which may rise if fossil fuel prices continue to increase. This means that an average GreenChoice residential customer will pay an additional $1.70 per month for electricity. But GreenChoice customers can expect that the cost will not increase.

Environmental costs

Currently the United States, with 5 percent of the world's population, accounts for 25 percent of the world's carbon dioxide (CO_2) emissions. The Intergovernmental Panel on Climate Change (IPCC), a commission of 2,500 of the world's leading scientists, economists, and risk analysts, has determined that the emission of CO_2 from fossil fuel burning is causing the Earth's climate to change at an accelerating rate: average temperatures are projected to rise as much as 10 degrees during this century. The impacts of this change, including a rise in sea level and more frequent and severe floods, droughts, and storms, are projected to cost the world $300 billion a year in a few decades.

CO_2 emissions bring other adverse effects as well. Air pollution, which is directly tied to auto exhaust and emissions from coal-fired electric generating power plants, is a major contributor to such diseases as asthma and lung cancer. It also causes water pollution in the form of acid rain, while oil spills from tankers transporting oil across the world's oceans further degrade water quality. And air and water pollution are responsible for the die-off of an ever-accelerating number of plant, fish, and animal species.

To combat these adverse conditions and stabilize the global climate, the IPCC has called for an immediate 50–70 percent reduction in CO_2 emissions.

Source: The third global assessment conducted by the IPCC is available at www.ipcc.ch. Specific details on the regional vulnerabilities of climate change in the United States can be found in the U.S. Global Change Research Program's national assessment, *Climate Change Impacts on the United States*. The overview is available online at www.usgcrp.gov.

Austin Energy has committed $6.8 million annually over the next decade to harness power from wind and extract methane gas from landfills. An additional $1 million per year will come from subscribers to the program. The goal of the program is to generate 40 megawatts (MW) of renewable energy each year, enough power for 20,000 homes in the Austin area. By switching a portion of its electricity generation to renewables, Austin Energy will reduce its carbon dioxide (CO_2) emissions by 160,000 tons per year.

For more information about Austin's GreenChoice program, contact Ed Clark at Austin Energy, 512/322-6514.

Conserve first!

Any energy management program should begin with conservation measures. Your cost savings will be far greater if you eliminate as many inefficiencies in your power use as possible before you install sustainable technologies. For example, the city of Frederick, Maryland, has saved an estimated $1 million by using highly reflective roofs on its public buildings in combination with tree plantings, which reduces the need for air conditioning. King County, Washington, saved more than $600,000 by using recycled materials such as retreaded tires and toner cartridges. Your citizens can save from 10 to 50 percent on their home energy bills by making their homes more energy efficient. *Energy Savers: Tips on Saving Energy & Money at Home*, a useful guide for citizens, is available online from the U.S. Department of Energy at www.eren.doe.gov/consumerinfo.

ELEMENTS OF SUCCESSFUL LOCAL ENERGY PRACTICES

Three technical elements are common to most successful urban energy strategies. The first is energy efficiency improvements. Energy efficiency is fundamental to curbing ever-growing energy requirements, reducing environmental risks, and making available—at affordable prices—the energy services that are vital to economic development.

The second technical element is combined heat and power (CHP) production. Power plants create waste heat, which can be used to heat buildings if there is a piping system for steam or hot water that connects it to heat consumers. In urban areas, CHP plants are often associated with district heating networks—local pipe systems that connect a building or complex of buildings to the power plant. The main advantage of such networks is the more efficient conversion of primary fuel sources into usable energy forms. To promote CHP systems, urban energy management programs can identify buildings owned or operated by municipalities or other

Key terms

Alternative fuel: A fuel that is not petroleum and yields energy security and environmental benefits. The U.S. Department of Energy currently recognizes the following as alternative fuels in accordance with this definition: methanol and denatured ethanol as alcohol fuels (alcohol mixtures that contain no less than 70 percent of the alcohol fuel), natural gas (compressed or liquefied), liquefied petroleum gas, hydrogen, coal-derived liquid fuels, fuels derived from biomass (soybeans, vegetable oil), and electricity (including solar energy). The city of Chattanooga, Tennessee, uses electric buses to service the downtown, thereby reducing carbon dioxide emissions by 1,750 tons per year.

For more information on alternative fuels, call the National Alternative Fuels hot line at 800/423-1363 or e-mail: hotline@afdc.nrel.gov.

Clean energy: Sources of energy, such as solar and wind energy, that are self-renewing and do not emit greenhouse gases.

Co-firing: The burning of biomass material with coal, burning two different resources at the same time.

Deregulation: A process of restructuring the way electricity is supplied to customers. Historically, electric utilities were legal monopolies in specified territories. Under new regulations, electricity generators are allowed to compete to sell electricity on a wholesale level to any utility. Some states are even granting electric companies the right to compete openly for retail customers.

Distribution: The delivery of electricity and natural gas to businesses and residences through the necessary wires, piping, and other equipment. This part of the gas and electric utility industry has not been regulated.

Fuel cell: A battery-like device that converts the chemical energy of a fuel (such as ethanol or hydrogen) into usable electricity and heat without combustion. Fuel cells are considered to have high potential for producing efficient, clean energy without harmful emissions. Prototype automobiles are being designed using hydrogen fuel cell systems.

Generation: The process of converting various sources of energy (solar, wind, oil, coal) into electricity. In many states, the generation of electricity is open to competition through deregulation.

Green power: Power generated from renewable energy sources, such as wind and solar power, geothermal power, hydro power, and various forms of biomass.

Green pricing: An optional utility service that enables customers to support a greater level of utility company investment in renewable energy technologies. Participating customers pay a premium on their electric bill to cover the extra cost of the renewable energy.

Landfill gas recovery program: A program that collects the methane gas (a greenhouse gas) that forms in landfills from the decay of organic materials and uses it for power. Prince George's County, Maryland, uses some of the methane it recovers to power a correctional facility and sells the rest to a local utility company. As a result, the county's annual energy revenues are nearly $1.3 million, and methane emissions from the landfill are reduced by 45,000 tons.

For additional information, see ICMA's 2000 report, Air Quality Tools: Local and Regional Strategies to Reduce Air Pollution.

Renewables: Energy resources that are constantly being replenished, such as wind and solar energy, will never run out. However, the United States currently relies heavily on fossil fuels—coal, oil, and natural gas—for its energy. Fossil fuels are *nonrenewable*—that is, they draw on finite resources that will eventually dwindle, becoming too expensive or too environmentally damaging to retrieve.

local authorities that might be heated in this way and can plan and develop the piping infrastructure. And because local authorities plan and oversee the development of industrial and commercial areas, they are in a position to site plants to facilitate CHP systems that serve nongovernmental buildings as well.

The third technical element is the use of renewable energy sources in the urban environment. While not all renewables are inherently clean, the choices are so diverse that a shift to renewables carried out in the context of sustainable development provides a far cleaner system than is feasible by tightening controls on conventional energy. Being by nature site specific, renewable energy sources favor a decentralized power system and locally applicable solutions that are more or less independent of the national network. Further,

Should my government purchase renewable energy?

The following questions can help you decide:

- Is the community located in or near a Clean Air Act nonattainment area?
- Do the government's constituents support renewables?
- Does the community pay high prices for electricity?
- Is there an abundance of a particular renewable resource in the region and/or on the electricity grid?
- Are there renewable energy businesses in the region?
- Are there relevant incentive programs (such as utility incentives, public trust funds in states with deregulated electricity markets, federal incentives) that can make the cost of renewables more attractive?
- Are there certain applications for which distributed renewables are the least-cost option?

Source: Adapted from Virinder Singh, "Clean Government: Options for Government to Buy Renewable Energy," Renewable Energy Policy Project (REPP), Issue Brief no. 12 (May 1999): 6.

the small scale of the equipment often makes the time required from initial design to operation short, providing greater adaptability.[1]

FIVE TYPES OF SUSTAINABLE ENERGY

Solar and wind energy are receiving widespread attention because of their long-range cost benefit. Small hydro power, geothermal power, and biomass resources are becoming popular energy sources in some regions. Wave and tidal power are still in the experimental stages but may be cost-effective for certain uses.

This section describes five major types of sustainable energy and explains the benefits and problems of each, along with regional considerations and cost comparisons per kilowatt hour. Case studies are offered to illustrate how local governments have put into use the specific energy source being discussed.

Sun Power

The collection of solar energy can be passive or active. Early human developments were wise enough to take advantage of the heat generated by the sun. The Anastazi Indians of Mexico, for example, selected caves with southern exposure for their dwellings. This process of siting buildings for a southern exposure and using skylights and windows facing south to help capture the sun's heat, especially in winter, is called "passive solar collection." Such "climate-responsive" architecture means designing buildings to be as energy efficient as possible, given the climate of a region. Using a building's structure to collect and store heat can save up to 50 percent or more of the energy used in the building—an advantage that can be especially beneficial in the United States, where lighting, heating and cooling buildings, and running appliances account for about one-third of all the energy used.

There are currently four direct ways to collect the sun's energy and convert it into heat and electricity: active solar, described here, and wind energy, hydro power, and bioenergy, discussed further on.

Photovoltaic (PV) cells or solar cells, which are made of semiconducting materials such as silicon, absorb and store sunlight and free electrons to generate electricity. PV cells are used to power calculators, watches, and satellites. Approximately forty PV cells are combined into a module, with ten modules mounted on a panel,sometimes called a "PV array." PV modules can be clustered in appropriate numbers to generate electricity for a town hall, a power plant, or a single residence.

The energy collected by PVs is stored in batteries so that electricity can be produced even on cloudy days or at night. Because PV systems are relatively unaffected by inclement weather and operate best in colder temperatures, they are suitable for communities in northern climates.

Solar hot water systems offer another way to actively harness the sun's energy to heat water for residences and public buildings. In an active system (solar hot water systems may also be passive), a solar collector is mounted on a south-facing roof with good exposure to the sun. Water circulates through the solar collector, where the sun's heat warms the water, to a storage tank in the building. Solar hot water heaters are efficient and reliable, and they generate little, if any, pollution.

Solar water heaters are rated and certified by the Solar Rating and Certification Corporation. This nonprofit organization offers a useful directory of certified solar systems and collectors (407/638-1537); www.solar-rating.org.

How sun power is used. Many local governments use solar power, as illustrated by the five case studies outlined below.

Civano-Tucson Solar Village. In 1989, the city of Tucson, Arizona (population: 459,000), launched a large-scale community development project as a co-venture with a number of public and private interests. Using solar energy and incorporating energy-efficient land use and architectural design, the project was intended to be a model of sustainable development in an arid climate.

The project began with 820 acres of land within the Tucson city limits. This land was targeted for planned development to demonstrate the marketability of a large-scale, energy-efficient project that offered affordable housing and commercial space. Along with

a wide range of partners that included citizen groups, the U.S. Department of Energy (DOE), the Arizona State Land Department, the Greater Tucson Economic Council, Public Technologies Inc., Tucson Electric Power, Pima County, Southwest Gas, and the Metropolitan Energy Commission, the city of Tucson developed a master plan in 1992 to help guide the project. To finance the project and leverage private sector investment, the city committed more than $3 million in local assistance and more than $30 million in tax-exempt bond financing for local services.

In 1994, a team of environmental experts developed performance targets for the project, along with requirements for meeting them. The team designed a system called IMPACT (Integrated Method of Performance and Contribution Tracking) as a way of organizing resource-efficiency goals, tracking stakeholder involvement, and measuring progress toward achieving project goals.

The overall goal is to reduce energy and water demands below Metropolitan Tucson baseline levels. Specific project goals include

- Reduce water consumption 54 percent lower than normal usage to 53 gallons per person per day
- Reduce energy consumption by 50 percent less than the model energy code
- Reduce solid waste by 30 percent to eventually 80 percent at the end of the project build-out.
- Reduce vehicle traffic by 40 percent over conventional development
- Ensure that 20 percent of the total units in the project meet affordable housing standards.

As of May 2001, the community's first of three neighborhoods has been constructed, and a solar energy manufacturing complex has begun operations as part of Civano's industrial park.

For additional information, contact Ron Koenig, project manager, City of Tucson Office of Special Projects, P.O. Box 27210, Tucson, AZ 85726-7210; 520/791-5119, ext. 16; e-mail: rkoenig@mail.ci.Tucson.az.us.

Medford Solar Project. The Medford, Massachusetts (population: 57,000), city hall and high school each use eight PV panels donated by the Medford Solar Project, sponsored in 1999 by the Massachusetts Electric Company (MECo) to promote solar energy. The program, which is managed by the Schott Applied Power Corporation, offers MECo customers with south-facing, asphalt-shingled roofs an opportunity to install one or two PV panels at approximately half the list price. Under the program, a single PV panel costs about $1,400 and generates 365 kWh/year; a two-panel system costs $2,800 and generates 730 kWh/year, or about 15 percent of total household consumption. These costs are for customers who elect to pay over four years. The program was expected to have a long-term payback of approximately twenty years. However, with rising standard electric prices, the payback will likely be shorter for program participants. Medford citizens who participate in the program are motivated primarily by their interest in and curiosity about solar technology as well as for environmental reasons. Many want an energy source that is clean and helps protect the environment.

For additional information, contact Jamie Braman, Schott Applied Power Corporation, at 781/684-6116; e-mail: jbraman@ascensiontech.com.

Christus Santa Rosa Health Care Facility. Christus Santa Rosa Health Care Facility in downtown San Antonio, Texas, saves approximately $17,000 per year on its hot water bill since switching from a steam boiler fired by fuel oil to a solar thermal water heating system. This system, which uses 5,000 square feet of solar collectors that are capable of holding 9,000 gallons of heated water at one time, provides up to 90 percent of the facility's hot water needs.

For additional information, contact Ron Wright at 210/704-2011.

Aachen, Germany, PV Program. The city of Aachen, Germany (population: 250,000), has developed a solar energy program that has become a model for more than twenty-five other cities in Germany. The city subsidizes the cost of the solar equipment to be used by home owners, small businesses, and schools. The power generated goes into the Aachen electrical grid, and consumers voluntarily purchase a portion of it at a premium price.

Owners of the PV systems are guaranteed a purchase price of $.60/kWh for twenty years, which represents a 0.75 percent return on their subsidized investment. While the return is low, participants in the program are willing to be involved for environmental and other reasons, according to Klaus Menirs, engineer with the city's Department of Environmental Administration. To date, more than 210 PV systems have been installed, generating approximately 900 kilowatts (kW) of electricity.

Block Island Renewable Program. In 1999, as the result of a DOE renewable energy grant, Block Island, Rhode Island, implemented a renewable energy project focused primarily on solar energy. An engineering firm was hired to administer the project, meet such DOE goals as technology transferability and innovation, and develop marketing tools to help engage island residents.

Several barriers had to be overcome in order to effectively carry out the goals of the project. These barriers included the limited accessibility of the island, the seasonal nature of the island's population (from 900 year-round residents to more than 15,000 people in the summer months), and the perception of property owners that renewable energy technology had not changed substantially since the 1970s. The engineering firm worked directly with property owners to assess the renewable

energy potential of their sites, to provide economic analyses, and to prepare requests for proposals to obtain qualified installers. It also offered seminars, gave presentations, held public hearings, and advertised the project as part of its public outreach efforts.

Their efforts paid off. The program has installed thirty-five solar PV systems, twenty-five solar hot water systems, and eight small wind turbines on local residences, a school, small commercial buildings, and several public buildings. When the grant period ends in June 2001, it is estimated that air pollution and greenhouse gas emissions will have been reduced by 5.5 million pounds of CO_2, 4,300 pounds of sulfur dioxide (SO_2), and 4,500 pounds of nitrogen oxides.

The project has also included installation of a 6-kW solar system for the Block Island post office. Payback is estimated in ten years. The primary advantage for the island post office is that the PV system helps ensure that no data will be lost and no computers interrupted in the event of a power outage.

For more information, contact Chris Warfel at ENTECH, Inc., 401/466-8978.

Benefits and concerns. One of the most significant benefits of solar energy is that it has no adverse impact on the environment. It produces no air or water emissions and its use does not directly contribute to global warming, acid rain, or smog.

PV systems are also highly durable (having no movable parts) and are easy to maintain. And they can be the least expensive power source for locations that are not connected to an electric power grid. In the Boston Harbor Islands State Park, for example, twelve PV systems provide electricity for five buildings that serve the park rangers and visitors to the islands.

For more information, call 800/351-0077 or e-mail: Energy@State.MA.US.

However, PV systems are more expensive than conventional power sources. The expense of the equipment means that costs to the consumer are high relative to the cost of power offered by the current utility industry, which enjoys economies of scale. But as the market increases and the technology improves, the price of PV systems will continue to drop.

PV systems may also be difficult to use in urban areas with older homes and in neighborhoods with large street trees. Retrofits are possible but expensive, and it is not always possible in cities to have the unobstructed southern exposure needed by PV systems, especially during peak sun hours between 10 a.m. and 3 p.m. each day. To make solar power more feasible in urban areas, neighbors must share it, installing PV systems on roofs that are south facing and distributing energy to those that are not. This type of collaboration is a growing phenomenon in such countries as Germany and Denmark.[2]

The advantages of a solar water heater are that it is far less polluting and more cost-effective than an electric hot water heater. For example, a solar water heater reduces CO_2 emissions by more than fifty tons over twenty years when compared with an electric hot water heater. And a study by the Florida Solar Energy Center in Coco, Florida, concluded that solar water heaters save owners 50–85 percent on their annual utility bills.[3]

On the down side, solar thermal tanks tend to be large (averaging 120 gallons for a domestic tank) and require equipment, such as a pump and controls, which needs to be maintained from time to time.

Wind Power

From the very beginning, people have been harnessing the energy of the wind. As early as 200 BC, windmills in China were pumping water and more complex windmills in Persia and the Middle East were grinding grain. The Dutch, credited with refining the windmill, used them for draining lakes and marshes in the Rhine River Delta. In the United States, farmers and ranchers used windmills in the late nineteenth century to pump water and, later, to generate electricity for homes and industry.

Today's wind turbine looks very different from yesterday's windmill, but it operates on the same principle. As the wind blows, it pushes against the blades, causing them to turn. The blades are connected to a drive shaft that turns an electric generator to produce electricity.

Large, modern wind turbines (100–750 kW) operate by the hundreds on what are called "wind farms," producing electricity for utilities. Smaller turbines are used as stand-alones by businesses, schools, and home owners to meet their energy needs. "Wind is homegrown energy that we can harvest right alongside our corn or soybeans or other crops. We can use the energy in our local communities or we can export it to other markets. We need to look carefully at wind energy as a source of economic growth for our region," states David

Where the wind blows

The top twenty states for wind energy potential, as measured by annual potential in billions of kilowatt-hours, are the following:

1. North Dakota	1,210	11. Colorado	481
2. Texas	1,190	12. New Mexico	435
3. Kansas	1,070	13. Idaho	73
4. South Dakota	1,030	14. Michigan	65
5. Montana	1,020	15. New York	62
6. Nebraska	868	16. Illinois	61
7. Wyoming	747	17. California	59
8. Oklahoma	725	18. Wisconsin	58
9. Minnesota	657	19. Maine	56
10. Iowa	551	20. Missouri	52

Source: *An Assessment of the Available Windy Land Area and Wind Energy Potential in the Contiguous U.S.* (Richland, Wash.: Pacific Northwest National Laboratory, 1991).

Benson, a farmer and county commissioner, Nobles County, Minnesota.

Additionally, the Great Plains states in particular, although not exclusively, have begun to look at "wind clusters." In what is generally considered the "European model," local residents often own and operate clusters of two to five windmills. Wind clusters are a way to involve communities in their own energy development, bolster local economies, reduce problematic visual impacts, and create relatively little strain on transmission and distribution systems.[4]

In general, for utility-scale wind power plants, a minimum annual average wind speed of 14 mph is needed to economically convert wind energy into electricity. According to a DOE study, thirty-seven states have enough wind resources to support the development of utility-scale wind plants.[5] Moreover, all fifty states that have winds sufficient to support small residential turbines in certain areas. Currently more than a dozen states have enacted legislation that will encourage the development of renewable wind energy, which DOE estimates could eventually supply nearly 20 percent of America's electricity needs.

For more information on wind speeds by geographical area, go to www.nrel.gov/wind/database.html.

How wind energy is used. The following four case studies illustrate how local governments are harnessing wind as a renewable source of energy for their communities.

Spirit Lake, Iowa. Every year people, companies, and local governments in Iowa spend between $4 and $5 billion for energy. Energy creates jobs and provides the services people want. But studies suggest that SO_2 emissions from Midwest power plants alone may result in $25 billion a year in health-related costs.

Spirit Lake, Iowa (population: 4,000), began studying the use of wind as a renewable source of energy for the school district in September 1991. Early in the study, the community formed a partnership with the Iowa Department of Natural Resources. During the next year the partnership developed an information base that was based on

- Measuring wind speed on the proposed site
- Analyzing the district's electrical costs
- Getting acquainted with wind turbine manufacturing
- Understanding both federal and state rules and regulations
- Visiting Iowa State utilities
- Visiting wind turbine sites.

The study indicated a payback on investment of 8.5 years. Once it had a vision of what it wanted to do, the partnership applied for a grant from DOE for three turbines—one each for the elementary, middle, and high school. A grant of $119,000 for one turbine to supply electricity to the elementary school was approved in December 1992. The project was also funded by a low-interest loan through the Energy Council of the Department of Natural Resources. The partnership estimated that the loan would be repaid in four years from savings on electrical costs.

The wind turbine for the elementary school was installed at a cost of $239,500. Mounted on a 140-foot tower with a propeller 87 feet in diameter, the turbine is located 800 feet south of the elementary school.

On July 22, 1993, this turbine began producing electricity. Five years later, it had produced 1,570,000 kWh of electricity—enough electricity for 190 average Spirit Lake homes for a year. This amount of electricity would have cost the district $124,900. In addition to providing all the electricity for the 53,000-square-foot elementary school, the turbine generated enough additional electricity to earn almost $25,000 in reimbursement from the utility company. Now that the final payment of the loan has been made, the almost $25,000 in annual savings go to the school's instructional programs.

The energy produced by the clean, renewable wind for the school since the turbine's installation would have taken 780 tons of coal or 2,800 barrels of oil. These fossil fuels would have emitted into the atmosphere 2,450,000 pounds of CO_2, 33,000 pounds of SO_2, and thousands of tons of other pollutants.

For more information on specific wind projects, visit the American Wind Energy Association's Web site at www.awea.org.

Philadelphia, Pennsylvania. Wind farms are generally thought to be easiest to site on the windy prairies of the Great Plains states or the where the ocean breezes buffet the West Coast. But with the latest wind energy technology able to turn wind turbines at lower speeds, small wind farms are popping up throughout the East as well.

The average annual wind speeds in the greater Philadelphia area are not enough to turn wind turbines at a profitable rate. Yet area businesses are being powered by wind energy. The wind that lights storefronts and runs office machines comes from two 65-kW turbines located in a mountainous region less than a hundred miles north, near Hazelton, Pennsylvania, where annual wind speeds are higher and more consistent. This newly developed wind power has been made available to customers in southeastern Pennsylvania through a partnership between Community Energy, Inc., a renewable energy marketing company, and PECO Energy Company, a utility. The wind power is available through "green pricing," in which customers voluntarily pay a premium on their electric bills to purchase some or all of their electricity from renewable resources.

Community Energy was formed when the Pennsylvania Clean Air Council partnered with the Land and Water (LAW) Fund staff to develop and market clean, renewable energy. The LAW Fund had successfully pioneered a wind electricity marketing approach in Colorado that attracted 20,000 residences, 500 busi-

nesses, and two dozen government entities. After market research had indicated that many customers in Pennsylvania wanted a renewable energy option, Philadelphia was chosen as a focus community because its high concentration of businesses made it easy for Community Energy staff to maximize its efforts. Community Energy went door to door selling "windblocks" of 400 kWh (the average home uses 500–600 kWh each month). The price of each windblock is set at a fixed premium over conventional supply, currently ten dollars. The more customers purchase, the more wind turbines are built. In four months Community Energy and PECO sold all the blocks available from the two turbines. PECO (now the Excelon Power Team) and a consortium of private companies, nonprofit organizations, and public agencies plan to build at least two more wind farms in Pennsylvania.

For more information on Pennsylvania wind energy, contact Evan Pappas, Clean Air Council, 215/567-4004, ext. 236.

Searsburg, Vermont. In the Green Mountains of Vermont is one of the largest commercial wind farms in the eastern United States. The wind farm cost $11 million with 64 percent of the cost supplied by Green Mountain Power and 6 percent covered by various subsidies. Green Mountain Power chose the Searsburg site because of its persistent and strong winds. Stronger winds mean that the plant can generate more electricity at the time it is needed most. Green Mountain Power estimates that the plant will eliminate approximately 22 million pounds of air emissions per year that would otherwise have been generated by a fossil fuel–burning plant.

Eleven windmills on this wind farm produce enough electricity to power approximately 1,500 homes. Each three-blade rotor measures 132 feet in diameter and is mounted on a 40-meter-tall tubular tower. This new tubular tower design has two benefits: first, maintenance workers are not exposed to the elements as they work on the windmill, and second, the towers are a deterrent to perching birds.

For more information, contact Jack Zimmerman, Green Mountain Power, 802/244-7522.

Benefits and concerns. Wind has several advantages as an energy source.

- Wind energy is clean. Wind turbines produce no air pollutants or greenhouse gases. The wind energy created in California in one year displaces the energy equivalent of 3.8 million barrels of oil and avoids 2.7 billion pounds of CO_2 emissions. It also avoids 15 million pounds of pollutants, such as sulfur and nitrogen oxides. It would take a forest of between 100 and 200 million trees to provide the same CO_2 reduction.[6]
- Wind energy is a recurring part of nature, an abundant and inexhaustible "free" power source.
- Wind energy is affordable, costing around $.03–$.10/kWh. This makes wind energy very competitive with fossil fuels, especially since the price of these nonrenewable sources of energy is escalating.
- Unlike solar energy, wind energy can be generated both day and night.
- Wind turbines can be used in single-home applications as well as on large wind farms for utility applications.
- The land on which wind farms are located can be used simultaneously for other purposes, including crop farming and animal grazing.
- Wind power plants take less time to construct than most conventional energy plants; they are modular; and they can be added as needed.

In addition to these benefits, wind energy offers specific benefits to local governments:

- Job creation: Six to seven permanent jobs are created for every hundred turbines installed. These mostly high-tech positions include experts to build and operate the turbines as well as to maintain and improve the wind plant's operations.
- Land-lease deals: Wind plant developers often lease property from local landowners. Lessors gain income from monthly lease payments as well as from royalties based on wind plant production.
- Local revenues: Wind plants keep energy dollars local by reducing the need to purchase coal or gas from elsewhere. Also, wind plants are a source of increased property tax revenues for local communities.

On the negative side are these concerns:

- Wind speed varies throughout the day and throughout the year, often unpredictably. However, such variations often match peak electricity demands of the region. In California, for example, people use more electricity during the summer months, when the winds blow harder and more constantly, than at other times. Similarly, the winds in California blow harder and more constantly during peak energy-use periods of the late afternoon and early evening.
- Wind turbines sometimes kill birds that fly into the spinning blades; however, manufacturers now paint the blades in dark colors so that, as they spin, they are visible to the birds. Additionally, newer turbines are built without ladders or other protuberances, which had in the past attracted birds to roost.
- Tall windmills visually impair the landscape, although many see an elegance in their design.
- Wind farms require large tracts of land, but as stated above, the land around the turbines can be used for grazing or planting crops.
- Some complaints arise regarding the noise the spinning blades create; however, new models are quieter in design. Noise was an issue with some early wind turbine designs, but it has been largely eliminated as a problem through improved engineering and the appropriate use of setbacks from nearby residences. Aerodynamic noise has been

reduced by adjusting the thickness of the blades' trailing edges and by orienting the blades upwind of the turbine tower. A small amount of noise is generated by the mechanical components of the turbine. To put this into perspective, a wind turbine 250 meters (approximately 270 feet) from a residence emits the same level of noise as a kitchen refrigerator.

This information has been provided by the American Wind Energy Association (AWEA), 202/383-2520.

Small Hydro Power

Water has been used for centuries to power grain mills and provide irrigation systems for agricultural use. Now with new technologies, water can be harnessed to generate electricity on the same scale. Small hydro power is a renewable energy source that can be effective in areas that have rivers and streams. This type of system generally produces energy below 500 kW and is small enough that it often does not require a dam to store water for power generation.

A small hydro power system is fairly straightforward in terms of equipment. Water from a river or stream is channeled through a pipe downhill to turn a turbine, which activates a generator to produce electricity. These "run-of-river" power stations use the power of the river water as it passes through the plant without causing an appreciable change in the river flow.

How small hydro power is used. The provincial government of British Columbia, Canada, is restructuring water rates to encourage the development of small hydro power projects by independent power producers. It is estimated that, over the long term, such projects have the potential to generate more than $450 million in new investment and 700 construction jobs throughout British Columbia. In addition, the use of new small hydro projects to meet part of the province's electricity demand will contribute to the province's greenhouse gas mitigation strategy.

For additional information, contact Lucy Stephenson, communications coordinator, Victoria, British Columbia, at 250/952-0606.

Benefits and concerns. Small hydro power systems have a number of benefits, including a proven technology that requires a small initial investment and an hourly energy rate that is lower than that for other energy sources. Generally, small, well-designed run-of-river hydroplants blend in with their surroundings and have minimal environmental impact when compared with large-scale hydro power plants and coal-burning electric plants.

However, some small hydro systems use dams, which can be harmful to the local ecosystem. A dam can block spawning paths for fish, and a reservoir and dam can cause water quality changes, such as higher temperatures, low oxygen, and increased phosphorous and nitrogen, which affect the health of fish and plant life.

Some solutions exist, such as the installation of fish ladders, which allow fish to bypass the hydro facility and continue upstream. Additionally, efforts can be taken to keep the flow rate of the river as close to normal as possible so as to maintain a healthy balance in water temperature, turbidity, and oxygen content.

Geothermal Power

Geothermal energy—heat (thermal) generated by natural processes within the Earth (geo)—is the heat energy contained in rock and fluid in the Earth's crust. It can be found in underground reservoirs of steam, hot water, hot saline fluids, and hot dry rock. Geothermal energy technologies use the Earth's heat for "direct-use" applications, geothermal heat pumps, and electrical power production.

Types of geothermal power. Much like solar power, geothermal power lends itself to several different technologies.

Direct heating. At low to moderate temperatures (90°–300°F), geothermal hot water near the Earth's surface can be used to heat buildings and homes and to supply heat for various commercial and industrial uses. Communities in eleven states currently use direct heat for commercial enterprises, including greenhouses and fish farms. A 1996 survey found that these direct-use applications provide roughly the energy equivalent of 1.6 million barrels of oil per year.[7]

Geothermal heat pumps. Ground-source heat pumps use the Earth or groundwater as a heat source in winter and a heat sink in summer. Using resource temperatures of 4°–38°C (40°–100°F), the heat pump, a device that moves heat from one place to another, transfers heat from the soil to the house in winter and from the house to the soil in summer. Accurate data are not available on the current number of these systems; however, the rate of installation is thought to be between 10,000 and 40,000 per year.

Geothermal electricity. At high temperatures (above 300°F) geothermal heat is used to generate electricity. Depending on the state of the geothermal resource (vapor or liquid) and its temperature, one or two different technologies are most often used to create electricity. Dry steam is cleaned as it comes out of the ground and is used in a turbine generator. Hot liquid, after leaving the ground, is flashed into steam as it enters the atmosphere; this steam then drives a turbine. Geothermal electric plants can also have hybrid designs, combining geothermal energy with supplemental energy from another source. In the United States, most geothermal electricity-grade resources are concentrated in the West.[8]

How geothermal power is used. The four case studies below illustrate ways in which local governments use geothermal power.

Boise, Idaho. Boise, Idaho (population: 127,000), boasts the largest geothermal direct heating system in the United States. Actually, four separate systems provide heat to a combined 2.25 million square feet of space. The oldest system has been in operation since the 1890s. The newest system heats the Veterans Administration hospital complex. The state developed its own system to heat the State Capitol Building and Capital Mall complex in Boise.

The city-owned direct heating system has more than fifty customers—everything from small offices to churches, schools, the Federal Building, and the new county courthouse, as well as the county building with more than 300,000 square feet of space. Customers are charged by the gallon and realize 30 percent savings from the cost of heating with natural gas.

Even though Boise's combined system is the largest in the country, it produces just 5 percent of greater Boise's heating energy. The U.S. capacity for geothermal heating is many times more than what we have currently developed. Reykjavik, Iceland, a town similar in size to Boise, heats 95 percent of its city's businesses and residences with direct geothermal heating. "It's because they have to pay a lot more for imported oil," says Kent Johnson, Boise's geothermal coordinator. "We [in the United States] have access to much cheaper oil, so we don't feel the need to develop renewable resources."

For more information, contact Kent Johnson, geothermal coordinator, City of Boise, 208/384-3926.

Pagosa Springs, Colorado. Pagosa Springs (population: 1,800), a small mountain town in the southwestern corner of Colorado, is located near a hot springs source. The town has owned and operated a geothermal heating system since December 1982. With an annual operating budget of $40,000, the system provides heat during the fall, winter, and spring to the elementary, junior, and senior high schools; a bank; two large office buildings; five retail buildings; two churches with accessory buildings; the town hall; the Archuleta County government; and two residential customers.

Start-up costs in 1982 were $1.4 million, funded mostly by DOE with the town adding $60,000 from its budget. Customers currently pay $.015/kWh, with a rate hike expected soon that will increase the rate to $.60/therm or $.02/kWh. These rates are 45 percent lower than natural gas rates on straight usage with no franchise fees or carrier charges. According to system administrator Mark Garcia, "the heating system has required nothing more than basic maintenance since its start-up."

For a more detailed description of the system specifications and operations, see the case study at http://geoheat.oit.edu/bullet and click on vol. 18, no. 3. Contact Mark Garcia, geothermal heating system administrator, Town Hall, P.O. Box 1859, Pagosa Springs, CO 81147; 970/264-4151.

Santa Monica, California. Santa Monica, California (population: 95,000), is the first city to require that all of its municipally owned facilities (485 accounts) be powered by 100 percent green energy. The city buys its green power off the grid from a California utility, which gets its energy from "The Geysers"—geothermal hot springs located in Sonoma County in the northern part of the state. The utility charges customers one cent more per kilowatt-hour than the going rate for nonrenewables.

For more information, contact Susan Munves, energy and green buildings coordinator; 310/458-8229.

Klamath Falls, Oregon. Klamath Falls (population: 35,000) first tapped its geothermal aquifer for energy in 1981. Since then, the city has developed two production wells that provide direct heating and hot water to twenty-four commercial customers, including six government buildings. City hall, the county courthouse, the library, and the museum, as well as the city wastewater treatment plant, are just a few of the facilities serviced by geothermal heat. Two new greenhouses, with a combined 100,000 square feet of space, will also be geothermally heated. Additionally, more than 550 private residential wells have been tapped for heat.

Downtown sidewalks are kept free of snow by a grid system that pumps the hot water through underground pipes. The same system runs under one of the city's bridges to keep it free of ice and snow.

Water from the geothermal source travels three-quarters of a mile to a heat exchanger building in which city water is heated and then sent to customers. The used geothermal water is reinjected into the same aquifer at the heat exchanger building. The geothermal source is not being depleted, as evidenced by the constant temperature and pressure readings over the life of the system.

The direct heating system currently runs at 50 percent of designed capacity. At $.56/therm, customers pay well below the natural gas rate of $.65/therm.

For more information, contact Mel Smith, Klamath Falls Public Works, 541/883-5260.

Benefits and concerns. Geothermal power provides the following benefits:

- Geothermal power is clean.
- Unlike solar power and wind energy, geothermal power is a constant, impervious to variations in wind speed or sunlight.
- Compared with coal and other alternative energy sites, geothermal power requires very little land for siting a power plant.
- Geothermal heat pumps can be used almost anywhere in the United States.

Disadvantages include the following:

- Strictly speaking, geothermal energy is not renewable on a human time scale. However, it is generated naturally, and by reinjecting the geothermal fluid back into the Earth after use, the thermal reservoir is maintained.

- Geothermal plants can contribute to water pollution. However, this can be avoided by collecting any discharged liquids from the geothermal plant and reinjecting them into the ground or sending them to specially designed evaporation ponds.
- Land subsidence and sink holes have occurred, which can be mitigated by reinjecting the thermal fluids back into the Earth.

Bioenergy

Biomass resources include any organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural food and feed crops, agricultural crop waste and residue, wood waste and residue, aquatic plants, animal waste, municipal waste, and other waste materials. Tapping energy that is stored in green plants and other organic matter through photosynthesis, biomass utilities burn wood, agricultural waste, or methane gases from landfills to create steam to drive generators and produce electricity.

Anything that can be made out of hydrocarbons (natural gas, petroleum, and coal) can be made out of carbohydrates (plant matter). Biomass energy feedstocks are generated by using agricultural, industrial, or municipal waste or by growing "energy" plants specifically for their energy production. According to DOE, switchgrass is one of the better candidates for developing dedicated biofuels feedstock; it has a high yield per acre on relatively poor soils, it is drought resistant, and it can be harvested without investing in additional hay-gathering equipment. Material handling, collection logistics, and infrastructure are important aspects of the biomass resource supply chain.

Types of biomass energy conversion. Direct combustion of wood and other plant matter is both the oldest and most widely used type of biomass energy conversion. Today the technology for power plants using direct combustion of wood, wood waste, or municipal solid waste is well developed. The United States has 10 gigawatts of installed biopower capacity, all of it based on mature direct-combustion technology. Future efficiency improvements will include the co-firing of biomass in existing coal-fired boilers and the introduction of high-efficiency gasification combined-cycle systems, fuel cell systems, and modular systems.

Biomass can be burned directly to produce steam for electricity production or manufacturing processes. In a power plant, a turbine usually captures the steam and a generator converts it into electricity. In the lumber and paper industries, wood scraps are sometimes fed directly into boilers to produce steam for their manufacturing processes or to heat their buildings.

Heat can also be used to chemically convert biomass into a fuel, which can be burned like petroleum to generate electricity. A variety of fuels can be made from biomass resources, including the liquid fuels ethanol and methanol, and such biodiesel and gaseous fuels as hydrogen and methane. Ethanol, an alcohol, is made by fermenting any biomass high in carbohydrates, such as corn, through a process similar to brewing beer. It is mostly used as a fuel additive to cut down a vehicle's emissions. Biodiesel is a clean-burning alternative fuel made by using vegetable oils, animal fats, algae, or even recycled cooking greases. It can be used as a diesel additive to reduce vehicle emissions or, in its pure form, to fuel a vehicle. Biofuels are primarily used to fuel vehicles but can also fuel engines or fuel cells for electricity generation.

Using high temperatures, gasification systems can even convert biomass into a gas for generating electricity. The gas fuels a turbine, which turns an electric generator. The decay of biomass in landfills also produces a gas, methane, which can be burned in a boiler to produce steam for electricity generation or for industrial processes.

For more information, contact David Morris, executive director, Institute for Local Self-Reliance; 612/379-3815; www.ilsr.org.

How biomass power is used. According to the National Biodiesel Board, more than fifty federal, state, and public utility vehicle fleets currently use biodiesel fuels derived from recycled vegetable oil. For example, cooking oil and waste grease are fueling buses in Cincinnati and Northern Kentucky. In a project funded by the area's Department of Transportation, 288 public buses are using a fuel that contains 20 percent biodiesel derived from recycled vegetable oil. Griffin Industries, Inc. of Cold Spring, Kentucky, collects and processes spent cooking oil and grease from area restaurants and will ultimately have supplied 500,000 gallons of biodiesel for the project, enough to run buses more than 2 million miles.

Cedar Rapids, Iowa. The city of Cedar Rapids, Iowa (population 109,000), has begun fueling its fleet of sixty city buses with biodiesel from soybeans. The city had used bio-based fuels previously, from 1993 to 1996, but stopped because of cost, not because of performance issues. Since 1996, however, the price of biodiesel has dropped dramatically. "We used biodiesel for 3 million miles and never had a single problem, so we didn't hesitate to begin using it again," says Bill Hoekstra, transit authority director.

"Part of the reason behind the decision to use soy-based biodiesel is that we're always concerned about emissions, and this helps us help the environment," says bus maintenance manager Roger Hageman. "We are conscientious about supporting Iowa's farmers, and using [biodiesel] will benefit them while decreasing our dependence on foreign oil."

Pure biodiesel has a similar horsepower, fuel economy, and performance as conventional diesel, yet produces 78 percent less CO_2 over its lifetime than regular diesel fuel.

For more information, contact Jenna Higgins, 1-800/841-5849.

Dresden, New York. AES, an electricity utility, produces nearly 11 MW of biopower by co-firing biomass residue in its coal boiler at Greenbridge Station in Dresden. New York State Electric and Gas designed and installed the biomass facility, where fuels include sawdust, furniture factory wood residues, and chipped pallets. These wood residues from local manufacturers currently provide about 5–10 percent of the total heat required for the boiler. Unlike traditional methods of co-firing, the process used here does not mix the coal and wood until they enter the boiler. This allows greater amounts of wood to be used than when the wood and coal are blended prior to injection into the boiler.

For more information on biopower, go to DOE's Web site at www.eren.doe.gov/biopower/projects.

Benefits and concerns. Bioenergy has the following advantages:

- Unlike the burning of fossil fuels, the combustion of plant matter releases no more CO_2 than is absorbed in plant growth and thus does not destabilize the climate.
- Plant matter contains negligible amounts of sulfur and nitrogen, and so even when it is burned, it contributes little to the acid rain problem.
- From an economic perspective, plant matter's bulky nature raises transport costs, which benefits regional processing facilities. This strengthens rural economies by encouraging local entrepreneurs to invest in local production plants that employ local citizens.
- Plant matter is a renewable resource whereas fossil fuel is not.
- Unlike other renewable resources, biomass can be converted directly into liquid fuels for transportation uses.

There are, however, some concerns about bioenergy:

- Certain agricultural practices appear to mine the soil rather than husband it.
- "Energy farms" raise concerns about the increased use of pesticides.
- Growing plant matter for energy will use up valuable land that might better be used to grow edible crops.
- Combustion of plant matter or fuel derivatives produces greenhouse gases similar to combustion of fossil fuels; however, as noted above, the combustion of plant matter releases no more CO_2 than is absorbed in the growth of plant matter.
- As more and more land is used for crops, the destruction of native wildlife habitats is a real threat.
- Groundwater becomes polluted through the extensive use of fertilizers.

COMPONENTS OF A SUSTAINABLE ENERGY PROGRAM

Secure energy provision and environmental protection are the two pillars of a sustainable energy program. To structure an effective program, the following steps can be taken:

- Identify a lead agency or organization to spearhead the effort. For example, the Tucson/Pima County program used the Metropolitan Energy Commission to initiate the community's strategic energy plan (see page 16).
- Identify key stakeholders and form partnerships. Public utilities, major corporations, small businesses, schools and universities, and professional and citizen groups can be key players in helping to develop and implement a sustainable energy program.
- Conduct an energy assessment. Inventory your current energy consumption, CO_2 emissions, and energy costs by key sector (e.g., transportation, residential, commercial). The International Council for Local Environmental Initiatives (ICLEI) provides local governments with CO_2 emissions software that streamlines the processes of conducting an emissions analysis, evaluating emissions reduction measures, and tracking measures.

  For more information, contact ICLEI at 510/540-8843; www.iclei.org.
- Involve your citizens. Learn about your community's concerns regarding energy and about the extent of citizens' knowledge. This will help you gauge how much community education is needed and what citizens think that government's role should be in energy management. Some may want strong local policies and ordinances while others may want less intervention, with an emphasis on voluntary measures. Focus groups, public listenings, and study circles are all mechanisms for public involvement.
- Work with your local utility. Ascertain any concerns that it may have regarding a sustainable energy program, determine how valid its concerns may be, and then make every attempt to overcome any reservations. Having your local utility's support will go a long way toward making your program successful.
- Develop energy goals and objectives. Two questions can be asked to help you focus on the concept of sustainability:
  - — What can be done in the immediate future to reduce air and water pollution?
  - — What framework should be put in place to move gradually toward an energy system compatible with nature's equilibrium?
- Develop action steps to meet your goals. These activities, projects, and programs should be spe-

cific and measurable, with time frames and lead persons identified.

- Consider experimenting with a number of technologies so that you and the members of your community can learn what types of renewables work best in your region.
- Create public outreach methods to educate the community about the program. Your program's success will depend on continued community buy-in and participation.
- Gain formal approval for the plan from your city council and/or county commission. It is key to ensure that funding support is also in place for the program.
- Implement the program. Rely on members of the community to help champion the program.
- Evaluate the key results. If you can monitor how well the program is doing on an ongoing basis, it will help you overcome barriers that might arise, employ the latest technologies, and take advantage of new scientific studies related to energy and environmental protection.

Municipal Aggregations

Municipal aggregations can help ensure a competitive market and support the use of renewable energy. The Cape Light Compact, an aggregation of the twenty-one towns on Cape Cod, Massachusetts, is an excellent example of municipalities collaborating to purchase electricity and support the use of renewable energy. (Municipal aggregation is allowed by state law in Massachusetts, so cities and towns can vote to purchase electricity for all its residents and businesses.)

The municipal franchise that has been formed represents the electricity demand of more than 185,000 residents, businesses, and municipal facilities on Cape Cod and the island of Martha's Vineyard. By pooling buying power, residents will save an average of $3.50 per month on their home electric bills. The franchise hopes to create a renewable energy fund so that it can make renewable energy devices, such as PV systems, affordable to residents by subsidizing 50 percent of their cost through the compact fund.[9]

For more information on the concept of municipal aggregation for the purchase of electric power, see the Web site of the Cape and Islands Self-Reliance Corporation, an advocacy organization for municipal aggregation: www.reliance.org/dereg.htm.

Public Benefits Funding

Some states and municipalities have developed a funding mechanism for renewable energy. Public benefits funding is a way to provide direct support to renewable energy and energy conservation programs by levy-

Good local practices

The Organisation for Economic Co-operation and Development has outlined the following principles that cities across the globe have recognized as essential to develop cost-saving energy management policies and programs.

- First of all, the definition of clear goals is essential to support city action and to raise the environmental interest of the local communities; indeed a strong environmental commitment characterizes most of the cities that participate.
- Secondly, participation and support of local communities has been recognized as crucial to achieve environmental and energy objectives. Sometimes local populations are already well informed about environmental issues; sometimes actions taken by the city activate a positive learning mechanism, thus raising citizen awareness. Usually an education component must be included.
- Thirdly, although many details of a "sustainable" energy system are debatable, one point has been stressed by most cities: such a system is possible only if energy efficiency is vastly improved. However, achieving energy efficiency gains requires a strategic change from supply-oriented policies to demand side programs.
- Participation, in some form, in the production and distribution of energy avoids conflicts of interest when implementing innovative energy programs, but also facilitates the integration of sectoral policies. Integrating energy considerations at the beginning of the decision-making process seems crucial to exploit successfully all savings' possibilities and new energy applications.
- Finally, energy pricing often constitutes an important barrier to change. Negative externalities of energy use are rarely taken into account. Setting the full cost of different energy technologies should include not only economic but also environmental and social factors: pollution, climate impact, land use, noise and visual impact, risks and effects of large accidents, degree of supply and security and safety. The environment needs to be introduced as a factor of production. It is likely that this will lead to higher prices for today's energy services. But when prices reflect full costs, the marketplace will facilitate the necessary adjustment in the choice of energy services demanded, and encourage efficiency improvements and technology substitution.

Source: Organisation for Economic Co-operation and Development, *Urban Energy Handbook: Good Local Practice* (Paris, France: OECD, 1995), 15–16.

ing a fee, or surcharge, on electric companies or customers. A similar concept was initiated on long-distance telephone calls to help preserve universal telephone service when the telephone industry was deregulated in the United States.

Selected Community Programs

Creating a sound energy policy requires that communities take a strategic approach, setting medium- and long-term objectives.

Saarbrücken Energy Management Plan. The city of Saarbrücken, Germany (population: 190,000), is the capital of the state of Saarland, a region rich in coal and mineral resources. The city enjoys a well-deserved reputation for innovative, effective energy policies dating back to 1964, when the first district heating lines were put into the ground. The city developed the Saarbrücken Energy Concept in 1980 in response to the oil price shocks; during the 1980s, implementation of the concept resulted coincidentally in a 15 percent reduction of total CO_2 emissions, laying the groundwork for a later comprehensive climate protection strategy.

In 1993, the city adopted a local action plan with the goal of reducing CO_2 emissions by 25 percent from 1990 levels by 2005.

Working closely with its municipal utility and local banks, the city has mounted one of the most comprehensive demand-side management systems in Europe. Encompassing fourteen core programs, Saarbrücken's Energy Management Plan is administered by Stadtwerke Saarbrücken, the public utility, and bolstered by the Participation Program, an innovative financing initiative involving local banks. The utility buys down the interest rate to make measures more cost-effective for the customer; the Participation Program is a loan program that allows residents to finance anything that saves energy or water. Achievements of the Saarbrücken plan include the following:

- From 1980 to 1996, the city reduced CO_2 emissions in its own buildings and facilities by 50 percent, resulting in a savings of 33,100 metric tons annually of CO_2 and of DM 6.3 million (U.S. $3.5 million) in annual energy costs.
- From 1988 to 1993, the Participation Program achieved energy savings of about 23,000 MWh with an investment of DM 43.4 million (U.S. $24.2 million) and a cost of saved energy ranging from 0.04–0.06 pfennig/kWh (U.S. $.02–$.04/kWh).
- The utility eliminated declining block rates (the more you use, the less you pay) and implemented a more linear rate structure in 1993, an experiment that proved successful by increasing the incentive for customers to save energy.

Based on the cogeneration of energy, the Stadtwerke Saarbrücken district energy system has grown since 1964 to 150 kilometers (92 miles) in length at a cost of more than DM 1 billion (U.S. $560 million). Today the system reaches more than 60,000 households and provides more than a third of the city's total space heating needs. This result has been achieved entirely on a voluntary basis by educating the public about the virtues of district energy as well as by offering attractive financing. Substantial capital subsidies from the federal government were also vital.

District cooling is now being added to the system to provide an efficient source of air conditioning during the summer, thereby tapping the wasted heat created in the warm season. The system provides the equivalent of 310 kW of cooling, reducing CO_2 emissions by 100 metric tons annually. There is a potential for 20 MW of cooling in the community, which will be developed further if the pilot proves successful.

Saarbrücken has also played a major role in commercializing solar energy at the local level in Germany. The city's ten-year comprehensive Solar Energy Initiative has led to the installation of 237 kW of PV cells on the rooftops of residents' homes and the implementation of various other projects, ranging from electric car demonstrations to solar hot water heating for municipal swimming pools. Many demonstration projects have been supported by the European Union. The Solar Rooftop Program became a model for a national program developed by the federal government.

In 1995, Saarbrücken was awarded the first European Solar Prize from Eurosolar, a private organization supporting solar options throughout Europe, for all of its activities in the solar field. Through its leadership in solar technologies, the city has demonstrated that municipal governments can play a vital role in speeding the commercialization and spread of beneficial new energy technologies.

This information came from ICLEI, Local Government Implementation of Climate Protection: Case Studies, *December 1997; http://www.iclei.org/co2/fact/cpcs97.htm*.

Sacramento, California. The Sacramento Municipal Utility District (SMUD) is the nation's sixth largest community-owned electric utility in terms of customers served. SMUD generates and distributes electric power to a 900-square-mile service area with a population of 1.2 million people. SMUD began providing electricity to its customers in 1946.

The SMUD utility is progressive and inclusive in its community approach. Promoting renewable resources for much of the past ten years, it used its public benefits fund to directly support renewable energy business development and developed a Request for Proposal to encourage the building of a local facility to manufacture PV panels. SMUD's mission is to "meet the energy and electricity needs of our customer-owners safely, dependably, economically and in an environmentally friendly manner." Key factors to its success are

- Community education and outreach
- Greenergy Program
- Million Trees program.

Community education and outreach. Information, education, and citizen referendums have been instrumental in promoting renewable and energy efficiency markets to the Sacramento community. SMUD's commitment to improving the environment was kick started when a 1989 citizen referendum directed SMUD to shut down its nuclear reactor. Wanting to turn around the public relations disaster that led to the shutdown, SMUD sought community input by mailing out ballots on power choices and holding workshops on supply options. Citizens endorsed a diverse resource strategy, including a 5-MW, utility-owned wind project as well as PV, wood waste, and other renewable technologies. Through its many public workshops, forums, and home energy audits, SMUD continues to educate the community on issues related to energy efficiency and renewable energy. At present, nearly half of SMUD's electricity is generated from renewable resources that include hydroelectric and geothermal power.[10]

Greenergy program. More than 10,000 customers participate in SMUD's Greenergy program. Participating customers' energy needs are matched with purchases of energy from renewable resources. The Greenergy program continues to gain popularity among SMUD customers as more and more residential customers opt for a cleaner substitute to conventional energy. Program highlights include the following:

- A power plant at the Sacramento County landfill uses methane gas tapped from the "green waste" already in the landfill.
- SMUD allocates 40 percent of Greenergy premiums directly toward building new renewable resources and expects to start building a new PV plant this year.
- SMUD's Greenergy All Renewable Option provides customers with a choice of 100 percent renewable electricity service.
- Participants pay a $3 premium on their electric bills and SMUD matches 50 percent of a customer's energy needs with renewable power purchases. A 100 percent program is available for $6 a month.

Million Trees program. On Saturday, April 28, National Arbor Day 2001, Sacramento reached its goal of one million trees planted in the past decade. SMUD is responsible for planting almost a third of them.

Trees—and all living plant matter to a lesser degree—serve as sinks, absorbing CO_2 emissions from the air. Additionally, properly sited and planted shade trees can reduce the need for air conditioning by up to 40 percent. According to SMUD, every 100,000 trees can save more than $400,000 in energy costs each year of the trees' lives.

For more information on SMUD's green pricing, energy efficiency, and renewable energy policies and programs, go to www.SMUD.org or contact Donald Osborn, superintendent, Renewable Generation Assets, SMUD, 916/732-6679.

Portland, Oregon. Known worldwide for its progressive energy policy, Portland is a city dedicated to improving the environment and reducing its output of greenhouse gases. In 1993 Portland became the first U.S. city to adopt a climate change action plan, also known as a CO_2 reduction strategy. Portland's action plan established a reduction target of 20 percent below 1990 emissions by 2010. To achieve its goal, it outlined areas where energy efficiency could be improved, and it developed programs to meet the goals it set.

Businesses for an Environmentally Sustainable Tomorrow is an integrated city program, offering the services of the Water Bureau, Energy Office, the Bureau of Environmental Services, and the Office of Transportation. Experts provide technical assistance in the areas of water and energy conservation, transportation alternatives, waste reduction, recycling, and pollution prevention to help businesses both use resources wisely and save money. The program recognizes innovation

The Portland city challenge: Cutting energy bills by $1 million

Portland's program, City Energy Challenge, is one example of how to save energy by increasing efficiency. In just five years the city saved close to $1 million. Its four-step plan is as follows:

1. Identify and quantify energy accounts. Choose a goal for energy savings that is realistic and achievable (10–25 percent) and get management to endorse it. Include the facilities staff in goal setting. Join the Environmental Protection Agency's Green Lights Program.
2. Select the best person to take responsibility for achieving the energy goal. That person could be in the facilities maintenance section or perhaps in the accounting department, where utility bills are paid. In Portland, the Energy Office was assigned the task.
3. Identify existing staff, resources, and funds to implement the energy efficiency program. Getting city council to budget for a new program and energy manager position can be difficult.
4. Track the results and publicize the success so that facility managers, employees, and customers are aware of accomplishments. Portland's City Energy Challenge uses a newsletter to accomplish this and thereby promote energy efficiency. Highly visible projects offer a prime opportunity to publicize success.

Source: Personal communication with Dave Tooze, Portland Energy Office, April 12, 2001.

with an annual awards program.

Other programs that Portland has implemented include Rebuild America: Portland Partners for Energy Efficiency, Green Building Program, Climate Wise, Tree Planting, and Telework.

The Portland city council has mandated that 5 percent of its municipal electricity needs be supplied by clean, renewable energy. Portland purchases its power from two utilities, Pacific Corporation and Portland General Electric, which generate their renewable power from wind. Customers pay a premium between $3 and $5 per month for this energy. Portland returns a portion of the savings from aggregating various government electricity accounts to ratepayers and will use the remainder to fund new renewable energy projects.

Portland's strategy is to address the question of renewables from a policy perspective first: Are we going to support clean energy use? Once the decision is made to do so, the city can go forward. It can select one of its high-visibility facilities (e.g., city hall or the library), make it the model for green energy, and begin to purchase renewables. Or, because the city is able to secure funding at lower interest rates, it can take an ownership stake in renewable energy by joining forces with a developer who wants to raise capital to develop a site. It can then either purchase renewables to supply energy to the development or mandate that a certain percentage of the development's energy (say, 5–10 percent) comes from renewables.

For more information, contact Dave Tooze, Portland Energy Office, 503/823-7582, or visit the office's Web site at www.ci.portland.or.us/energy/.

INVOLVING CITIZENS

Where municipal governments have taken the lead in purchasing renewable energy, many local businesses have been quick to follow. The local government's purchase of green energy provides community leadership for renewables; garners media attention; and helps to certify that renewable energy is a credible, environmentally preferred product. Cities and towns have used their publications and broadcasts—cable television programs, newsletters, and municipal bills—to heighten citizen awareness of the economic and environmental implications of energy choices.

Beyond this, there are a number of other ways to encourage citizens to use renewable energy and to gain their support for municipal energy efficiency programs and renewable energy projects.

Energy Planning

Beginning in 1991, the mayor and council of Tucson, Arizona, and the Pima County board of supervisors directly involved their citizens in a community-wide strategic energy planning process.

The governing bodies initiated the planning process by directing the Metropolitan Energy Commission (MEC) to examine Tucson's long-term energy situation and recommend strategies to address the city's and county's energy issues. The MEC is a sixteen-member citizen board appointed by the mayor and council and board of supervisors to serve as advisors on community issues and concerns related to energy. As part of the planning process, the MEC directly pulled together more than 150 citizens in focus groups and small group meetings to help determine what the community thought about energy. Several important concerns were identified:

- Some citizens favored strong local government policies and ordinances while others wanted only minimal government intervention.
- Most citizens targeted community education about energy as a key to supporting government efforts and projects.
- Many citizens felt that the city and county should play a facilitating role in developing public-private partnerships (e.g., solar energy projects, energy- and water-efficient landscaping, and alternative building designs) and in providing incentives for renewable energy use.

Using this feedback, the MEC was able to identify its strategic goals, areas of potential priority, and action items, which resulted in the Community Strategic Energy Plan, completed in 1995.

For more information on the Tucson/Pima County Community Strategic Energy Plan, see www.tucsonmec.org.

Sustainable Energy Tax Incentives

To finance renewable energy systems, many states offer utility rebates. The state of Massachusetts offers a number of tax incentives to individuals and businesses that install renewable energy systems for their homes or commercial space.

- State income tax credit: An income tax credit is provided for individuals who install wind or solar power energy systems for their residences. The credit is 15 percent of the net expenditure, which includes installation for the system, or $1,000, whichever is less.
- State sales tax exemption: Any equipment directly relating to any solar, wind, or heat pump system to be used to supply the energy needs of a person's residence is exempt from state sales tax.
- Local property tax exemption: Anyone who installs a solar- or wind-powered system for heating or supplying the energy needs of his or her residence or business is eligible for an exemption from the local property tax. This exemption is good for twenty years.
- Corporate income tax deduction: A business is eligible to deduct from its net income, for state tax purposes, any costs incurred from installing a

solar- or wind-powered climatic control unit or water-heating unit at any installation in the state.

For more information, contact the state of Massachusetts Division of Energy Resources, 617/727-4732, or e-mail: Energy@State.MA.US.

Net Metering

With "net metering" or "net billing," a residential household or business that generates its own electricity (e.g., using PV systems or small wind turbines) can feed surplus electricity back to its utility company. The customer then pays only for the net electricity used over the billing period. One interesting aspect of net metering is that the meter actually spins backwards as the customer feeds electricity back to the utility company. About half the states, including California, Idaho, Maine, Massachusetts, Maryland, Minnesota, New Hampshire, New Mexico, New York, Rhode Island, Texas, Vermont, and Washington, allow net metering.

For a full discussion of net metering, see the Union of Concerned Scientists Web site at www.ucsusa.org/energy/brf.net.html.

Public Information

Surveys show that consumers are willing to pay more for clean and renewable energy. However, they need information about appropriate renewable energy choices for their region and reliable renewable energy products. Several efforts are currently under way to provide public education and outreach about renewable energy technologies.

Disclosure labels. Disclosure labels (information typically provided in customer billing and material that is distributed to utilities customers) provide consumers with facts about the price of electricity generation, the supply mix (i.e., the percentage of the sources of electricity to supply the product—e.g., coal: 30 percent; solar, wind, or biomass energy: 20 percent; natural gas: 20 percent), and air emissions, such as nitrogen oxides, SO_2, and CO_2. Several states currently require some form of disclosure; for example, California and Maine require that fuel sources be disclosed on a customer label, and Massachusetts, Connecticut, and Illinois require disclosure of fuel mix and air emissions.

Certification. The Center for Resource Solutions, a nonprofit organization based in San Francisco, established the Green-e Renewable Electricity Certification Program to provide a simple way for citizens to quickly identify environmentally superior electricity options, or "products," in restructured markets. When the Green-e logo is displayed next to an electricity option, it means that at least 50 percent of the electricity comes from renewable resources, including solar, small or low-impact hydroelectric, wind, biomass, and geothermal energy.

If the electricity has a nonrenewable portion, the air emissions from that portion must be equal to or lower than that from conventional electricity. Furthermore, Green-e products must contain at least 5 percent new renewable resources in the second year after restructuring and 10 percent in the third year. No specific purchases of nuclear power may be made for Green-e certified electricity. Companies selling Green-e certified electricity are required to abide by the Green-e Code of Conduct, which governs the way companies represent their electricity products.

The Green-e program is administered by the Center for Resource Solutions. For more information, contact Suzanne Tegen at 415/561-2100.

Educational programs. Outreach programs engage citizens in learning about energy efficiency and renewable energy technology. The Small and Cool Program targets small business owners to assist them in becoming more energy efficient and reducing their greenhouse gas emissions. The program is a collaboration of the Northeast States for Coordinated Air Use Management and Tufts University's Clean Air–Cool Planet organization. Specifically, the program helps small businesses conduct an energy audit to learn about their current energy use and greenhouse gas emissions, and to implement energy efficiency measures.

For more information, contact T. J. Roskelley of NESCAUM at 617/367-8540; tjroskelley@nescaum.org, or Charlene Garland of Clean Air–Cool Planet at 603/422-6464; cgarland@cleanair-coolplanet.org.

CONCLUSION

This is an exciting and demanding time for local elected officials and administrators, as rising energy costs, dependence on foreign oil supplies, concern for the environment, and the looming specter of an energy crisis are just a few of the major energy-related issues now facing local governments. In 1997 DOE commissioned a working group to examine the potential for public policies and programs to foster efficient and clean energy technology solutions. The study, *Scenarios for a Clean Energy Future*, concluded that (1) smart public policies, such as voluntary agreements, efficiency standards, and increased research and development, can significantly reduce not only CO_2 emissions but also air pollution, petroleum dependence, and inefficiencies in energy production and use; and (2) policies that support clean energy could produce direct benefits, including energy savings, that exceed their direct costs (e.g., technology and policy investments).

As this report shows, many local governments have indeed embarked upon such policies by investing in renewable energy sources. Local power utilities, energy commissions, and city councils are partnering in unique projects to deliver sustainable power that goes a long way to protect the environment, provide long-term cost savings, and mitigate climate change.

According to the California Energy Commission, renewables are becoming more cost-effective for both

the private and public sectors. The commission reports that applications for the state's on-site energy systems (mostly solar) subsidy program have quadrupled—from 50 applications per month last year to 200–250 per month currently.

For more information, see the California Energy Commission Web site: http://38.144.192.166/renewables/index.html.

Local governments are also involving their citizens in developing new energy policies and strategies. This report offers examples of public involvement efforts, including tax incentives, net metering, and public information programs. Continued efforts to educate citizens about sustainable power sources and how they work will help communities make better informed and more effective public energy policy.

All in all, the possibility of endless supplies of energy that have minimal effects on the environment and can be cost-effective is already a reality. Local governments are taking a leadership role in helping to ensure that the lives of their citizens are enhanced by this new energy age.

1 Organisation for Economic Co-Operation and Development, *Urban Energy Handbook: Good Local Practice* (Paris, France: OECD, 1995).

2 Courtney Miller, AIA, president of New England Solar Homes, Arlington, Massachusetts.

3 U.S. Department of Energy, Energy Efficiency and Renewable Energy Network, *Consumer Energy Information: EREC Fact Sheets*, February 2000, www.eren.doe.gov/erec/factsheets/solrwatr.html.

4 John R. Dunlop, "Wind Clusters: Expanding the Market Appeal of Wind Energy Systems," Renewable Energy Policy Project, *Issue Brief* no. 4 (1996).

5 K.O'Dell, *Wind Powering America: Clean Energy for the 21st Century*, DOE/GO-102000-0989 (Golden, Colo.: National Renewable Energy Laboratory, March 2000).

6 Jennifer Carless, *Renewable Energy: A Concise Guide to Green Alternatives* (New York: Walker and Company, 1993), 54.

7 See www.eren.doe.gov/RE/geo_direct_use.html.

8 Carless, *Renewable Energy*, 82.

9 Matthew Patrick, director of the Self-Reliance Corporation, the lead agency in developing the Cape Light Compact.

10 Peter Asmus, "Power to the People," Renewable Energy Policy Project, *Issue Brief* no. 9 (1998): 10.

APPENDIX A: UNITS OF POWER

Energy is measured in units of power, or the rate of energy flow. The System International (SI), most commonly know as the metric system, is the system of measurement for electrical energy. The SI is based on units of ten.

Watts are the SI measurement of the rate of energy flow. SI prefixes are used to describe the scale of watts of high and low value. The most common measurement of power is the kilowatt (1,000 watts) and the megawatt (1,000,000 watts).

Watts describe the rate at which electricity is being used at a specific moment. For example, 100 watts describes the amount of electricity that a 100-W lightbulb draws at any particular moment. A compact fluorescent bulb uses 18 watts, an equivalent incandescent bulb uses 75 watts, and a television uses 200 watts.

Watt-hours, which are a combination of how fast the electricity is used (watts) and the length of time it is used (hours), measure the total amount of electricity used over time. For example, a 100-W lightbulb, which draws 100 watts at any one moment, uses 100 watt-hours of electricity in the course of one hour.

Kilowatts and **kilowatt-hours** are useful for measuring amounts of electricity used by large appliances, such as refrigerators, and by households. Kilowatt-hours are what show up on your electricity bill. One kilowatt (kW) equals 1,000 watts, and one kilowatt-hour (kWh) is one hour of using electricity at a rate of 1,000 watts. New, energy-efficient refrigerators use about 1.4 kWh per day, and about 500 kWh per year.

Megawatts are used to measure the output of a power plant or the amount of electricity required by an entire city. One megawatt (MW) = 1,000 kilowatts = 1,000,000 watts. The average size U.S. power plant produces 213 MW. A 1000-MW power plant is a large plant.

Gigawatts measure the capacity of large power plants or of many plants. One gigawatt (GW) = 1,000 megawatts = 1 billion watts. In 1990, if all electrical generating plants were operating at full capacity at the same time, they would have produced 690 GW.

Btu, or British thermal unit, is a measure of energy content, usually used to describe the energy content of fuels. Because a Btu is so small, energy is usually measured in millions of Btus. For example, a "therm" of natural gas, such as you would find on your gas bill, is 100,000 Btus of gas.

Source: Adapted from the *Community Energy Workbook* (Snowmass, Colo.: Rocky Mountain Institute, 1995).

APPENDIX B: RENEWABLE ENERGY RESOURCE LIST

The following list contains some, but by no means all, of the organizations currently offering information and support for leaders of communities wanting to incorporate renewable energy options into their energy systems:

Renewable Energy (General)

Renewable Energy Policy Project (REPP). REPP supports the advancement of renewable energy technology through policy research. The organization offers a platform from which experts in the field can examine issues of medium- to long-term importance to policy makers, green-energy entrepreneurs, and environmental advocates. www.repp.org.

Solstice: Center for Renewable Energy and Sustainable Technologies. This is an excellent online resource for sustainable energy information. www.crest.org.

U.S. Department of Energy

Energy Efficiency and Renewable Energy Network (EREN). A comprehensive resource for DOE's energy efficiency and renewable energy information, plus access to more than 600 links and 80,000 documents. www.eren.doe.gov/.

National Renewable Energy Lab (NREL). The U.S. Department of Energy's premier laboratory for renewable energy and energy efficiency research, development, and deployment. www.nrel.gov/.

World Energy Modernization Plan. Among the plan's goals are (1) to create a world energy modernization fund using the revenues from a tax on international currency transactions or other comparable revenue sources to finance development of climate-friendly renewable and low-carbon technologies, and (2) to eliminate fossil fuel subsidies and instead provide subsidies for renewable technologies and job retraining for displaced fossil fuel workers. www.heatisonline.org/solutions.cfm.

Bioenergy

Institute for Local Self-Reliance. Provides technical assistance and information on environmentally sound economic development strategies. 202/232-4108; www.ilsr.org.

New Uses Council. An international nonprofit association promoting uses of grown matter for electricity, fuels, chemicals, resins, aromatics, building materials, and industrial resources. www.newuses.org.

Geothermal

Geo-Heat Center. Provides information developed through extensive research and firsthand experience with hundreds of projects to individuals, organizations, and companies involved in geothermal development. The Oregon Institute of Technology, 541/885-1750; http://geoheat.oit.edu.

Geothermal Resources Council. Encourages the development of geothermal resources worldwide through the collection and timely distribution of data and technological information. www.geothermal.org.

Small Hydro

International Network on Small Hydro Power. A United Nations–sponsored, nonprofit clearinghouse for information about small hydro power around the world. E-mail: hic@mail.hz.zj.cn; www.digiserve.com/inshp/first.htm.

Solar

American Solar Energy Society. A national organization that promotes the use of solar energy, publishes a bimonthly magazine on solar technologies, sponsors the annual national solar energy conference, and distributes solar publications. www.ases.org.

Northeast Sustainable Energy Association. A regional membership organization of engineers, educators, builders, and planners to support the development of green energy. Sponsors the annual American Tour de Sol Electric Car Championship. www.nesea.org.

Solar Electric Power Association. An nonprofit organization whose membership consists of electric service providers, research organizations, solar manufacturers, and educational institutions who create and encourage partnerships to support and expand the PV market. www.ttcorp.com/upvg/.

Wind

American Wind Energy Association. Advocates the development of wind energy as a reliable, environmentally superior energy alternative in the United States and around the world. www.awea.org.

U.S. Department of Energy Wind Energy Program. Includes a comprehensive wind energy research program; wind turbine research and development; and support for utilities, industry, and international wind energy projects. www.eren.doe.gov/wind.

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Introduction to Activity Based Costing, 02/98	42306

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