Sustainable Infrastructure for Small System Public Services

A Planning and Resource Guide

RURAL COMMUNITY ASSISTANCE PARTNERSHIP

an equal opportunity provider and employer

This guide was originally written by staff of Rural Community Assistance Corporation (RCAC), the Western RCAP, and was expanded and adapted for national publication (original publication by RCAC in September 2009). The creation of the original material was funded in part by Grant Number 90EF069/01 from the United States Department of Health and Human Services and by the Utilities Program of the United States Department of Agriculture.

The entire contents of this guide are available on the RCAP website at *www.rcap.org*

This material is based upon work supported under a grant by the Utilities Programs, United States Department of Agriculture. Any opinions, findings, and conclusions or recommendations expressed in this material are solely the responsibility of the authors and do not necessarily represent the official views of the Utilities Programs.

Sustainable Infrastructure for Small System Public Services

A Planning and Resource Guide

Rural Community Assistance Partnership, Inc.

1701 K St. NW, Suite 700
Washington, DC 20006
202/408-1273
800/321-7227 (toll-free)
info@rcap.org
www.rcap.org

Table of Contents

Introduction

At the local level, decision-makers and staff deal with the challenges of operating their small utility on a daily basis. They must make decisions on operating costs, with aging infrastructure, with the pressures of increasing regulatory compliance, with volunteer burnout, and many other factors. Put together with the growth of sustainability as a measure of a utility's success, the processes of incorporating "green" practices can further burden a small utility.

This planning and resource guide is a starting place for very small (fewer than 1,000 connections) to medium (up to 5,000 connections) communities to initiate and integrate green elements in their facilities and projects.

Communities that actively seek to become more sustainable need leadership and specific tools to address the long-term needs of their residents. Communities, like businesses, must plan to age well over time. Water-quality and -quantity questions are complex. Each community with water, wastewater and solid-waste issues must have the financial stability, managerial competence, and technical oversight to match its immediate and projected needs, decrease pollution, and protect the community health and well-being in a sustainable manner.

This guide assists a community in identifying very specific actions that can be taken as next steps as it fosters and promotes sustainability.

The purpose of this guidebook

Rather than presenting theories, this guidebook provides informational material, worksheets, examples, case studies and resources on water conservation, energy efficiency and renewable energy for small utilities.

Who should use this guidebook?

This guide includes a step-by-step process for a utility's decision-makers, staff and community members wanting to operate increasingly efficient utility systems. It offers a flexible approach to evaluating sustainable alternatives for a utility's operations. Leaders of a utility who are beginning to think of ways to save on operating costs and wiser and more efficient use of resources will find this guide helpful.

What topics are addressed in this guidebook?

The first chapter focuses on water conservation, its elements, tools and resources to develop and implement a water-conservation program for small utility systems. The second chapter focuses on energy efficiency. It helps you to review your current energy consumption and provides you with tools and resources to become more energy-efficient. The third chapter focuses on renewable energy. This chapter gives a thorough review of this concept, specific to small water and wastewater systems, and where a utility might be able to take advantage of resources depending on its geographic location and available natural resources.

Chapter 1
Water Conservation

Water Conservation Overview

Population growth, increased demand and the growing intensity of the hydrological cycle caused by climate change are likely to increase the need for stringent water-conservation measures. Researchers estimate that by 2025, half the world's countries may face shortages of fresh water, while up to three-quarters of the world's population may experience fresh water scarcity by 2050.

Water conservation should not be something we think about only during times of drought. Conserving water is a way of life and a way to ensure that there is water available at a reasonable cost for future generations.

Reducing water demand by practicing water conservation may add years to the life of our local aquifers, reduce the cost of water and wastewater treatment, and save energy and other costs.

Water conservation is any action, program or technology that:

- reduces the amount of water withdrawn from water-supply sources
- reduces water use (indoor and outdoor)
- reduces water loss or waste
- improves the efficiency of water use
- increases water recycling and reuse
- prevents water pollution

Many resources and tools are available to implement effective water-conservation programs and help utilities understand and implement conservation measures to reduce damage to the environment.

Water Utility Water Conservation

Traditionally, water utilities have focused on developing additional supplies to satisfy increasing demands associated with population growth and economic development. However, over time, an increasing number of water utilities throughout the U.S. have recognized that water-conservation programs can reduce current and future water demands to benefit the customer, the utility and the environment.

This section describes how a water utility can manage customer water demands by implementing sound water-efficiency practices.

At the utility level, water-conservation efforts are usually prompted by a number of factors that include:

- growing competition for limited water supplies and increasing concerns about impacts of water withdrawals on stream flows, wetlands and other groundwater users
- increasing costs and difficulties in developing new supplies
- the ability to delay or reduce capital investments in expanding the capacity of a water system
- growing public support for the conservation of limited natural resources and overall protection of the environment

Although conservation is sometimes an alternative to developing additional supplies, it is more often one of several complementary supply strategies for a utility. A conservation strategy, like any supply strategy, is part of a utility's overall integrated resource planning to ensure that all important community objectives and environmental goals are considered.

The first step in the process is to evaluate your utility's current conditions. **The Systems Conditions Summary Worksheet** (below) is a good tool for this evaluation process.

Systems Conditions Summary Worksheet

Planning questions	Yes	No	Comments
Is the system in a designated critical water-supply area (designated critical block)?			
Does the system experience frequent shortages or supply emergencies?			
Is there substantial water that cannot be accounted for in the system?			
Is the system experiencing a high rate of population growth and/or demand?			
Is the system planning substantial improvements or additions?			
Is the system meeting water-rights allotments?			

Water-conservation approaches

A fundamental requirement for implementing a water-conservation program is to obtain detailed information that describes how customers currently use water and to assess how the water utility tracks and maintains its system. This information is considered baseline data with which a water utility can assess the types of water-conservation opportunities that exist and characterize the public's existing water-conservation behaviors and attitudes to help implement a water-conservation program. A system's conservation plans should identify specific goals and objectives and identify efficiency measures.

Water conservation goals and objectives

Accurately understanding real opportunities for conserving water is important. The reliability of conserved water depends on accurate estimates of potential savings, expected benefits and costs. Therefore, careful analysis and planning is a prerequisite to your utility making major investments in conservation programs.

Reliability concerns also underscore the need for utilities to monitor and document the effectiveness of their conservation programs. Goals such as the ones listed below can help a utility develop a good conservation program.

Conservation program development goals

- measures that promote efficient water use
- identification of best management practices and state-of-the-art conservation and efficiency technologies
- using sound planning principles
- demand-side and supply-side measures or incentives
- development, transfer and application of science and research

A tool to help determine goals should include a review of current conditions to determine possibilities for the water-conservation program (see Table 1 on page 6).

Table 1. Review of Current System Conditions [a]

A. RESIDENTIAL DEMAND	**Current Year**	**2-year forecast**	**5-year forecast**	**10-year forecast**
1.Current annual water residential sales *(total gallons)*				
2.Current population served [b]				
3.Residential sales per capita *(line 1 divided by line 2)* [b]				
4.Projected population [b]				
5.Projected annual residential water demand *(line 3 multiplied by line 4)*				
B. NON-RESIDENTIAL DEMAND [c]				
6.Current annual water non-residential sales *(total gallons)*				
7.Current number of employees or jobs [c]				
8. Water use per employee or job *(line 6 divided by line 7)*				
9.Projected number of employees or jobs				
10. Projected annual non-residential water demand *(line 8 multiplied by line 9)*				
C. NON-ACCOUNT WATER (water not sold to customers)				
11. Current and forecast amount [d]				
D. WATER SYSTEM TOTAL DEMAND				
12. Current total annual water demand *(add lines 1, 6 and 11)*				
13. Projected total annual water demand *(add lines 5, 10 and 11)*				
14. Adjustments to forecast (+ or -)				
15. Current (line 12) and adjusted total annual water demand forecast (*add lines 13 and 14*) [e]				
16. Current and projected annual supply capacity [f]				
17. Difference between total use and total supply capacity (+ or -) *(subtract line 12 from line 16*)				
E. AVERAGE-DAY AND MAXIMUM-DAY DEMAND				
18. Average-day demand *(line 15 divided by 365*)				
How does it compare to previous month or previous year, same month?				
19. Current maximum-day demand				
20. Maximum-day to average-day demand ratio *(line 19 divided by line 18)*				
21. Projected maximum-day demand *(line 18 multiplied by line 20 for all forecast years)*				
22. Adjustment to maximum-day demand forecast [e]				
23. Current (line 19) and adjusted maximum-day demand forecast *(add lines 21 and 22)*				
24. Daily supply capacity *(divide line 16 by 365)*				
25. Ratio of maximum-day demand to daily supply capacity *(divide line 23 by line 24)*				

RCAP

[a] Note: Separate forecasts should be prepared for large-volume users.

[b] Planners can choose to use service connections or households instead of population and per-connection water use or per capita water use.

[c] Explanatory variables other than employees or jobs can be used as appropriate. The forecast should be disaggregated by sector of water use to the greatest extent possible (for example, commercial and industrial water use and non-account water) and a qualitative-sensitivity analysis ("what if") should be performed for each sector's forecast.

[d] Please provide an explanation of the forecast of non-account water, including all relevant assumptions.

[e] Please provide an explanation of adjustments to your forecasts, including all relevant assumptions.

[f] Supply capacity should take into account available supplies (permits), treatment capacity, and distribution system capacity and reflect the practical total supply capacity of the system, including purchased water.

Analyzing the information gathered in Table 1

What does line 3 tell you?

Do you know what the per capita water usage is for similar systems in your area?

What does that information tell you about your system?

Is it higher/lower than the average? Why?

What does line 20 tell you?

Is ratio of maximum-day demand to daily supply, in line 25, less than 1.0?

Water audits as a means of conservation

A water audit is another management tool used to determine how efficiently a system is operating and where the losses might occur. An audit identifies how much water is lost and what that loss costs the public water supplier. Records and system-control equipment (such as meters) are thoroughly checked for accuracy. The overall goal is to help the public water supplier select and implement programs to reduce losses in the system's water works. The public water supplier should perform a water audit annually. In this manner, the public water supplier will determine the volume of lost water, the need to do regular field leak detection, and the dollar value of water that is lost. Water audits allow adjustments to be made to metering system calculations and acceptable meter errors.

Free water audit software is available from the American Water Works Association (AWWA) at *www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48511&navItemNumber=48158*

How to conduct a water audit

To be successful, you need a team of key players. This team might include the system's operator, manager, bookkeeper, field staff and users.

The steps for completing a water audit are:

1. Collect records for a specific review period (usually one year).
2. Use source and service meter readings to calculate how much water enters and leaves the system during that period.
3. Track and estimate any unmetered but authorized uses. If you don't track and estimate these uses, the loss is probably due to leaks in the distribution system.
4. Test meters for accuracy as recommended by the manufacturer. Calibration and replacement is different for source and service meters. Generally, you should test source meters more often than service meters.

5. Calculate the total amount of leakage.
6. Determine possible reasons for leakage, including physical leaks and unauthorized uses.
7. Analyze results to determine the improvements you may need. They may include better accounting practices, a leak survey or replacing old distribution pipes.

Table 2. Water Audit Analysis

Water Audit Worksheet

Water system name: Date:

Line	Item	Water Volume: Subtotal	Water Volume: Total Cumulative	Water Volume: Units*
TASK 1: MEASURE THE SUPPLY				
1.	Uncorrected total water supply to the distribution system *(total of master meters)*			
2.	Adjustments to total water supply			
2A.	Source meter error *(+ or -)*			
2B.	Change in reservoir or tank storage			
2C.	Other contributions or losses *(+ or -)*			
3.	Total adjustments to total water supply *(add lines 2A, 2B, and 2C)*			
4.	Adjusted total water supply to the distribution system *(add lines 1 and 3)*			
TASK 2: MEASURE AUTHORIZED, METERED USE				
5.	Uncorrected total metered water use			
6.	Adjustments due to meter reading lag time *(+ or -)*			
7.	Metered deliveries *(add lines 5 and 6)*			
8.	Total sales meter error and system-service meter error *(+ or -)*			
8A.	Residential meter error *(+ or -)*			
8B.	Large meter error *(+ or -)*			
8C.	Total *(add lines 8A and 8B)*			
9.	Corrected total metered water deliveries *(add lines 7 and 8C)*			
10.	Corrected total unmetered water *(subtract line 9 from line 4)*			

** Units of measure must be consistent throughout the worksheet. The particular unit used is designated by the user.*

RCAP

Water Audit Worksheet *(Continued)*

Line	Item	Water Volume Subtotal	Total Cumulative	Units*
TASK 3: MEASURE AUTHORIZED, UNMETERED USE				
11A.	Firefighting and firefighting training			
11B.	Main flushing			
11C.	Storm-drain flushing			
11D.	Sewer cleaning			
11E.	Street cleaning			
11F.	Schools			
11G.	Landscaping in large public areas:			
	• parks			
	• golf courses			
	• cemeteries			
	• playgrounds			
	• highway median strips			
	• other landscaping ______________________________			
11H.	Decorative water facilities			
11I.	Swimming pools			
11J.	Construction sites			
11K.	Water quality and other testing (pressure testing pipe, water quality)			
11L.	Process water at treatment plants			
11M.	Other unmetered uses:			
12.	Total authorized, unmetered water use *(add lines 11A through 11M)*			
13.	Total water losses *(subtract line 12 from line 10)*			

* *Units of measure must be consistent throughout the worksheet. The particular unit used is designated by the user.*

Water Audit Worksheet *(Continued)*

Line	Item	Water Volume: Subtotal	Water Volume: Total Cumulative	Water Volume: Units*
TASK 4: MEASURE WATER LOSSES				
14A.	Accounting-procedure errors *(e.g., transposing numbers, data entry error transposing numbers, data entry error)*			
14B.	Unauthorized connections			
14C.	Malfunctioning distribution system controls			
14D.	Reservoir seepage and leakage			
14E.	Evaporation			
14F.	Reservoir overflow			
14G.	Discovered leaks			
14H.	Unauthorized use			
15.	Total identified water losses *(add lines 14A through 14H)*			
TASK 5: ANALYZE AUDIT RESULTS				
16.	Potential water system leakage *(subtract line 15 from line 13)*			
17.	Recoverable leakage *(multiply line 16 by 0.5)*			
Line	**Item**	**Dollars per unit of volume**		
18.	Cost savings			
18A.	Cost of water supply			
18B.	Variable operation and maintenance costs			
19.	Total cost per unit of recoverable leakage *(add lines 18A and 18B)*			
Line	**Item**	**Dollars per year**		
20.	One-year benefit from recoverable leakage *(multiply line 17 by line 19)*			
21.	Total benefits from recovered leakage *(multiply line 20 by 2)*			
22.	Total cost of leak-detection project			
23.	Benefit-to-cost ratio *(divide line 21 by line 22)*			

Prepared by:
Name:

Title: Date:

** Units of measure must be consistent throughout the worksheet. The particular unit used is designated by the user.*

RCAP

Now that you have a more complete picture of your customer base, the efficiency of your system and the impact to your finances, you can also determine the efficiency of water produced versus water sold.

Is your unaccounted water loss within your state-recommended range (usually 10 to 15 percent)?

Photo by Randy Vessels, RCAC

Leak Detection

A leak-detection survey is a physical evaluation of a water system to identify specific leaks. It involves using a listening device to find leaks in pipes or fittings within the distribution system.

The distribution system leakage standard is a significant element of water-use efficiency. The best way to obtain the most accurate assessment of leakage information includes collecting service-meter data. Nothing provides more accurate information than using consumption data collected from service meters to calculate the leakage.

Leaky water systems are costly. Significant revenue is lost through leaks, including:

- energy costs for pumping water
- water-treatment costs
- water that could be sold to other customers

Water is a precious and limited resource and should be used efficiently. You should make every effort to keep leakage to a minimum and strive to meet the standard. Once you are fully metered, calculate leaks annually, and include the results in your annual performance reports and planning documents.

The state of Washington has some of the best guidance documents on leak detection and water audits: *www.mrsc.org/Subjects/Environment/water/wc-measures.aspx#Leakdetect*

AWWA has written an article on the Washington model: *www.awwa.org/publications/MainStreamArticle.cfm?itemnumber=36758*

The following may also be purchased from AWWA: *www.awwa.org/Bookstore/*

- AWWA Manual: *Water Audits and Leak Detection*, 1999, M36
- *Water Loss Control*, published by McGraw-Hill Professional Edition: 2008; hardback, 632 pp.; ISBN 978-0-07-149918-7; Catalog No. 20511
- DVD: *Leak Detection and Repair*, 16 minutes, Order No. 65112

Based on the information gathered in the previous exercise, establish a reasonable and achievable goal to accomplish in your conservation program. The next table is an assessment of the different resources and tools available to help you meet your goals.

Table 3. Water-conservation Assessment

Program	Already Implemented	Evaluated	Comments
Education/outreach/information dissemination			
Public education			
Water saving			
Demonstrations			
School programs			
Informative and understandable water bills			
Water-bill inserts			
Other [specify]:______________________			
Technical assistance			
Customer water-use audits			
Targeted at large users			
Targeted at large landscapes			
Water-conservation expert available			
Other [specify]:______________________			
Rate structures and billing systems designed to encourage efficiency			
Volume billing			
Conservation (tiered) rate structure			
Increased (monthly) billing frequency			
Other [specify]:______________________			
Regulations/ordinances			
Addressing fixtures and appliances			
Standards for fixtures and appliances			
Time-of-sale upgrades			
Other [specify]:______________________			
Addressing landscapes			
Turf restrictions			
Landscape design/layout			
Soil preparation			
Irrigation equipment			
Water waste prohibition			
Other [specify]:___________________			

Table 3. Water-conservation Assessment *(continued)*

Program	Already Implemented	Evaluated	Comments
Incentives			
Rebates			
Giveaways			
Other [specify]:________________________			
Distribution-system efficiency			
Leak identification			
Meter source water			
Meter service connections			
Meter testing and replacement			
Improved water accounting			
Analysis of non-account water			
Other [specify]:________________________			

The Water-energy Nexus

Nexus* — *noun, plural nex-us-es, nex-us. *1. a means of connection; tie; link. 2. a connected series or group. 3. the core or center, or a matter or situation.*

Energy can be the largest variable and controllable cost of providing water or waste-water services to the public. Water and waste-water utilities can be among the largest individual energy users in a community. Water leakage in small utilities can vary from 10 to 60 percent. The savings from repairing a water leak, saving energy as well, could be applied to improving infrastructure. Water conservation is also a form of energy efficiency that can offer savings for energy costs.

Water, energy, land-use planning and transportation are inextricably linked in a community. All use energy, and all impact water. This water-energy nexus is where the double-benefit opportunities and double-threat risks arise. It makes sense to further the sustainable community-development process initially through your local water utility. Utilities that address their managerial self-sufficiency, financial self-sufficiency and technical self-sufficiency can systematically integrate water conservation, energy efficiency and renewable energy. Due to their structures and services, it is logical for the local water, wastewater and/or solid-waste utilities to be an entry point for the greater community to begin to look at its energy and water footprints.

Begin by first looking at your utility's distribution system as a network. The picture will possibly soon include the interconnection of a local school, church, community center, trailer park or post office with this asset network. Many of the activities within these facilities cannot take place without the supply of water and its embedded benefits. This relationship can be made explicit with the question *What things will we not be able to do if the water system is without water or power for an extended period of time?* The public will be very interested in your success in saving energy and water and protecting some activities they see as crucial. Residents may be interested in learning more about how they might save money.

Public Education and Outreach

An education or outreach program should demonstrate to water consumers that investments in water-use efficiency and conservation will provide water users with long-term savings by enabling a utility to avoid having to develop and treat new water supply sources and to develop wastewater treatment facilities. Also, the utility should highlight the environmental benefits of reducing water demands. Education programs should inform consumers about the relationship between groundwater and surface water and the potential impacts of withdrawals on in-stream uses, such as habitats for fisheries and other wildlife and water-based recreation. The focus of a water-conservation program may initially target the largest water users, user groups or the users with the greatest opportunity for water-use reduction to quickly achieve the greatest potential savings. A conservation program's benefits will then become rapidly noticeable. Public outreach and education can be approached in a number of ways.

Information and education are critical to the success of any conservation program. Information and education measures can directly produce water savings, such as when customers change their water-use habits. These savings can be difficult to estimate, however. Also, public education alone may not produce the same amount of sustained water savings as other, more direct approaches (such as leak repairs and retrofits).

Educational measures also can enhance the effectiveness of other conservation measures. For example, it is widely believed that information plays a role in how water consumers respond to changes in price. Generally, customers who are informed and involved are more likely to support the water system's conservation planning goals. The following is a list of measures for systems to use in assessing their information and education programs.

Ways that a utility or community can increase communications on water conservation:

- ☐ Sending speakers to meetings of local clubs (Moose, Elks), associations, etc.
- ☐ Water bill inserts
- ☐ Booths at fairs
- ☐ Farmer's markets
- ☐ Watershed associations
- ☐ School programs, like water activity days
- ☐ Homeowner associations
- ☐ Offer free home water audits
- ☐ Local publications (newspaper, newsletter)
- ☐ Local public websites
- ☐ Local public radio
- ☐ Physical representation of saving, like a giant thermometer
- ☐ Name water-use categories (super savers, savers, standard, wasters, abusers)
- ☐ Other___________________________

- *Understandable water bill.* Customers should be able to read and understand their water bills. A clear water bill should identify volume of usage, rates and charges, and other relevant information.
- *Available information.* Water systems should provide information pamphlets to customers on request. Public information and education are important components of every water-conservation plan. Consumers are often willing to participate in sound water-management practices if given accurate information. Providing information and educating the public may be the key to getting public support for a utility's water-conservation efforts. An information and

education program should explain to water users all of the costs involved in supplying drinking water and demonstrate how water-conservation practices will provide water users with long-term savings.

- *Informative water bill.* An informative water bill goes beyond the basic information used to calculate the bill based on usage and rates. Comparisons of current to previous usage and tips on water conservation can help consumers make informed choices about water use.
- *Water bill inserts.* Utilities can include inserts in their customers' water bills that provide information on water use and costs. Inserts also can be used to disseminate tips on household water conservation.

Water conservation incentives through rate structuring

The best water-conservation incentive is pricing for use. More and more utilities are using price as a demand-management tool. According to an AWWA survey, approximately 60 percent of the utilities in the U.S. use a conservation rate structure.[1] These rate structures are classified as:

- flat-rate or fixed-fee
- uniform rate
- decreasing block rate
- increasing block rate
- seasonal rate

Under each of these rate structures, systems have the flexibility to set different rates for different categories of customers (for example, a different rate for residential users versus agricultural users). Table 4 (page 16) describes and summarizes some of the advantages and disadvantages of the five rate structures most frequently used. Remember, there are other rate structures in addition to those listed in the table, such as priority pricing (for example, customers choose a higher rate to guarantee service), which may be more appropriate for your system.

[1]*Source: www.awwa.org/*

Determining the right rate structure for a utility

Each utility will be presented with a unique set of circumstances that it must assess prior to implementing a conservation rate structure. In general, criteria that may be helpful in evaluating the effectiveness of a specific type of water efficiency-oriented rate structure include:

- Which rate structure produces a measurable reduction in water usage?
- Which rate structure increases the awareness of resource availability by its customers?
- Which rate structure allows the utility to stabilize and predict revenue?
- What is the general public acceptance of the rate structure?
- What is the perceived equitability of the rate structure?
- What is the administrative efficiency of the proposed rate structure?

The appropriateness of a given conservation rate structure is dependent in part upon the circumstances of the particular utility. Each rate structure has advantages and disadvantages. The type of rate structure currently in place can also have an influence on the response to a conservation-oriented rate structure. For example, an immediate change from a declining block rate structure to an inverted block rate structure would likely result in large cost increases to high-volume water users but could result in lower rates to low-volume users (which collectively is the largest water user group), inducing the group of low-volume users to use more water.

Similarly, the type of customer base served by a utility is important to consider when implementing a conservation rate structure. For example, an inverted block rate structure may provide a considerable incentive for large water users to reduce their usage requirements without charging high water rates to water users with low monthly usage levels. However, in some instances, those large water users may be industrial facilities with limited options to implement substantial water conservation measures, and yet they would be paying higher water rates under the inverted rate structure. A utility should research and work with its customer base to determine the best method for achieving its water-conservation goals.

Based on your program selection from Table 3 (page 12), use Table 5 (page 17) to calculate the reduction in demand. Determine your aim. Which one of the measure/ programs reviewed in Table 3 best fits your utility and will help you achieve your goal?

Table 4: Rate Structure Classifications

Rate structure	Description	Advantages	Disadvantages
Flat-rate or fixed-fee	All customers pay the same amount each month regardless of quantity of water used.	• Easy to implement	• Everyone pays too much or too little for what they consume. • Does not promote water conservation.
Uniform rate or single block rate	Customers are charged a uniform rate per unit of water (per 1,000 gallons, per cubic feet) regardless of the amount of water used. Often coupled with a minimum monthly charge. Used in metered systems.	• Easy to administer • May encourage water conservation • Cost to the customer is in direct proportion to the water consumption	• Has the ability to discourage high-volume users
Decreasing block rate	The price of water declines as the amount used increases. Each succeeding consumption block is cheaper. Used in metered systems.	• Attractive to high-volume users	• High water consumption increases the need for waste-water treatment facilities. • Does not offer an incentive to conserve water. • Is complex to determine and administer.
Increasing block rate	The price of water increases as the consumption increases. Used in metered systems.	• Promotes water conservation • Provides a reasonable amount of water at reasonable price • May discourage high-volume use	• Requires a computerized billing system
Seasonal rate	Rates vary according to the time of year. This rate is normally used in conjunction with block rates or uniform rates.	• Promotes water conservation • Equitable for transient communities (campgrounds, seasonal communities, etc.)	• May affect high-consumption users during the time of the year when rates are highest • Revenues will most likely fluctuate

Table 5. Reduction in Demand

Line	Measure/program	Selected Program	Criteria for selecting/ rejecting the conservation measure/program	Estimated reduction in demand for selected measures/programs (gallons per day)	
				Average day demand	Maximum day demand
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
			Total:		

Planners will need to convert estimates of annual water savings to estimates of reductions in average-day and maximum-day demand for each measure or group of measures/programs.

Now take the information from Table 5 to establish your reduction in demand over the short- and long-term.

Table 6. Demand Forecast

Line	Item	Current year	Year 2	Year 3	Year 5
1.	Average-day demand before conservation				
2.	Average-day demand after conservation				
3.	Reduction in average-day demand *(line 1 less line 2)*				
4.	Maximum-day demand before conservation				
5.	Maximum-day demand after conservation				
6.	Reduction in maximum-day demand *(line 4 less line 5)*				
7.	Ratio maximum-day to average-day demand before conservation *(line 4 divided by line 1)*				
8.	Ratio maximum-day to average-day demand after conservation *(line 5 divided by line 2)*				

Gathering all this information will be counterproductive if it is not used to develop an implementation plan. The last step in the process is integrating the information, programs and/or measures identified, required action and deadlines. Using the table below, develop an implementation schedule.

Table 7. Implementation Plan

Line	Measure/program	Required action	Beginning date	Completion date	Notes
1.					
2.					
3.					
4.					
5.					

Completing all of these steps should result in a comprehensive water-conservation program to help address the needs of the utility. The water-conservation plans need to be reviewed periodically, because if the plans are used the way they are intended, water-conservation measures have the ability to improve the system's water sales revenues.

Water Conservation at the Home Owner's Level

So far, this chapter has covered how utilities can proactively work to conserve water. However, home owners also can adopt and implement water-conservation practices to help preserve fresh drinking water sources.

Drought Contingency Planning

Drought is a natural hazard that differs from other hazards in that it has a slow onset, evolves over months or even years, affects a large geographic region, and occurs in virtually all climatic zones. Its characteristics vary significantly from one region to another. Its onset and end are often difficult to determine, as is its severity.

Drought originates from a deficiency of precipitation over an extended period of time, usually a season or more. This deficiency creates a water shortage for some environmental activity of the entire environmental sector. Factors such as high temperature, high winds and low relative humidity are associated factors that can aggravate its severity.

There is a second type of drought that occurs slowly over time. Growth-induced drought is when more and more people share the same limited source of water. Growth-induced drought occurs much slower, but it never goes away.

Because droughts are a normal part of climate variability, it is important to develop a drought-preparedness plan to deal with the somewhat expected extended periods of water shortages in a timely and systematic manner. To be effective, these plans must evaluate a region's exposure and vulnerability to the hazard and incorporate these elements in a way that evolves with societal changes. Elements of this Drought Planning Manual were adopted from *The Drought Preparedness Planning: Building Institutional Capacity* (Wilhite et al., 2000), which developed a ten-step drought-planning process. Some of the steps were modified to apply to small water systems.

Drought-preparedness planning will define a process to mitigate drought impacts. A locally relevant plan will include drought conditions and ways to respond or possibly avoid droughts. Drought-response planning is an objectives-based focus on matching responses to actual conditions and preventing crisis. These objectives are accomplished through the development of drought triggers and indicators and by providing guidance on responses to drought conditions for the various sectors impacted by droughts:

1. Monitor and record data for the determination of drought conditions;
2. Determine intensity levels of drought; and
3. Develop methods and procedures to collect and distribute information, convene committees, promote water conservation and other means to encourage stewardship.

Drought-response planning provides guidance and support to various aspects of drought activities, including, but not limited to:

- establish drought-response phases based upon drought intensity levels; and
- review the Drought Management Plan every five years or after a drought event to evaluate performance as response effectiveness and long-term intensity trends for suitability.

Droughts are responsible for a wide range of potential impacts. These impacts can be categorized as social, environmental and economic. Each impact carries direct and indirect implications to the lives of your customers. Planning needs to account for individuals being affected by multiple impacts at the same time, for example: a customer's landscape watering needs will increase as the supply of water for irrigating is diminishing. Potential impacts' synergy or "perfect-storm" situations should be integrated into the planning, mitigation and response activities to help minimize the impact. A water system could find itself in the uncomfortable position of having to raise user rates at the same time austere conservation measures are implemented.

Drought-management planning process

1. Recruit a drought-planning task force
2. Provide the task force with functions
    a. Supervise and coordinate development of the plan
    b. During times of drought, when the plan is activated, the task force coordinates actions, implements mitigation and response programs and makes recommendations (policy).
3. Task force drafts plan purpose and objectives
4. Conduct a strengths, weaknesses, opportunities, threats (SWOT) analysis of the utility's ability to respond to drought
5. Identify research needs and matching existing materials
6. Check state and federal government drought policy guidance
7. Task force will draft plan
    a. Seek stakeholder participant
    b. Plan for possible conflicts created by a drought event
    c. Identify drought impacts to specific customer groups/types
8. Publicize drought plan
9. Garner drought-plan responses and adjust as needed
10. Finalize plan
    a. Get the plan into the hands of those who will be implementing the response activities (not just in your filing cabinet)

The drought contingency planning process identified above can and should be used to serve beyond its intended purpose. Due to its planning nature and the need to be revised and updated periodically, this ten-step process has the flexibility to be modified, adjusted and implemented as a climate-change adaptation measure for a specific region (county-level or multi-county level; multiple utility systems and all the way to the watershed level).

Most drought-contingency plans identify the issues and challenges specific to the utility, which are based on historical knowledge and the utilities' proven response. Unfortunately, climate change has the potential to challenge historical knowledge and most definitively has the ability to deplete existing resources.

As EPA identifies climate change on its Climate-Ready Water Utilities website, "temperature changes and resulting changes in water quality and availability contribute to a complex puzzle of climate-change challenges that have potentially significant implications for sustainability of the water sector."

EPA refers to the "water sector" acknowledging that when it comes to climate change-related issues, individual utilities cannot address them alone. The priority of a water utility is and will always remain the provision of safe drinking water to its customers. However, climate-change related issues force utilities to reach out to entities beyond their traditional operating circle; to plan and operate more vigilantly; and to carry out long-range planning in a comprehensive approach.

Outdoor water use

Outdoor water-conservation programs need to be incorporated into the city or county land-development code to provide more options. A water system's service area may fall within one or more land-development planning authorities. The land-development codes need to allow developers and builders the flexibility to incorporate water-conserving landscape designs. This can be done most flexibly by providing a system based on water conservation points per acre. Such a system will offer more landscaping choices and reward developers for conserving water. Points are awarded to aesthetic elements like outdoor art pieces, long-term water savings and sustainability.

Many existing land-development codes require builders to plant grass in landscaping strips and provide a certain number of trees or shrubs as a mandate. This "one-size-fits-all" approach ignores the fact that many people choose to work with indigenous plants.

Outdoor water use increases during spring and summer by as much as 50 percent. Landscape watering and car washing are the two main outdoor water uses responsible for this higher demand for water. This increase in water demand comes at exactly the time of year when there is naturally less water available in the environment due to warmer temperatures and plant uptake.

By implementing just a few minor changes in how home owners use water outdoors, they will find that they can maintain their existing outdoor activities using much less water. This will lower their water and electric bills and protect the environment by leaving more water in local rivers, wetlands and aquifers. In the case of lawn watering, using water more efficiently will actually improve the durability of the grass, reduce the need for chemical additives, and decrease lawn-mowing frequency.

Water-fixture rebates, retrofitting and replacement

A water utility can reduce the demand for water by assisting its residential and commercial customers with the installation of add-on devices or new water fixtures that use water more efficiently, while at the same time meeting the needs of the customer. Examples of these types of devices include water-saving toilets, drip irrigation systems, and low-flow faucets and shower heads. The advantage of water-saving devices is that the savings achieved lasts forever. The devices have an initial capital cost and require customer participation. Utilities can assist residential and commercial customers through:

- rebates or billing credits to water users who purchase and install water-saving devices
- installation of retrofitting devices by representatives of the utility at a reduced cost or free of charge in conjunction with a water-auditing program
- coordination with local communities to develop ordinances that limit outdoor water use by customers and require all new construction projects to use water-efficient fixtures
- encouraging local building inspectors to rigorously enforce existing plumbing and building codes

Water systems can promote conservation through a retrofit program. Retrofitting involves making an improvement to an existing fixture or appliance (versus replacement) to increase water-use efficiency. Retrofit programs usually target plumbing fixtures.

According to the North Georgia Water Supply and Water Conservation Management Plan[2], homes built in or prior to 1993 may contain inefficient toilets. Before the 1950s, toilets typically used 7 gallons or more for each flush. By the end of the 1960s, toilets were designed to flush with 5.5 gallons, and in the 1980s, the new toilets being installed were using only

[2] Source: "North George Water Supply and Water Conservation Management Plan, " May 2009; Metropolitan North Georgia Water Planning District, *www.northgeorgiawater.com*

3.5 gallons. Today, a new toilet uses no more than 1.6 gallons of water, and high-efficiency toilets (HETs) use no more than 1.28 gallons of water per flush. Replacing an inefficient toilet with a low-flow model will conserve water.

Water fixtures such as shower heads can also be retrofitted to conserve water. A regular shower head uses 5 gallons per minute. Low-flow shower heads use as little as 1.5 gallons per minute. Other fixtures, such as bathroom and kitchen faucets, can be converted into water-conservation devices with relative ease and minimal cost. Most faucets can be converted with a simple, inexpensive aerator that will reduce the water flow to as little as 2.5 gallons per minute or less.

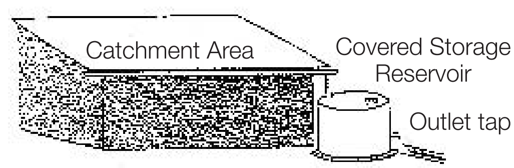
Retrofit kits available. A basic retrofit kit may include low-flow faucet aerators, low-flow shower heads, leak-detection tablets and replacement flapper valves. Retrofit kits may be available free or at cost. Visit *www.epa.gov/watersense/* for more information.

AWWA has a handy water-drip calculator to assist with such calculations[3]. Access it at *www.awwa.org/awwa/waterwiser/dripcalc.cfm*

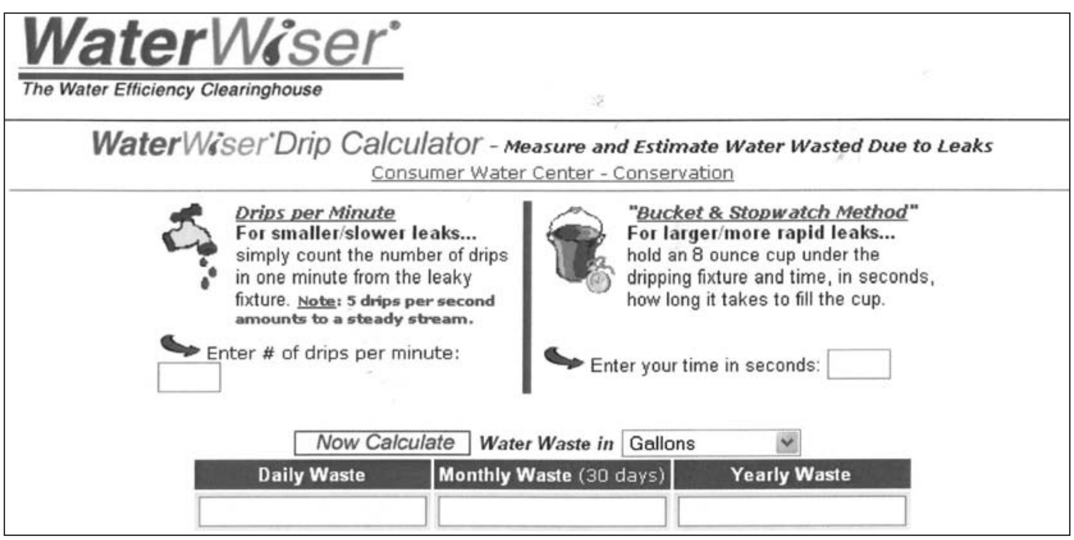
Rainwater Harvesting

Rainwater harvesting is an old idea that is popular again. The future of our nation's water supply depends, in part, on innovative approaches like this. Communities with homes that have a roof area of 2,500 square feet and a yearly average rainfall of 32 inches can expect to collect almost 45,000 gallons of rainwater per home in a typical year. Obviously, rainwater harvesting is potentially a viable method to achieve sustainable water resources.

Roof Catchment System[4]



The basic concept of harvesting rainwater is simple. It is the process of intercepting storm-water runoff and putting it to beneficial use. Rainwater is usually collected or harvested via gravity from rooftops, concrete patios, driveways and other impervious surfaces. Buildings and landscapes can be designed to maximize the amount of catchment area, thereby increasing rainwater-harvesting possibilities.



[3] WaterWiser© Drip Calculator reprinted with permission of AWWA

[4] Reprinted with permission from Global Development Research Center, Dr. Hari Srinivas, *http://www.gdrc.org/uem/water/rainwater/index.html*

Intercepted water then can be collected, detained, retained and routed for use in evaporative coolers, toilet flushing, pet and car washing, indoor plant watering, pet and livestock watering, and for lawn and garden irrigation.

Typically, roof catchment systems consist of gutters, downspouts and storage containers. Directing rainfall to plants located at low points is the simplest rainwater-harvesting system. In this system, falling rain flows to areas with vegetation. Inexpensive rainwater-storage systems commonly make use of above-ground containers, such as a barrel or plastic tank with a lid, to reduce evaporation and bar access to breeding mosquitoes. Any container capable of holding rain dripping from a roof or patio can be used in a rainwater-harvesting system.

Water-quality issues related to rainwater harvesting

Rain in urban and industrialized areas may contain various impurities absorbed from the atmosphere, including arsenic and mercury. There are areas in the country where rainwater is infrequent; the rainwater quality can be inadequate due to the accumulation of bird droppings, dust and other impurities on rooftops between rain events. These impurities may occur in high concentrations in rooftop runoff when it does rain. The best strategy is to filter and screen out contaminants before they enter the storage container.

Due to concerns surrounding microbial contamination of harvested rainwater, it is not recommended as a source of drinking water for humans. However, systems that are properly designed, constructed and maintained and that include disinfection steps have been successfully used for private domestic water supplies. Consult your local health department prior to constructing rainwater-harvesting systems.

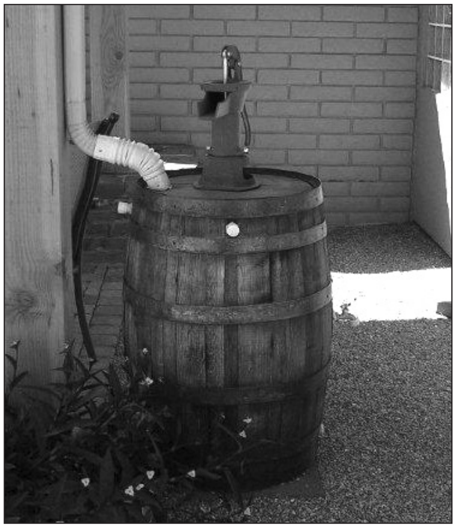
Water-rights issues concerning rainwater harvesting

In some states, diversion and rainwater use is subject to state statutes and case law. The use of water in Colorado and several other western states is governed by what is known as the ***prior appropriation doctrine***. This system of water allocation controls who uses how much water, the types of uses allowed, and when the water can be used. A simplified way to explain this system is often referred to as the priority system or "first in time, first in right."

It is recommended that before you develop a rainwater-harvesting system you check with the local building, zoning and environmental departments to determine what plumbing requirements, local restrictions, neighborhood covenants, or other regulations or guidelines exist.

Rainwater catchment has several advantages:

- Rainwater harvesting technologies are simple to install and operate.
- Residents can be easily trained to construct and operate a system.
- Home owners have full control of their systems.
- Operating costs are almost negligible.



Rainwater catchment barrel photo courtesy of Cado Daily, Water Wise Program, University of Arizona
www.ag.arizona.edu/cochise/waterwise

- Water collected from roof catchments usually is of acceptable quality for non-potable domestic purposes.
- In some areas of the country, rainwater can be a continuous source of water supply. Depending upon household capacity and needs, both the water-collection and storage capacity may be increased as needed within the available catchment area.

Rainwater catchment also involves some disadvantages, including:

- Limited supply and uncertainty of rainfall.
- Big tanks are generally aesthetically intrusive and may not meet local building-code primary water source requirements for new construction.
- Catchment systems may require more ground space than a well for storage tanks and a pumping system.
- Rainwater catchment requires a good-sized roof.
- Roofing materials and airborne pollutants can pollute the rainwater.
- Gutters require constant maintenance.
- Water quality is inconsistent.

Rainwater catchment barrel photos courtesy of Cado Daily, Water Wise Program, University of Arizona www.ag.arizona.edu/cochise/waterwise

Calculate your rainwater-harvesting potential

If you are interested in rainwater harvesting at your home, here's how to estimate annual water supply:

Collection area (sq. ft.) x Rainfall (in./yr.) / 12 (in./ft.) = Cubic feet of water per year

Cubic feet per year x 7.48 (gallons per cubic foot) = Gallons per year

For example, a 500 sq. ft. roof that gets 36 in./yr. will produce 1,500 cubic feet or 11,145 gallons of water per year.

PLEASE NOTE: This calculation is for horizontal projection areas and does not take into consideration system losses, such as evaporation or leakage.

Greywater

Any water that has been used in a home, except water from toilets, is called greywater. Dish, shower, sink and laundry water comprise 50 to 80 percent of residential "waste" water. This may be reused for other purposes, especially landscape irrigation.

(This is the definition common in Europe and Australia. Some jurisdictions in the U.S. exclude kitchen sink water and diaper wash water from their definition of greywater. These are most accurately defined as "dark greywater" or "blackwater.")

Greywater uses

It is a waste to irrigate with great quantities of drinking water when plants can thrive on used water containing small quantities of nutrients. Unlike a lot of ecological stopgap measures, greywater reuse is a part of the fundamental solution to many ecological problems and will probably remain essentially unchanged in the distant future. The benefits of greywater recycling include:

- lower fresh-water use
- less strain on failing septic tanks or treatment plants
- groundwater recharge
- plant growth
- reclamation of otherwise wasted nutrients
- increased awareness of and sensitivity to natural cycles

Greywater reuse is an increasingly accepted practice to:

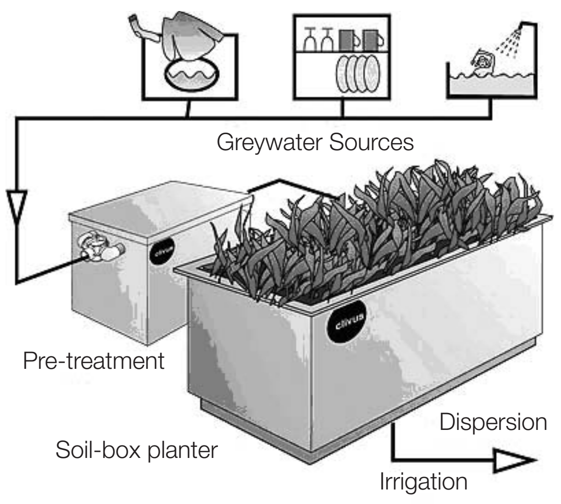
1. provide irrigation water and some fertilizer to landscapes
2. reduce wastewater loads to sewage systems
3. improve the effectiveness of on-site waste-water disposal
4. reduce pressure on limited potable-water resources in some communities, especially during drought crises

California now allows greywater systems, and various municipalities and utility districts have passed specific greywater ordinances.

The primary motivation for installing grey-water systems has been the ability to irrigate landscapes during dry seasons and times of more extreme drought. The most obvious advantage of domestic greywater use is that it may potentially replace other water used for landscape irrigation. Filtered greywater is most suitable for subsurface irrigation of non-edible landscape plants. Not only does its use on landscapes conserve treated tap water, but greywater may also benefit plants because it often contains nutrients, such as nitrogen or phosphorus.

Greywater use may offer financial savings to already overburdened municipal sewage-treatment facilities because greywater use diminishes sewer flows, thereby lowering the hydraulic loading and lessening the need to expand such facilities. The diversion of greywater does not significantly decrease the organic or nutrient loading on wastewater treatment facilities.

Greywater system[5]



[5] ©2000. Greywater illustration reprinted with permission from Carl Lindstrom; *www.greywater.com*

WATER CONSERVATION

However, diminished sewer flows may have a downside because greywater use can result in insufficient sewer flows to carry waste to the sewer plant. Another concern is that with increased use of greywater, less effluent water will be available for treatment, resulting in less reclaimed water for municipal uses and downstream appropriators.

Legalities to Consider

Programs for rainwater catchment or reuse of greywater will have impacts on neighbors. Many small, rural communities are located at the headwaters of watersheds and depend on their resources for survival, but so do other populations downstream. Watersheds are critical to economic development and environmental protection and are key to a community's long-term sustainability. For that reason, due diligence needs to be done on the potential impacts of your policies and programs to your local watershed. There are significant benefits to water and wastewater providers when they participate in watershed-based collaboration efforts. One of the major benefits is communication of current and future needs so that conflicts with neighbors can be avoided or limited. Does your water-conservation program create a benefit for more than just your customers? Are there ways for the others who benefit from your water-conservation to provide incentives for or reward your efforts? Watershed collaborations are a forum for this type of information to be shared. It is also a great way to keep up on the most current best practices on place-based issues related to water conservation.

Assessing the vulnerability of local water resources is the utility's responsibility as is the development and implementation of proper conservation measures. The same responsibility carries over to the watershed level. Spearheading the management of watersheds at the local level is a proactive approach to protecting the environment that surrounds a community and guarantees long-term sustainability.

Each state has a number of watershed associations. You can find your state's watershed associations online, usually along with maps. Greywater legality is almost always an issue for permitted new construction and remodeling, unless you are in a visionary state such as Arizona, New Mexico or Texas (and soon, Nevada, Montana, Oregon and California). Check with your local building department to determine what is permitted.

Save Water, Save Energy

Reprinted from U.S. EPA Water Sense, *www.epa.gov/watersense/water_efficiency/benefits_of_water_efficiency.html*

It takes a considerable amount of energy to deliver and treat the water you use every day. American public water supply and treatment facilities consume about 56 billion kilowatt-hours (kWh) per year—enough electricity to power more than 5 million homes for an entire year. For example, letting your faucet run for 5 minutes uses about as much energy as letting a 60-watt light bulb run for 14 hours.

By reducing household water use you can not only help reduce the energy required to supply and treat public water supplies but also can help address climate change. In fact:

- If one out of every 100 American homes retrofitted with water-efficient fixtures, we could save about 100 million kWh of electricity per year—avoiding 80,000 tons of greenhouse gas emissions. That is equivalent to removing nearly 15,000 automobiles from the road for one year!
- If one percent of American homes replaced their older, inefficient toilets with WaterSense-labeled models, the country would save more than 38 million kWh of electricity—enough to supply more than 43,000 households electricity for one month.

Rural Community Economic Development

Economic opportunities in rural communities may be limited by lack of infrastructure, distance from markets, and isolation from financial centers (capital). Along with low populations, a limited revenue base and technical expertise, these competitive disadvantages result in low wages and a higher cost of living (after adjusting for the lower cost of housing and lower return on housing) and higher rates of poverty among working families. Depending upon your location, these problems may be exacerbated because many local economies have been historically dependent on natural resources. During recent decades, opportunities in the mining, timber, fishing and agricultural industries have been diminished by increased international competition, mechanization, resource exhaustion and sensitivity to environmental protection. Such reduced opportunities keep workers who possess few transferable skills and live in communities where resources for acquiring new skills are scarce out of the workforce. Limited transportation and childcare options also reduce job opportunities. As a result, many displaced workers are forced to accept service-sector jobs with sharp decreases in income.

An economic-development strategy for small communities should not focus on building industrial parks or encouraging big businesses to relocate. Small, isolated communities require a different approach to create the jobs, income and community self-determination necessary for long-term economic self-sufficiency. Economic development in small, rural communities has to begin with investments in human capital. Another key element for sustainable rural-community economic development is creation of business ventures and jobs by local entrepreneurs and community-based organizations.

Multiplier Effect

Imagine one dollar bill circulating through a community's economy. First, someone buys a donut at the bakery. The bakery owner uses that dollar and others to pay one of the employees. The bakery employee then buys groceries at the local supermarket, using the original dollar, which is then paid to one of the employees of the supermarket. The supermarket employee uses the dollar to buy gas at a local service station. The dollar is then paid to a service-station employee, who buys home-repair materials at the local hardware store, and so on. The value of that one dollar to the community's economy was multiplied many times as it is circulated. If a community is too small to have businesses, there is no multiplier effect. Very small communities should focus on creating opportunities to start small businesses. If seed money for business start-ups cannot be accessed from outside resources, the community should consider savings realized from conservation or other sources to aid start-ups either as a revolving loan or one-time donation. Eventually the benefit will be realized for everyone once a multiplier effect takes hold.

A key principle of community economic development is to keep money circulating within the local economy as long as possible. When money takes a path outside the local economy, the multiplier effect ceases. How does money leak from the local economy? Possibilities include:

- Businesses located in the community, but owned by outside companies, sending significant portions of their proceeds outside the community to their headquarters elsewhere. This can include local utilities.
- Residents shopping in other communities.
- Local businesses buying goods or raw materials from sources outside the community.

Some rural communities are so small and isolated as to not constitute an economy in and of themselves. Residents commute to neighboring towns to work. They also must commute to larger towns to spend their money because there are no local businesses. The money that comes in and goes out of the community will benefit only individual households.

Modern economies are complex and linked in intricate ways, making it extremely difficult, if not impossible, to eliminate all "monetary leaks." Identifying and plugging leaks to the extent possible can have profoundly positive effects.

What does all of this have to do with utility systems? Utilities are also essentially businesses that impact and are impacted by the economies of the communities they serve. Utilities employ local residents, hire contractors, buy supplies, consume energy, produce waste, collect fees and engage in a host of other economic activities. Drinking water, wastewater and solid waste utilities either increase or decrease the multiplier effect and prevent monetary leakage or not.

Food for Thought

Are your water and wastewater systems operated by local residents who spend their wages in the community, or by a contractor from outside the community that sends contract payments out of your community? Is there an opportunity to switch to local ownership and control?

Economic Development Water-conservation Questions:

1. Name at least three water features in your community:
   - ☐ Lakes/ponds
   - ☐ Intermittent streams
   - ☐ Leaking pipes
   - ☐ Golf course(s)
   - ☐ Other ______________________
   - ☐ Rivers
   - ☐ Water utility
   - ☐ Big trees
   - ☐ Agriculture
   - ☐ Other ______________________

2. How might conservation related to any of these water features help to bring funding into my community? Can include education. ______________________________________

   ____

3. In my community, water-conservation jobs might include:
   - ☐ Landscape / xeriscape
   - ☐ Rancher
   - ☐ Contractor
   - ☐ Tourism
   - ☐ Farmer
   - ☐ Water-utility worker
   - ☐ Water operator
   - ☐ Water-conservation specialist
   - ☐ Other ____

4. To increase our local economy, I believe we could incorporate the following idea(s) for water conservation: ____

   ____

5. Possible partners on economic development related to water-conservation in my community include:
   - ☐ Soil and conservation service
   - ☐ Local water utility
   - ☐ Chambers of commerce
   - ☐ State conservation agency
   - ☐ Other ______________________
   - ☐ Water operator
   - ☐ U.S. Department of Agriculture
   - ☐ Council of governments
   - ☐ Other ______________________
   - ☐ Other ______________________

Additional Information

If you have any questions about implementing a water-conservation program, contact the regional partner in the Rural Community Assistance Partnership network for your state. See the inside back cover of this guide for contact information.

Reference documents are available from various websites to assist with the implementation of water-conservation programs.

Resources

Amazon.com water-conservation policy books
www.amazon.com/Soil-Water-Conservation-Policies-Programs/dp/0849300053

American Water Works Association (AWWA) bookstore
www.awwa.org/Bookstore/

The following are helpful AWWA publications that are offered through the AWWA bookstore:

- *Water Audits and Leak Detection*, 1999, M36
- *Leaks in Water Distribution Systems*, 1987, 48 pp., Order No. 20236
- *Leak Detection and Repair*, VHS, 16 minutes, Order No. 65112
- *Water Meters—Selection, Installation, Testing and Maintenance* (M6), Order No. 30006
- *Sizing Water Service Lines and Meters* (M22), 1975 112 pp., Order No. 30022
- *Flowmeters in Water Supply* (M33), 1989, 40 pp., Order No. 30033
- *Automatic Meter Reading for the Water Industry*, 1992, 358 pp., Order No. 90594
- *C700-95 Cold Water Meters—Displacement Type Bronze Main Case*, Order No. 043700
- *C701-88 Cold Water Meters—Turbine Type*, *for Customer Service,* Order No. 043701
- *C702-92 Cold Water Meters Compound Type*, Order No. 043702
- *C703-96 Cold Water Meters Fire Service Type,* Order No. 043703
- *C704-92 Propeller Type Meters for Waterworks Applications*, Order No. 043704
- *C706-96 Direct Reading Remote Registration Systems for Cold Water Meters*, Order No. 043706
- *C707-82(r92) Encoder Type Remote Registration Systems for Cold Water Meters*, Order No. 043707
- *C708-96 Cold Water Meters Multi Jet Type*, Order No. 043708

AWWA free water-audit software
www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48055

AWWA presentation on water-conservation strategic planning from the M52 Manual, February 2006, AWWA Water Sources Conference, Albuquerque, N.M.
www.awwa.org/waterwiser/references/pdfs/PLAN_PROG_Maddaus_L_Highlights_from_WCDs_AWWA_Manual_M52.pdf

AWWA WaterWiser program
www.waterwiser.org

British Columbia water conservation strategy
www.env.gov.bc.ca/wsd/plan_protect_sustain/water_conservation/wtr_cons_strategy/toc.html

California Department of Water Resources, water-use efficiency publications
www.water.ca.gov/wateruseefficiency/publications/

Florida, instructions for completing a water district water audit, 17 pages
www.sjrwmd.com/rules/pdfs/40C205902.pdf

Georgia Department of Natural Resources, Environmental Protection Division, Water Conservation Plan, state outline
www.gaepd.org/Files_PDF/forms/wpb/munwconsplan.pdf

Guidelines for landscaping irrigation
www.zone7water.com/index.php?option=com_content&task=view&id=62&Itemid=265

Landscape conservation
www.californiagreensolutions.com

Massachusetts water audit forms and worksheets
www.mass.gov/dep/water/approvals/wmgforms.htm

Massachusetts, water audit guidance document and forms, 5 pages
www.mass.gov/dep/water/approvals/guidance.pdf

Massachusetts, water conservation overview, includes tools and resources for water wise community, examples of city plans and checklist formats
www.ipswichriver.org/resources/water-conservation-resources

Massachusetts Water Resources Authority: Conservation issues
www.mwra.com/04water/html/wat.htm

North Carolina Division of Pollution Prevention and Environmental Assistance
www.p2pays.org

State of Washington water audit and leak detection site, good examples and forms
www.mrsc.org/Subjects/Environment/water/wc-measures.aspx#Leakdetect

U.S. Environmental Protection Agency (USEPA) document on case studies on water conservation, 54 pages, includes Albuquerque, N.M.; Ashland, Ore.; Cary, N.C.; Gallitzin, Pa.; Gilbert, Ariz.; Goleta, Calif.; Houston, Texas; Irvine Ranch Water District, Calif.; Massachusetts Water Resources Authority; Metropolitan Water District of Southern California; New York City; Phoenix, Ariz.; and Santa Monica, Calif.
www.epa.gov/watersense/docs/utilityconservation_508.pdf

U.S. Environmental Protection Agency's (USEPA) WaterSense partnership program
www.epa.gov/watersense

WATER CONSERVATION

References

Gould, J.E. *Rainwater Catchment Systems for Household Water Supply*, *Environmental Sanitation Reviews*, No. 32, ENSIC, Asian Institute of Technology, Bangkok, 1992.

Gould, J.E. and H.J. McPherson. *Bacteriological Quality of Rainwater in Roof and Groundwater Catchment Systems in Botswana,* Water International, 12:135-138, 1987.

Landcaster, Brad. *Rainwater Harvesting for Drylands and Beyond*, Rainsource Press, 2006.

Nissen-Petersen, E. *Rain Catchment and Water Supply in Rural Africa: A Manual*. Hodder and Stoughton, Ltd., London, 1982.

Pacey, A. and A. Cullis. *Rainwater Harvesting: The Collection of Rainfall and Runoff in Rural Areas*, WBC Print Ltd., London, 1989.

Schiller, E.J. and B.G. Latham. *A Comparison of Commonly Used Hydrologic Design Methods for Rainwater Collectors*, Water Resources Development, 3, 1987.

UNEP [United Nations Environment Programme]. *Rain and Storm Water Harvesting in Rural Areas*, Tycooly International Publishing Ltd., Dublin, 1982.

Wall, B.H. and R.L. McCown. *Designing Roof Catchment Water Supply Systems Using Water Budgeting Methods*, Water Resources Development, 5:11-18, 1989.

Water Efficiency Magazine, *www.waterefficiency.net*, the journal for water-resource management. The website has an archive of past issues dating back to 2006.

RCAR

NOTES

ENERGY EFFICIENCY

NOTES

Chapter 2
Energy Efficiency

Sustainability

Reasons to Improve Energy Efficiency

Why is your community considering improving energy efficiency for your utility/facility?

If you can define the reasons that will motivate your energy-efficiency program, you can set more effective energy-efficiency goals. When something has as many possible options as are available with energy efficiency, knowing why you are doing it can help you decide how to do it best. For example, if you just want to save money, then you can evaluate all options solely upon an investment-to-savings ratio. This will allow you to purchase accordingly to maximize capital return. However, some of your selections may require very complicated operational skills or lots of maintenance.

Major stakeholders should agree upon your reason or reasons to improve energy efficiency. Majority agreement is not necessary; however, at least a consensus should be achieved. Consensus is reached when all participants can say, "I may not like this option, but I can live with it." Who are the parties that might need to agree upon your energy-efficiency goals?

A team approach to incorporating energy efficiency can create durable decisions and segue to adoption of the agreed-upon actions.

Possible stakeholders:

- ☐ Neighbors of the facility
- ☐ Regulatory agencies
- ☐ Investors
- ☐ Power supplier
- ☐ Funding agencies
- ☐ Customers
- ☐ Utility staff
- ☐ Utility management
- ☐ Board of directors
- ☐ Efficiency equipment supplier

You can use the checklist below as a survey to gather the opinions of different stakeholder groups, as a discussion point to start a dialog, or as criteria to rank possible options. Ask individuals or groups to complete the survey and return it. You can even do the survey as a series of quick phone calls. You can then compile the survey results and see if there is an existing consensus or if consensus-building needs to be conducted. The important thing is to understand and share why you are doing it before getting started to reduce or avoid conflict later in the planning stage.

Energy-efficiency Readiness Survey Checklist

Check the reasons for energy efficiency that interest and motivate you:

- ☐ **Create political capital:** Provide a public display of your financial and environmental leadership and/or stewardship
- ☐ **Save money:** Pass savings on to customers both now and in the future
- ☐ **Lower electric bill:** Buy fewer kilowatt hours or reduce the price per kilowatt hour by using more off-peak power
- ☐ **Increase financial stability:** Reduce the percentage of your expenditures spent on energy, which is a variable cost
- ☐ **Capture a competitive advantage:** Deliver better or more service using the same or less energy
- ☐ **Economic development:** Convert energy-consuming automations into local green jobs
- ☐ **Increase equipment life:** Preserve equipment by running it at reduced or steady loading
- ☐ **Increase emergency-response capacity:** The less energy you use, the less you need for an emergency
- ☐ **Climate-change concerns:** It's the right thing to do. It's a moral issue. It protects the planet. It lessens your carbon footprint. Join the "green" movement.

Survey results can be used to group similar interest collaborators into a relevant aspect of your energy-efficiency project/program.
The survey results can also be used for public education and outreach. Just asking about all of the different benefits of energy efficiency may educate the survey taker to unknown benefits. Survey results also can be used to identify areas where more intensive outreach and social marketing efforts are needed. This outreach and social marketing does not have to be completed before the project is started. It can be strategically placed within the project. Energy-efficiency events and programs can leverage your resources. For example, an energy-efficiency expert can give a public presentation while on the same site visit to conduct an audit or investigation.

Fostering Solutions

Energy efficiency can incorporate or build upon existing successes. For example, regionalization efforts are full of energy-efficiency opportunities. Regionalizing is when geographically close communities share resources. Regionalization is often enacted to increase utilities' sustainability or reduce future costs. The connection to energy efficiency is not always explicit in these cases. The efficiency increase of regionalization projects and programs is normally thought of as "economies-of-scale" benefits. Economies of scale are normally realized by an increase in units produced, which is applied to a fixed cost. Energy is a variable cost, so economies of scale may not have a direct influence. However, energy efficiencies can be created in various ways, including:

- reduction of redundant energy uses like heating/cooling of office space — there is one office rather than several offices
- ability to respond only as needed — a single, small utility cannot afford to keep all of the possible equipment sizes needed to respond to emergencies like breaks in the lines. Therefore, equipment is oversized for the worst-case scenario. The oversized equipment is even used for smaller emergency events because a smaller alternative is not available.
- bulk purchasing creates energy savings in the transportation of materials
- increased spare stocks create energy savings in the transportation of personnel and equipment

Involvement in regionalization projects and programs does not imply increased energy efficiency for everyone. However, it can produce efficiency for the collective whole. A useful approach to regionalization is asking the question: *What can we share?*

Regionalization is not a single project or program approach. Some forms of regionalization that also can increase energy efficiency are:

- Aggregation: combining smaller systems together into one larger entity
- Collaboration: working together for win-win solutions
- Mutual aid: agreeing to assist each other when needed to increase resource efficiency
- Partnership: combining smaller systems and keeping individual identity

Agree upon how to create energy efficiency

Energy-efficiency considerations

Energy efficiency is not all about gains. It has both costs and benefits. Well-informed decision-makers need to consider both the costs and benefits. There are two basic types of costs for energy efficiency. One cost is the required investments of money, time, personal energy and more. The cost and benefits of multiple options can be compared using "life cycle analysis." Life cycle analysis compensates for the time value of money for the initial investment, the ongoing operation costs, the ongoing maintenance costs, the recovery value and the expected useful life. Compare multiple options by adjusting for the time value of money.

The second cost is exposure to risks like the risk of service interruption or failure. The costs associated with the risks include causing damage, lost revenue, broken trust and not living up to expectations. The risk can be measured in both probability of specific events and potential importance for spoiling customer goodwill required for future projects. The risks will not be the same for all utilities, so the best way to look at risks is to list the possible risks and then categorize them as *likely to happen*, *possible* and *not likely to happen*. Each risk should also be categorized as *very important*, *somewhat important* or *not important*. Risks can then be ranked in the order that they should be addressed or mitigated. Risks that are likely to happen and are very important deserve attention first. Risks that are not likely to happen and are not important do not deserve attention. You will not have the time or resources to mitigate all of your risks, so you should address only a few of the highest-ranking risks. Some individuals are much more risk-averse than others. An explicit process for discussing risk allows a group to create consensus on how to proceed. This will reduce future conflict in the process of managing change to create energy efficiency.

The discussion of risks is best undertaken by a small group of participants from different disciplines or backgrounds. The range of opinions that a group can provide will help build sensitivity for different tolerances to risk exposure. You may wish to recruit volunteers just for this one activity or recruit them for the entire energy-efficiency planning process. Planning experience in energy efficiency is an asset that will be useful for them to use in other organizations.

No matter what the decision on energy-efficiency efforts, **a utility should never skip the planning and research process** and simply implement renewable energy projects. Energy efficiency eliminates wastes and maximizes the value of energy resources. Use of renewable energy sources is not a substitute. Maximizing future financial performance and sustainability will require both energy efficiency and a transfer to renewable sources.

Table 8. Sample Risk Table

Risk	Possibility			Importance		
	Likely to happen	Not likely to happen	Will not happen	Very important	Somewhat important	Not important
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						

Activity

Invite a diverse group of volunteers to your meeting. People and professions you might wish to include:

- ☐ Engineer
- ☐ Operation technician
- ☐ Management
- ☐ Building trades
- ☐ Social sciences
- ☐ Accountant
- ☐ Other shareholders who might be exposed to some portion of the risk

Table 9. Sample Risk Assessment for Energy Efficiency

Option being reviewed:						
Date:						
Possible problems	Mark just one option			Mark just one option		
	Probability it will happen			Importance to you		
	Likely to happen	Possible	Not likely to happen	Very important	Somewhat important	Not important
Installation funding is not available						
Requires large initial investment						
Lots of unforeseen additional costs						
Operational costs are higher than expected						
Replacement parts are very expensive						
Other cost increases are greater than the energy savings						
Time to recover investment through savings is too long						
It doesn't work						
It performs poorly or does not match manufacturer's claims						
It is not compatible with other existing equipment						
It creates a bad smell						
It makes a loud noise						
It makes a by-product that is difficult to properly dispose of						
Equipment complexity is beyond operator's capacity						
Technical support is not available						
Maintenance support is expensive						
Maintenance support is hard to access						
It is difficult to maintain						
Other issue:____________________						
Other issue:____________________						

This sheet can be used for a point-by-point discussion outline, or each group member can complete his/her own sheet and a tallied result is produced. During the latter, if a large difference appears in the individual responses, some consensus discussion may be needed.

Current energy use

Determine the areas in which your organization can make improvements. You may want to go after those things that are easiest or least expensive to implement. Another possible strategy is to focus on options that will give the greatest return on the investment. This latter group is normally best integrated during system improvements, expansions and modernization projects. Measure energy consumption in each area to most accurately predict benefits. You do not need to begin a large project by measuring all aspects of energy consumption.

Areas of energy consumption include:

- aeration
- filtration
- disinfection
- pumping
- cleaning
- emergency energy supply
- excavation
- system repairs
- heating water
- geating buildings
- cooling buildings
- instrumentation/controls
- communications
- lighting — indoor and outdoor
- transportation of equipment
- transportation of materials and supplies
- transportation of personnel

Then, graph current energy use in the different areas where you use energy (see graph on page 41, and visit the EPA's Energy Star Manager to begin using the free tool). Energy use should be documented and graphed over time. There will be some seasonal fluctuations. There will be trends over time. Possible trends include slow increases, quick increases, remaining constant or decreases. These trends are important to long-term goal setting. For example, do you want to prevent future increases or slow the increase? It is suggested that you chart the actual quantities used as well as the money expended. The graphing should show usage over time, so graph the last few years of usage, if possible.

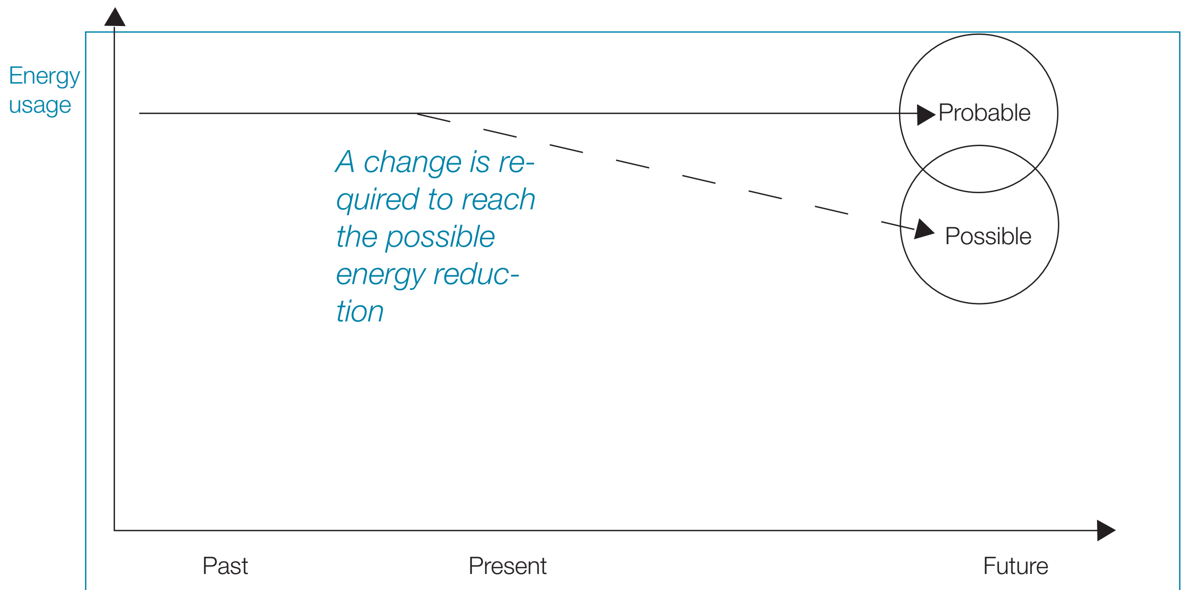
By drawing a graph, you can easily make comparisons over time to show actual savings realized by your efforts. This also will alert you if any big spikes or drops occurred. Your team can then investigate to see if the cause can be determined. These events might prove to be some of the low-hanging fruit of energy efficiency. ***For example, if the energy used for one well dropped when a new, more efficient pump was installed, you could conclude that updating similar pumps at other wells will produce the same sort of savings.***

Evaluate the following uses of:

1. Electricity for
    - Pumping
    - Lighting
    - Heating
2. Natural gas for
    - Heating
    - Vehicles
3. Gasoline/diesel for
    - Vehicles
    - Emergency pumps
    - Equipment

ENERGY EFFICIENCY

Energy Use Over Time



See Chart of Energy-efficiency Measures, page 42

Amount: baseline units of measure

The most basic measure used to compare different types of energy is the British Thermal Unit (BTU).

BTU Content of Common Energy Units[1]

1 barrel (42 gallons) of crude oil = 5,800,000 BTU

1 gallon of gasoline = 124,000 BTU

1 gallon of heating oil or diesel fuel = 139,000 BTU

1 cubic foot of natural gas = 1,028 BTU

1 gallon of propane = 91,000 BTU

1 short ton of coal = 20,169,000 BTU

1 kilowatt hour of electricity = 3,412 BTU

Comparison of alternatives is best conducted by using the same unit of measure. For example, price per BTU can be use-cost versus benefit for energy efficiency as compared to development of new energy sources. Noting that utility bills are rising or falling is not specific enough to make these comparisons. If the electric bill is rising, it may be rising electric prices, an increase in the number of customers served, a short somewhere in the wiring or installation of new equipment. Investigation into the cause can be aided by good baseline energy-usage data.

Energy consumption per customer can be very valuable data for equitable rate setting. For example, a small drinking water system knows the energy consumption per customer before a new uphill customer is connected to the system. If connecting the new customer greatly impacts the system's energy usage, this cost can be tracked and assigned to the new user, rather than being passed on to the existing customers.

Location: distribution alternatives

Distributed energy is used or stored physically near the point of generation. Distributed energy can be three times as efficient in remote, rural settings. Small, rural utilities should include consideration of distributed power along with traditional power sources. This is most efficiently done during the feasibility investigation phase of system construction, upgrades or expansion.

[1]Source: Energy Information Administration, Official Energy Statistics from the U.S. Government *www.eia.doe.gov/basics/conversion_basics.html*

Energy Efficiency Measures Chart

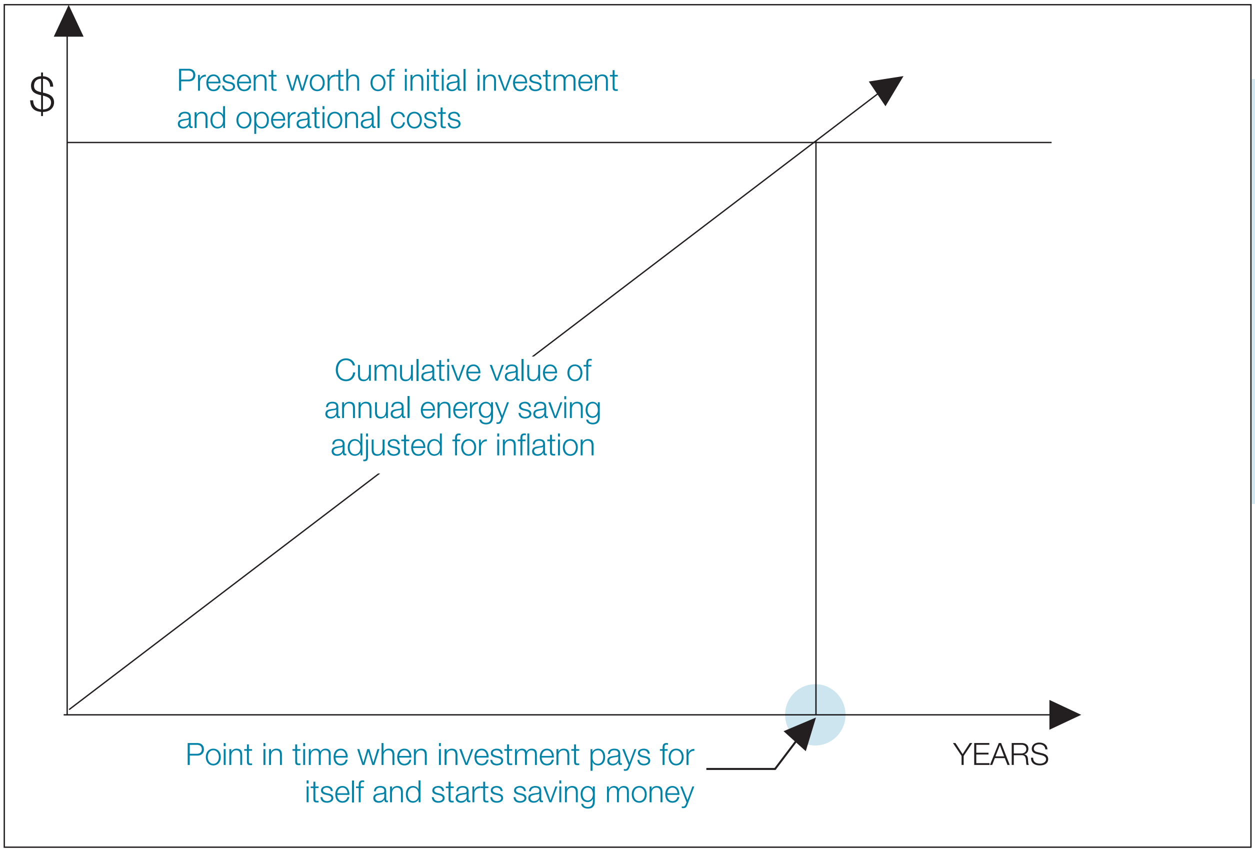
		Application	Benefit	Availability
Building heat	Passive solar building design			
	Geothermal heat pump			
	Increased wall and ceiling insulation			
	Programmable thermostat			
	Lowering room temperature in winter			
Building insulation	Increased insulation			
	Structural insulated panels			
	Blown-in foam			
	Low-emissivity windows			
Lighting	LED lighting indoors			
	LED lighting outdoors			
	Solar/wind powered street lights			
	Fluorescent lighting			
	Motion-detector operated lighting			
	Skylight			
	Solar/wind security lights			
	Solar landscape lights			
	LED landscape lights			
	Window orientation to maximize light			
Meters	Visual read			
	Radio transmitter			
	SCADA			
Personnel transport	Bicycles			
	Fuel-efficient cars			
	Fuel-efficient pickup trucks			
Water pumping	Variable-speed pumps			
	Increased pipe size			
	Smooth pipe			

Distributed energy sources have several energy-efficiency advantages:

1. They can save on infrastructure costs, such as long transmission lines.
2. Such sources save on energy losses in transmission wires.
3. They save on energy losses when converting voltage.
4. They make strategic implementation of renewable sources cheaper.
5. They keep dollars in the local community.
6. They can provide power during large system failures without the use of an emergency source.

Energy-efficiency Costs versus Benefits

Energy-efficiency goals reflect energy cost savings over time and provide a way to measure when the initial investment will pay for itself.



Calculation

Annual savings = annual energy cost reduction – annual operation and maintenance costs required

Cost/(annual savings adjusted for inflation) = years required to recover investment

ENERGY EFFICIENCY

Life-cycle cost

What is life-cycle cost?

Life-cycle cost is the present worth of all costs and revenues over the full life span of the specific project option being analyzed. Remember that different components within the same project will have different life spans. Life-cycle analysis converts these differing costs over different lengths of time to annual costs so that you can compare options with different life spans.

Life-cycle cost analysis of alternatives is a service that engineering firms provide.

Life-cycle cost analysis elements:

- initial costs
- periodic costs
- periodic revenues
- salvage value at end of useful life
- useful life

Time Value of Money

The value of money changes over time. For example, during consistent 5 percent inflation, $100 today will be worth $105 in one year, and it will be worth $127.63 in five years at 5 percent per year (compounded annually).

Present worth

The time value of money also works backwards:

- For example, still assuming 5 percent inflation, $127.63 in five years is worth $100 today.
- This is called "present worth."
- So a $127.63 cost in five years has a present worth of $100.

Calculating annual costs as a present-worth cost

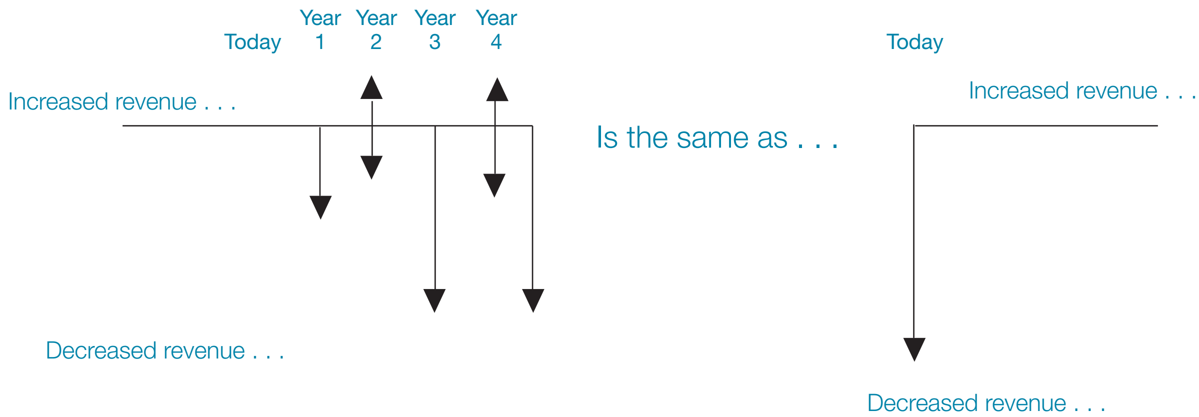
Annual costs can also be represented as a present-worth cost:

- $100 per year for five years is the same as $432.94 today (at 5 percent)

Figuring Costs and Revenues as a Present Worth

This calculation allows you to figure all costs (and revenues) on a common basis.

$$\frac{(\text{Annual Cost})\,(1+i)^n-1}{i(1+i)^n} \qquad \text{Present Worth}$$



Calculation of present worth

Equations

P= present worth, i= interest rate and n= period in years

- Convert future cost to a present-worth cost

  $P = (\text{future cost})\,(1+i)^{-n}$

- Convert annual cost to present-worth cost

  $$P = (\text{annual cost})\,\frac{(1+i)^n - 1}{i(1+i)^n}$$

Replacement: Remaining life of existing assets

Infrastructure that is already in place has a remaining useful life. Assets that do not have much useful life remaining are the right place to apply energy efficiencies that can reduce the energy implementation costs. For example, if a piece of equipment is expected to operate only five more years before being replaced, it may be a better candidate than another piece of the same equipment that will not need to be replaced for another 20 years. You would sacrifice five years instead of 20 years of remaining useful life.

Energy Audits

An energy audit is an assessment of the local water and wastewater utility operations and the energy used. The audit is basically to help a small utility reduce its energy costs, to improve reliability and performance. The utility's assets are evaluated through a look at energy consumption and ways to become increasingly efficient. Deciding if you need to perform an energy audit can be as simple as looking at the amount of money you spend on electricity each year. If this amount is significant in relation to your other expenses, then an audit is in order.

For a small water utility, the audit process might include the well or pump house, all associated buildings, and distribution lines, storage tank, etc. Often, the infrastructure in small communities is basic and includes only submersible pumps, wall heaters, incandescent lights, and chlorinator pumps. Sometimes the physical configuration of infrastructure, such as distribution lines and storage tanks, does not have a direct bearing on energy use like a pump does, but causes energy inefficiency in the pump house. Electrical operations are often confined to just a pump house or vault. This relationship between energy used and water is the water-energy nexus and can occur anywhere in the system with an energy-consumption manifestation in the pump house.

Active-mixing technology in a distribution system tank eliminates the need to deep-cycle water to maintain fully mixed conditions, which in turn eliminates extra energy load. For example, consider a single 2-million gallon tank that usually has 10 percent of its volume deep-cycled daily to promote mixing. With active mixing and assuming system pumps operate at a total dynamic head of 150 feet, a pump mechanical efficiency of 80 percent, and a motor efficiency of 90 percent, it is estimated up to 48,000 kilowatt hours per year in pumping energy and associated carbon emissions could be eliminated. [2]

[2]Reprinted with permission: *Opflow*, "Sustainable Operations: Mix it up and go green," Volume 36, No. 1, January 2010

There are many variations on the results produced during an energy audit. The variations can be significant in quality, cost and content. Particularly for small community systems, energy audits are less defined than for much larger systems. Check with your electricity provider to see what options and cost ranges are available. You will want to match the sophistication of your audit to the complexity of your energy-use patterns. See the two energy-audit case studies in the appendix from Ohio on the small communities of Salineville (page 112) and Cadiz (page 114).

Most energy audits begin with your electric-utility billing records for at least one year. The actual audit looks at your energy usage and the process. The report should include recommendations for:

- facility improvements
- reduced costs of operation
- energy-use benchmarking
- potential funding options, rebates, incentives

possible renewable-energy options

Increasing energy efficiency is one of the most effective ways to reduce costs and improve environmental performance.

Best practices-oriented audits that are specific to small communities are only now becoming available. Planning monies have not been available for small-community public utilities to take advantage of state or federal dollars, and the local electric-utility rebates and incentives for energy audits are usually based on paying for everything up front and receiving the rebate much later. Although access to rebates and incentives is changing for small-community utilities, very few to zero small-community water and wastewater systems have been able to take advantage of these rebates. With 85 percent of America's water and wastewater utilities being small systems, this is now considered low-hanging fruit, ripe for energy-efficiency measures. Ask your electric-services provider what programs, rebates and incentives it might have for small-utility energy audits.

With energy-audit information in-hand, the process can be expanded into an energy-management plan. This includes asset management, capital-improvement plans, and alignment with the state intended-use plans. EPA is expected to showcase a series of pilot energy-management plans for small communities.

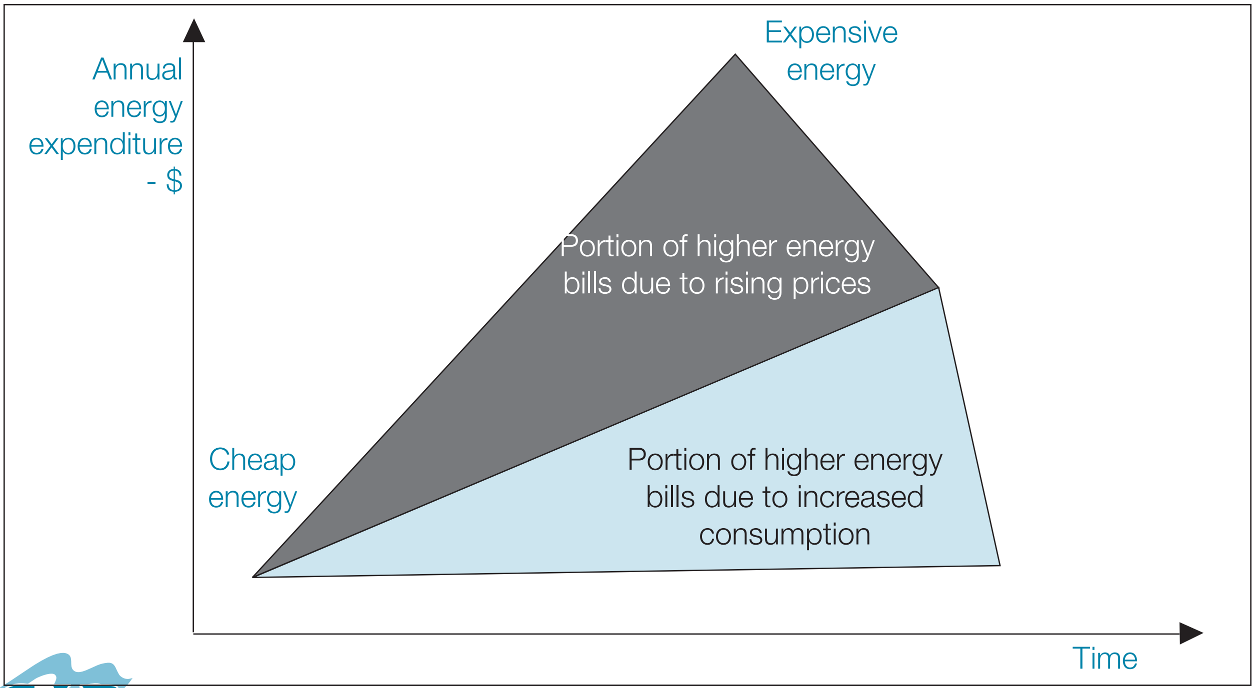
Reduction

Energy-intensity reduction and energy efficiency can be achieved through plan, implement and check (PIC) cycles. Energy intensity is the amount of energy used per unit of work produced. In lay terms, you decide what to do, do it, and then check to see if what you hoped would happen actually occurred. This could be as simple as writing and approving new operational policies and procedures. With this cyclical process, you we can focus on energy use with minimum increase to the current workload. We then plan ways to make positive changes that get the most out of every dollar spent on energy.

However, no matter how good the planning phase is, it will have no value until things actually get done in the implementation phase. Then this process should become a learning opportunity in the check phase. The checking should involve regular review that allows for gradual shifts and fine tuning rather than large-scale pass/fail evaluations. Regular review and small corrections let you do more of the things that work well and stop doing the things that do not work. You may be pleasantly surprised at how this effort takes on a life and forms a culture of its own within your utility.

Utilities can document the changes in their energy costs over time. However, measuring an increase or decrease in your energy bill is not going to be accurate enough to create an energy-efficiency program. For example, chances are that you are now paying more per year for gasoline in your automobile. The increased amount you are paying is most likely not only because of gas-price increases. The average American driver drove twice as many miles in 2003 as he or she did in 1973. So, even if gas prices had not increased from 1973 to 2003, the average American would be paying twice as much per year for gas.

Therefore, you will need to track the amount of energy used, recaptured or lost, rather than simply the amount paid. Today, American industry loses one out of every three units of energy consumed to nonproductive by-products, such as dissipated heat. Preventing energy loss or developing systems of energy reuse are often much more cost-effective and sustainable than simply supplying those bad habits with clean or alternative energy.



How energy efficiency applies to your water, wastewater or solid waste utility

To determine how to apply energy efficiency, you need to understand where and how energy is currently being used. The electricity needed to pump water can be the single highest energy cost for very small water systems using wells. The electricity to pump and aerate wastewater is significant. The fuel to collect and transport solid waste also is a significant contributor to the service expense.

Challenges and barriers relevant for your utility

Challenges and barriers can best be handled by brainstorming strategies for success. Check the list of challenges and barriers, and list any others that might come to mind.

Next, prioritize the list according to the probable challenges and barriers that will cause the most disruption in the implementation of an energy-efficiency program. Review this list with your group, starting with the top-ranked challenge/barrier, then brainstorm solutions. As new topics are covered, creative strategies may surface. Feel free to keep multiple topics open to allow ideas to build on each other. Designate a recorder to list each challenge on a board or flip chart where the entire group can see it and work together to list strategies to overcome the challenges.

Strategies for Success

Barrier and risk aversion to investing in energy efficiency

List of challenges and barriers
(check as many as apply)

- ☐ Everyone is already too busy
- ☐ Experience of a past energy-efficiency project failure
- ☐ Finances do not allow for anything but the most essential of projects
- ☐ General difficulty to take on and implement new projects
- ☐ Have not kept current on the industry's energy-efficiency improvements
- ☐ High staff turnover that prevents implementing long-term improvements
- ☐ Inadequate technical capacity
- ☐ Just completed a large project that didn't include energy efficiency, so backtracking and changing things will not be welcomed
- ☐ Lack of refinement in operations toward efficiency
- ☐ No tradition of seeing value in energy efficiency
- ☐ Not able to find energy-efficiency advisers with relevant small-system experience
- ☐ Not enough political will to overcome possible opposition
- ☐ Poor previous advice or design from professional consultants who did not include energy efficiency
- ☐ Prejudice that energy efficiency is in the "other" political camp
- ☐ Project is so small that the initial investment will cause a large jump in customer rates
- ☐ Unaware of the benefits of energy efficiency
- ☐ Unwillingness of others to change practices or beliefs about energy efficiency

Save the flip charts, and assign someone to type them up to distribute at a future meeting.

Goals, objectives and targets

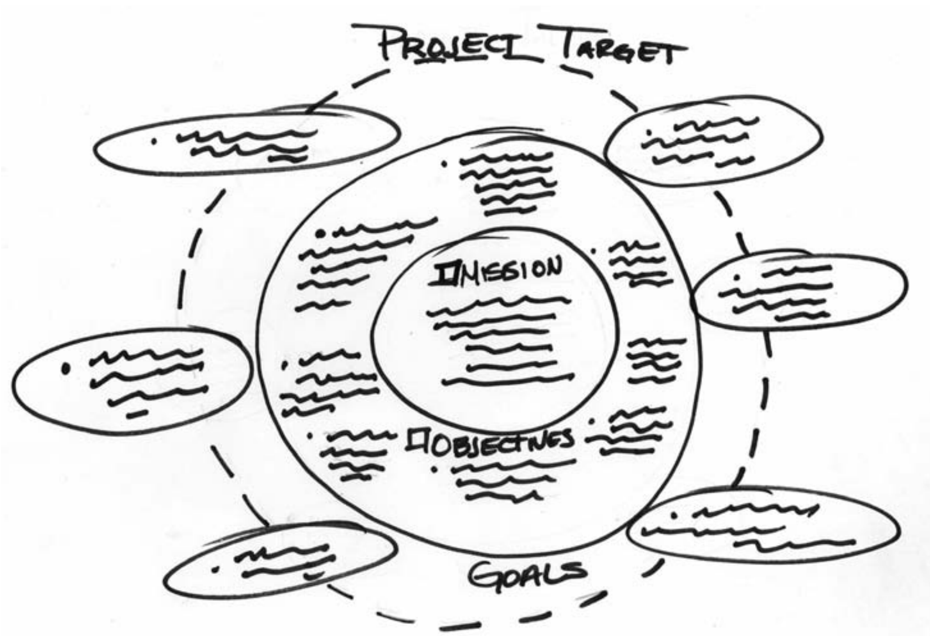
Goals and targets need to be challenging and meaningful. Goals in an energy-efficiency program or project are needed to build consensus for the reasons to systematically work toward energy conservation. You may recruit multiple energy conservation partners. If each partner has a unique motivation or desired outcome, this may create conflict during the project's implementation. Goals are also needed so that you have a way to monitor progress and a reason to celebrate accomplishments. If you are already doing a great job with energy conservation, it may be very difficult to reduce power consumption by 20 percent. However, if you have never practiced energy conservation at all, that goal might be very easy to reach. When you make goals explicit, you can build consensus for your energy-conservation reasons. Stakeholder knowledge of your energy-conservation reasons make planning future programs and projects much easier.

Energy Star[3] and Leadership in Energy and Environmental Design (LEED)[4] provide energy-efficiency goals, such as to:

- save money
- stabilize expenditures
- create groups of possible objectives/targets
- demonstrate leadership vision
- demonstrate resource stewardship
- create sustainability
- create jobs
- prevent climate change

There may be multiple ways to achieve each objective or target. A matrix of possible strategies to reach each objective can be very useful. The matrix also should contain possible and probable barriers to reaching the objective.

(See Table 10, page 50: Objective/Strategies/Action Grid for a template.)



Beyond this guide, see "Toward a Sustainable Community: A Toolkit for Local Government" for a formal process on visioning, defining and achieving conservation goals. Information on this toolkit is included in the resources at the end of this section.

Illustration by Olga Morales, RCAC

[3] Source: *www.energystar.gov/index.cfm?c=tools_resources.bus_energy_management_tools_resources*

[4] Source: *www.usgbc.org/DisplayPage.aspx?CategoryID=19*

Table 10: Objectives/Strategies/Actions Grid Template

Objective/Target	Strategies	Actions	Resources
A.	A.	1.	1.
			2.
		2.	3.
			4.
	B.	1.	1.
			2.
		2.	3.
			4.
	C.	1.	1.
			2.
		2.	3.
			4
B.	A.	1.	1.
			2.
		2.	3.
			4.
	B.	1.	1.
			2.
		2.	3.
			4.
	C.	1.	1.
			2.
		2.	3.
			4
C.	A.	1.	1.
			2.
		2.	3.
			4.
	B.	1.	1.
			2.
		2.	3.
			4.
	C.	1.	1.
			2.
		2.	3.
			4.

NOTE: This sheet can be enlarged from 8.5 x 11 to 24 x 36, as a black and white copy. Some copy shops will charge less than $1 for this service.

Type-Alternatives
Areas of Improvement

Type of technology	Option	Potential savings in energy units	Protected monetary and resource cost	Resources required to support this choice	Additional information
EXAMPLE	*Variable speed pump*	*$.50/1000 gal.*	*$5000/yr*	*$12,000*	*Available locally*
Pumping	Option 1				
	Option 2				
	Option 3				
Heating water from freezing	Option 1				
	Option 2				
	Option 3				
Heating buildings	Option 1				
	Option 2				
	Option 3				
Filtering	Option 1				
	Option 2				
	Option 3				
Aerating	Option 1				
	Option 2				
	Option 3				
Disinfection	Option 1				
	Option 2				
	Option 3				
Chemical feed	Option 1				
	Option 2				
	Option 3				
Mixing/settling	Option 1				
	Option 2				
	Option 3				
Dewatering	Option 1				
	Option 2				
	Option 3				
Emergency energy supplies	Option 1				
	Option 2				
	Option 3				

Type of technology	Option	Potential savings in energy units	Protected monetary and resource cost	Resources required to support this choice	Additional information
Head loss due to friction	Option 1				
	Option 2				
	Option 3				
Excavation for system repairs	Option 1				
	Option 2				
	Option 3				
Excavation for system expansion	Option 1				
	Option 2				
	Option 3				
Cleaning of lines, tanks, etc.	Option 1				
	Option 2				
	Option 3				
Cooling	Option 1				
	Option 2				
	Option 3				
Lighting indoors	Option 1				
	Option 2				
	Option 3				
Lighting outdoors	Option 1				
	Option 2				
	Option 3				
Transportation of equipment	Option 1				
	Option 2				
	Option 3				
Transportation of supplies	Option 1				
	Option 2				
	Option 3				
Transportation of personnel	Option 1				
	Option 2				
	Option 3				
Instrumentation (SCADA, meters and parts ordering)	Option 1				
	Option 2				
	Option 3				
Communications (electronic like Facebook, websites, etc.)	Option 1				
	Option 2				
	Option 3				
Other:____________	Option 1				
	Option 2				
	Option 3				

Energy-use plan

Form teams to examine the different areas where you use energy and **graph current energy use** (*see sample graph on page 41*). It is suggested that you chart actual quantities used as well as the money expended. The graphs should show energy usage over time, so graph the last few years of usage, if possible. By doing this, you can easily make comparisons later to show actual savings realized by your efforts. This also will alert you if any big energy spikes or drops occurred. Your teams can then investigate to see if the cause can be determined.

Make conservation and/or energy-improvement goals

Take your time, from a week up to a month, to think about the areas that could be improved. Gather your team together again. This would be a good time to review identified areas for conservation or energy-improvement goals. Your team can be given a copy of all the ideas listed. Give your team a five-minute period to rank the possible projects in order of priority.

A couple of goals could be projects that can be:

- finished soon
- inexpensive to start
- possible to accomplish

A lower priority can be given to projects that will potentially make larger impacts, but will take longer and require more financial resources to accomplish. For example, it may be easier, faster and cheaper to install a timer on a lighting system, then later you may want to change all the facility lighting to more energy-saving varieties. In the end, your goals will be that both projects are done, but the effect is that your team can have measurable goals and achieve progress.

Sample goals:

1. Incorporating energy efficiency into capital-improvement projects
2. Changes in agreements
3. Changes to operating procedures
4. Training of conservation techniques
5. Practice of conservation techniques

Next Steps

(Refer to Energy-efficiency Readiness Survey Checklist on page 36 to leverage existing motivations.)

Activity? Can be circled and numbered above and then broken into specific tasks	Who will take the lead on completing this task?	When will this be completed?	What resources are needed to do this?	How will they communicate this to us?
EXAMPLE: Challenge A, task 1 research resources	*City Manager, Brightens R. Day*	*May 15, 2010*	*Phone, internet access, computer with printer— she has this covered.*	*At the May 18 monthly meeting of our water board, she will report on this*
EXAMPLE: Pump station "A" has 40-year old pumps. Newer models are more efficient .	*City Planner, Need A. Buck*	*Sept. 30, 2010*	*RFP for pump replacements*	*Annual budget process*

ENERGY EFFICIENCY

RCAR

Worksheet: Rank Energy-efficiency Partners

More important

Less important

1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	

NOTE: It may be easier to only list partners first. After ranking them, you can create a second sheet of ranked partners using this worksheet.

Now that you have a list of priorities, your team can develop an **action plan**. This part of the program may take a couple of meetings. The person(s) who originally came up with the idea needs to explain his/her point of view to the group, giving an estimate of requirements to accomplish the change. It is recommended that each idea's explanation be kept to a few minutes. Then the group can give feedback and ask questions about the possible project. Then as a group you can:

1. Set dates and responsibilities for action
2. Contact other agencies as collaborators

Implement your energy-efficiency plan

This is the time to get to work and implement your plan. You may need to start with a contracting process. Does your plan call for a change in procedures? Some projects can be assigned to your current employees. Can you select a group member to write up the changes in your procedures for management approval? You will want to try to give each member in the group a role in this effort. It will keep members invested in the process and keep their energy level and enthusiasm high for the objectives of the program. In this phase, actions are completed and the effects on your group will be noticed.

Steps to implement the plan

1. **Contact** other agencies.
2. **Hire** contractors to complete some of the work, as needed.
3. **Delegate** some of the work to group members, utility employees, hired consultants, professional service providers, suppliers, etc. Keep everyone involved and up-to-date on the status and implementation changes as they are made.
4. **Share** news stories or report your group's activities via a company newsletter. This will encourage everyone in the community to help you with your goals.

ENERGY EFFICIENCY

Energy-efficiency Program

Check your energy-efficiency progress

1. During the process of incorporating energy efficiency, you will want to **graph energy use throughout the project** (visit *www.energystar.gov/benchmark* for an energy portfolio manager). One of the best indicators that this is a useful effort is when you can see all forms of energy consumption decline.
   a. Determine kilowatt hours used per month at each facility compared to flow totals.
   b. Determine if someone on your team can map out your systems' carbon footprint, heat-loss footprint and your water-loss footprint.
   c. Think of other comparisons.
2. As an additional effort, you will want to have your group **meet regularly.** As a suggestion, your group could meet every week to start this process. After the initial planning phase, you may decide to have a meeting every two weeks or even monthly. It is suggested that you do not delay meetings for more than one quarter at a time as it becomes too easy to lose focus on the objectives of the effort.
   a. Budget time for regular meetings.
   b. Publish progress reports in newsletters.
   c. Give employees recognition for energy savings.
   d. Make this effort a contest with cash prizes (designate a percentage of the

money saved in the first year to give back to the employees as a cash reward.)

3. Make this a living process. As you accomplish various goals and objectives, share the news in company emails, newsletters and office memos. Let all employees know and understand that this is an important issue to you and them. Getting "buy-in" from employees and residents can go a long way toward success. It helps remind people to shut off lights and water systems when not needed, which can add significantly to your efforts to reduce consumption. When possible, give incentives, such as handing out gifts, that encourage people to reduce consumption.

   Keep others in your organization aware of conservation efforts:

   a. Continuously train employees and/ or volunteers about your energy-efficiency efforts.
   b. Share emails.
   c. Assign an advocate.
   d. Advertise your efforts.

Energy uses and efficiency teams

Evaluating a program is critical in order to create new successes that build upon old ones. The best way to perform an evaluation is to set goals during the planning process. A measurable, time-bound goal can be easily evaluated.

Sample goal

We are going to keep our pumping cost the same for the next five years, even with rising energy costs.

This goal can be easily evaluated five years later. Evaluation needs to be realistic and agreed upon to create future successes in your energy-efficiency program. Evaluation cannot be a retrospective search for any and all declining trends and then attempting to take credit for them. You planned; you did the work; so did what you expected to happen, happen? This question allows you to determine whether what you intended happened or did not happen, so next time you can make effective changes.

Ways that our utility or community might increase communications on energy efficiency:

- ☐ Request that the electric utility identify relevant rebates and incentives
- ☐ Identify the cost savings through water conservation
- ☐ Energy-efficiency tips in water-bill inserts
- ☐ Publish energy-efficiency program savings
- ☐ Break energy expenditures out as a separate budget item
- ☐ Calculate and publish the trends over time of energy cost per 1,000 gallons
- ☐ Signage on facilities that are in public view; Example: "This smart meter saves 10 percent."
- ☐ Other ______________________

Incorporating Renewable Energy Sources Using the CEDAR Protocol[5]

Once energy efficiency is applied, the final step in achieving utility sustainability is to incorporate renewable energy sources. A framework that is very useful to leverage the success of your efficiency efforts is "CEDAR."

A new energy strategy that we call the CEDAR protocol is a rational approach to prioritizing comprehensive and integrated energy investments of many kinds. Practically, CEDAR offers a boost to national security, the prospect of new jobs in every rural county in the U.S., and a range of other compelling benefits to agriculture and rural communities. The national impacts of a strong rural CEDAR program on energy demand, supply and net carbon emissions could be immense, while the local impacts on living costs and income could save many rural workers from bankruptcy.

The CEDAR protocol is compiled primarily from "off-the-shelf" technologies like insulation, demand controls and solar panels. The program costs for CEDAR are reasonably low (remarkably cheap, in fact, compared to the rural economic impacts of recent gas/diesel price excursions or the cost of new power generation), and often can be paid out of energy cost savings.

CEDAR differs from "business-as-usual" by emphasizing the primacy of human factors in reducing costs and increasing revenues, and its five prioritized action areas rationalize cost-effectiveness in a step-wise fashion.

CEDAR

C **Conservation**: using low-cost, no-cost practices and measures; these are mainly behavior-related and action-oriented ways to reduce the energy used in an existing home by 25 percent

E **Efficiency:** reducing waste with investment-grade improvements in materials and equipment, saving another 25 percent of energy used

D **Demand peak reduction:** upgrading efficiency at the power-grid scale, with long-term moderating effects on utility rates

A **Ancillary reductions** of non-metered energy and carbon emissions: including vehicle operation; 3R (reduce, re-use, recycle) practices; water-energy nexus; and carbon impacts; each area offers energy and cost savings as well as targeted reductions in net carbon emissions

R **Renewables:** solar, wind, geothermal and biofuels; whether at small (home) scale, community scale or industrial scale, carbon-neutral technologies offer new jobs and career paths for rural workers

Adopting the CEDAR protocol can help capture significant early rural payoffs in jobs, income and career options.

[5]Reprinted with permission of Dr. Tom Potter, Director of Rural Programs, Southwest Energy Efficiency Project (SWEEP); 303/503-2230; *tpotter@swenergy.org; tpotter@allamericanenergy.com*

Asset-management Planning and Energy Efficiency

An asset-management (AM) plan is a process of accounting for *all* of a utility's assets and assessment of their physical condition. There are myriad templates to complete an AM plan, but most of them include as the first step the physical inventory and cataloging of the utility's assets and their present conditions. As part of the conditions assessment, criticality level is assessed: How severely will the system be impacted/impaired if that particular asset fails? The other assessment on the condition of the asset is on the level of redundancy: Can the system afford to have spare parts sitting around? Can that particular asset be eliminated without hindering the system's operations?

The age and condition of each component is noted, normally on a database or spreadsheet. The expected useful life span of each component is researched. The age of each component is subtracted from the expected life span to give the remaining life expectancy. The cost of the components is now researched. The information gathered for the useful life and the age of the asset will determine how much time the decision makers have to either repair or replace the asset and what kind of financial impact it can have.

Now, armed with the remaining life and replacement cost, a capital-replacement plan can be drafted. A capital-replacement plan is then incorporated into the utility's financial plan and reserve set-aside to eventually fund it through a proper rate structure.

Asset management and asset managing are not a simple process, but as utility infrastructure across the nation ages and financial resources diminish, this can be a great tool to assist utilities to sustain their established level of service. The AM plan can assist decision makers to identify and properly plan infrastructure projects and fund them adequately without creating financial burdens on the utility itself or its customers.

The AM plan can be taken to the next level. Part of the planning process can incorporate the implementation of energy efficiencies. Estimating the energy-efficiency savings of new upgrades at the time of repairing or replacing system components can be incorporated. Example: A well pump reaches its life expectancy. A new, much more efficient pump can be used to replace it. Subtract the amount of expected energy savings from the anticipated loan payment for the new pump. This is the real amount the new pump will affect your budget, rather than the full amount. This reduction in future budgeting impacts may make energy-efficient projects more attractive sooner.

For a full version of free asset-management software, refer to the EPA-developed Check-Up Program for Small Systems (CUPSS) at *http://water.epa.gov/infrastructure/drinkingwater/pws/cupss/.*

Basic Economic-development Strategies

Two broad strategies for maintaining and strengthening local economies are:

1. reducing the cost of living through efficiencies
2. increasing real income because you are plugging holes in the local economy

Local utility services play important roles in both of these strategies.

Reduce the cost of living for residents and those who commute from the community

Decrease costs of goods and services

Affordable housing. Utility services affect the cost of housing for everyone. Infrastructure costs, the cost of connecting homes to the infrastructure, drinking water production, and waste treatment all add to the cost of housing. **Anything that can be done to reduce the cost of utility services will make housing more affordable for all.**

Cooperative or community-owned enterprises. In some cases, utility systems owned and operated by local government, cooperatives or community-based organizations are more cost-effective than for-profit operations.

Reduce time and travel cost

Business-district development. Does your community have a business district or downtown? Is it thriving or slowly dying due to leakage from the local economy? If the district is healthy, are efforts being made to sustain it and strengthen it? Supporting your local businesses makes shopping less costly, less time-consuming and more enjoyable. **A healthy business district requires reliable and affordable utility services, while at the same time providing income and services to the utilities and their employees.** A good mantra for today is "Think globally. Shop locally."

Targeted commercial real estate development. This is another step toward reducing time and travel costs. What goods and services do residents of your community need that are not currently available locally? Is there a vacant parcel of land that can be developed to meet the needs? A key factor in any real estate development project is the availability of reliable and reasonably priced utility services.

Food for Thought

Are your recyclable materials shipped to distant markets, whose residents are paid to process the materials and make new products from them? Could any of the new products be made by residents of your community?

1. How might sharing resources help your community be more energy-efficient?

   ____

   ____.

2. How might energy efficiency bring jobs to your community? Can include education.

   ____

   ____.

3. In my community, energy-efficiency jobs might include:
   - ☐ electrician
   - ☐ energy auditor
   - ☐ weatherization
   - ☐ educator
   - ☐ water operator
   - ☐ other

4. To grow our local economy, we think we could incorporate the following idea for energy efficiency: ____

   ____

   _______________.

5. Possible partners on energy efficiency in my community might include:
   - ☐ local schools/community colleges/universities
   - ☐ local businesses
   - ☐ local electric utility
   - ☐ local fire department
   - ☐ water, wastewater utility
   - ☐ other ____________________________
   - ☐ local plumbers
   - ☐ county manager's office
   - ☐ U.S. Department of Agriculture
   - ☐ state energy offices

ENERGY EFFICIENCY

Resources

American Council for an Energy-Efficient Economy (ACEEE) — Water and Wastewater
www.aceee.org/industry/water.htm

California Energy Commission Energy Efficiency with Water
www.energy.ca.gov/process/water/eff_water.html

Combined Heat and Power Partnership – Municipal Wastewater Treatment Facilities
www.epa.gov/chp/markets/wastewater.html

The Community Energy Workbook: A Guide to Building a Sustainable Economy, by J. Baldwin, 1995, out of print but still available used from some online booksellers

Database of State Incentives for Renewables & Efficiency (DSIRE): *a listing of available funding as grants, loans and tax credits that can make your efficiency project feasible*
www.dsireusa.org

Distributed Energy Magazine, the journal of energy efficiency and reliability
www.distributedenergy.com

Energy Star for Wastewater Plants and Drinking Water Systems
www.energystar.gov/index.cfm?c=water.wastewater_drinking_water
www.energystar.gov/benchmark

Homepower Magazine
www.homepower.com/home

Massachusetts Department of Environmental Protection: *resources to help individuals conserve energy*
www.mass.gov/dep/energy.htm

Montana State University Montana Technical Assistance Center at the Montana Water Center. Saving Water & Energy in Small Water Systems A four-section curriculum on water conservation, energy management, alternative energy sources and water accounting. This is a great resource with case-study videos and lots of information.
http://watercenter.montana.edu/training/default.htm

National Renewable Energy Laboratory: *resources on the use of renewable energy and energy efficiency*
www.nrel.gov
www.eere.energy.gov/industry/saveenergynow

Sustainable Infrastructure: A best practices guide for Arizona Wastewater Utilities. Water Infrastructure Finance Authority of Arizona, April 2009: *maps, graphs, energy and water conservation*

Toward a Sustainable Community: A Toolkit for Local Government
www4.uwm.edu/shwec/publications/cabinet/reductionreuse/SustainabilityToolkit.pdf

U.S. Department of Agriculture Rural Development, Rural Energy for America Program (REAP): *Grants for energy audits for farms and small, rural businesses*
www.rurdev.usda.gov/rbs/busp/REAPEA.htm

U.S. Department of Energy: *free software for industry energy efficiency ITP's comprehensive suite of software tools, which can help your organization identify energy savings opportunities. Download these tools, free of charge, to improve industrial compressed air, motor, fan, pump, process heating and steam systems.*

www1.eere.energy.gov/industry/bestpractices/software.html

Software includes:

- ASDMaster, which evaluates adjustable-speed drives and their application
- AirMaster+, which assesses compressed-air systems
- MotorMaster+, which assists in selecting and managing energy-efficient motors
- Process Heating Assessment and Survey Tool (PHAST) to assess process heating systems
- Pumping System Assessment Tool (PSAT) to assess the efficiency of pumping systems
- NOx & Energy Assessment Tool (NxEAT) to analyze NOx emissions and energy efficiency
- Steam System Scoping Tool (SSST) profiles steam-system operations and management
- Steam System Assessment Tool (SSAT) to assess steam systems
- 3E Plus, which determines whether boiler systems can be optimized through insulation of steam

U.S. Department of Energy definition of energy efficiency
www.eia.doe.gov/emeu/efficiency/definition.htm

U.S. Department of Energy, Energy Efficiency and Renewable Energy website, information link; Industry programs and possible funding grants and tax incentives
https://www1.eere.energy.gov/informationcenter/

Wind Energy for Municipal Water Supply
www1.eere.energy.gov/windandhydro/municipal_water_supply.html

U.S. Energy Information Administration: an in-depth description of energy efficiency and how it is measured
www.eia.doe.gov/emeu/efficiency/contents.html

U.S. Environmental Protection Agency (USEPA)
Performance Track: a program to track your performance, including energy consumption/efficiency that allows you to improve performance above simply complying with regulations
www.epa.gov/performancetrack

Promoting Energy Efficiency in the Water Sector
www.epa.gov/waterinfrastructure/pdfs/memo_si_bengrumbles_nexus-between-water-energy_02142008.pdf

Sustainable Infrastructure for Water and Wastewater
www.epa.gov/waterinfrastructure

Sustainable Infrastructure for Water and Wastewater: A resource that identifies approaches to integrate energy-efficient practices into daily management and long-term planning
http://water.epa.gov/infrastructure/sustain/bettermanagement.cfm

Water Conditioning & Purification Magazine. The WCP website has an archive of old magazines dating back to 1998.
www.wcponline.com

NOTES

Chapter 3
Renewable Energy Sources

Renewable Energy Sources Overview

Our quality of life and economy depend on the availability of energy. If you manage or operate a water or wastewater system, the everyday functions of your operation might require electricity and natural gas to generate and distribute or collect water. In the United States, a significant amount of electricity is generated by the combustion of fossil fuels (mostly natural gas and coal). The extraction, transport, refining, and use of fossil fuels may cause serious environmental impacts to the earth's surface and pollution to water sources. In the last few decades, there has been a national trend to increase the use of renewable energy sources. Renewable energy sources provide energy without depleting fossil-fuel reserves. The water-energy nexus is the crossover where energy provides water and water produces energy.

This chapter focuses on different types of renewable-energy sources and their uses. It is designed to assist you and your community to acquire a better understanding of the renewable-energy sources concept and how you might take advantage of it based on your geographic location and environmental factors. It provides activities to help you evaluate existing local energy resources and how they might benefit your utility. It also provides you with renewable-energy sources reference and resource materials.

The use of renewable-energy sources is not free from human and environmental impacts. Renewable-energy sources offer opportunities for us to lessen the impacts on the environment, others and ourselves. The advantages offered by renewable energy sources are most effectively leveraged by installing them on a platform of energy efficiency and implementing them with durable, consensus-based community involvement.

Energy Planning

Renewable-energy planning and transition is a community-visioning process and a technology-implementation project. Renewable energy is not free from impacts. The Rocky Mountain Institute developed a workbook that maps out a step-by-step process for getting the most community and cultural benefit from your renewable-energy projects. (*The Community Energy Workbook* is no longer available from the Rocky Mountain Institute but may be available in used form from online booksellers.)

There are cultural, economic and environmental costs and benefits embedded in infrastructure.

Using a designed process allows you to make these costs and benefits explicit in order to create consensus and a shared vision during decision-making.

Step1:
Recruit an energy-management team.

Step 2:
Collect current data on your energy usage.

Step 3:
Create consensus-based energy goals (objectives with goals).

Step 4:
Identify constraints and barriers.

Step 5:
Research available and potential resources.

Step 6:
Evaluate alternatives.

Step 7:
Develop a strategic plan.

Step 8:
Achieve project realization.

CEDAR[1] revisited

The CEDAR protocol was covered in chapter 2 (refer to page 58). Before proceeding with a renewable-energy project, be sure that your utility is first operating in an energy-efficient way. The CEDAR approach provides a way to incorporate into your operations the use of renewable energy in a way that builds sustainability. CEDAR can be used as a checklist to ensure you are ready to take on renewable energy, or it can be a strategy timeline for arriving at a point of maximizing the cost-effectiveness of renewable energy.

RENEWABLE ENERGY SOURCES

Ways that our community or utility might increase communication about renewable energy and its role as an energy source

- ☐ Is there a comprehensive plan for the county? Does it include renewable energy?
- ☐ Case studies of similar-size systems and communities
- ☐ Renewable-energy tips in water-bill inserts
- ☐ Incorporate renewable energy into existing county ordinances
- ☐ Introduce renewable energy and place project in public view, if possible
- ☐ Provide signage on renewable-energy projects advertizing the benefits
- ☐ Field trips to your facility by students at local schools
- ☐ Other ____

Always look at the water-conservation and energy-efficiency options and solutions before you begin considering renewable energy!

Energy efficiency comes before implementation of renewable energy.
Reduction of energy waste is more cost-effective than replacing an energy source. The most effective sustainability strategy addresses energy efficiency first then turns to renewable energy in the most environmentally friendly manner.

[1] CEDAR, Dr. Tom Potter, Director of Rural Programs, Southwest Energy Efficiency Project (SWEEP); 303/503-2230 *tpotter@swenergy.org; tpotter@allamericanenergy.com*

ENERGY-10

A U.S. Department of Energy tool for ensuring energy efficiency is ENERGY-10. ENERGY-10 software can identify the best combination of energy-efficient strategies, including daylighting (using natural light for daytime lighting of building interiors), passive solar heating and high-efficiency mechanical systems. Using ENERGY-10 at a project's start takes less than an hour and can result in energy savings of 40 to 70 percent, with little or no increase in construction costs. For more information about ENERGY-10, visit *www.nrel.gov/buildings/energy10.html.*

Conducting team activities helps you apply and retain energy-efficiency practices while incorporating practices related to renewable energy.

Team Activity A

Project Definition

Develop a profile of the incentives available for your project in your state. Use the www.dsireusa.org website to find and print out the available renewable-energy incentives for participants in this team activity. The type of programs and the amount of incentives and resources vary from place to place. This website is specific enough that incentives vary even from county to county within some states.

Divide participants into groups of five to seven people each. Have each group decide upon just one location to examine.

Step 1. Have each smaller group record the following information on a flip chart:

- ☐ Project owner (The availability of some incentives sometimes varies depending on whether the owner is a private company, public entity, nonprofit organization, etc.)
- ☐ Location (This may need to be as specific as the particular county.)
- ☐ Energy-efficiency components of the project/program
- ☐ Renewable-energy source or sources
- ☐ Project type
- ☐ Project size
- ☐ Project timing (Based upon the type of incentives available, are there timing constraints or concerns?)
- ☐ Possible participants (partners, collaborators or stakeholders)
- ☐ Project benefits (savings, sustainability, reduction of pollution, etc.)
- ☐ Beneficiaries (those who will benefit from the project)
- ☐ Possible revenue streams from beneficiaries (ways they can help pay for the benefit they receive)

Step 2. Have each group list, on a separate flip chart, available renewable-energy sources. Each group will put together a profile of the possible renewable-energy sources available in the area. Provide each group with a copy of the following information. The following resources can assist you in identifying locally available renewable-energy resources:

- ☐ National Renewable Energy Laboratory (NREL) resource maps (wind, solar, geothermal and hydropower)
- ☐ Specific local information (Google Earth)
- ☐ Possible project collaborators
- ☐ Resources each collaborator has to offer (technical expertise, money, available space, moral support, etc.)

Team Activity B

Accounting for Natural Capital

Divide participants into groups of five to seven people each. Provide each group with a copy of the document "A Plan for Building Community Prosperity Through Natural Capital" (see Appendix). Have the group combine the information from the two flip charts of the last activity into a list of project possibilities for building community prosperity through natural capital. Record all project possibilities on a flipchart to share with the entire group. Have all smaller groups report out to the larger group.

Team Activity C

Technology Applications

Divide participants into small discussion groups. Provide each group with a set of catalog pages of off-the-shelf alternative-energy products, such as Real Goods Catalog, *www.realgoods.com*. Have each group list all of the possible uses for these technologies by small water/wastewater utilities. Record all of these uses on a flip chart. Have each group share one possible use for each technology. Continue going from group to group until everyone's list is exhausted without repeating ideas. Then go on to the next technology.

Sustainability is a process loop that continues to systematically improve a utility's costs, use of energy, impact on the environment, and its role in a community. Consider these four questions for your organization/utility, adapted from "The Four System Conditions" by The Natural Step at *www.naturalstep.org/the-system-conditions*:

1. How might our utility systematically reduce and manage water-quality impacts?
2. How might our utility systematically reduce and manage air-quality impacts?
3. How might our utility systematically reduce what we use that is extracted from the earth's crust?
4. How might our utility systematically improve equity within our utility and in our local community?

The three legs of the sustainability stool are **economics, equity and environment.**

Visit Redefining Progress to explore what your ecological footprint is: *www.ecologicalfootprint.org*. Take the quiz. Ecological footprints measure humanity's demand on nature.

Team Activity D

Renewable Energy Asset-based Inventory

1. Define and ask people to give examples of the five renewable-energy resources (see page 72).

2. In a group, brainstorm an inventory list of local renewable-energy resources.

3. Using a separate list, brainstorm renewable-energy resources that are not currently available but that, due to the geographic location and local environmental conditions, could be beneficial to the area.

4. Create a map of the service area, county or geographic area being discussed. This will help the group visualize the location of the resources.

5. Provide each participant with one or two colored dots and ask them to place the dots on the list of existing resources that:

   a. Can be expanded to include other uses besides the current one.

   b. Have proven to be the right technologies for the area and their intended use.

6. Using more colored dots, ask the participants to place a dot on the list of available renewable-energy resources not currently existing in the area but that may have potential based on geographic location and environmental conditions.

7. Using the lists and the map, answer the following questions:

   a. Are the current resources being used to their optimum level?

   b. Who would be the optimization partners?

   c. Where might the optimizations take place?

   d. Is there room for new, renewable-energy resources to make current operations more cost-effective and environmentally friendly?

Team Activity E

Project Impact Analysis and Stakeholder Identification/Futures Wheel

Purpose:

- Impact analysis gets you to look at the potential impacts, both positive and negative, of a proposed project.
- It requires you to consider direct and indirect, immediate and long-term results.
- Based on the information gathered through the analysis, decisions to amplify, promote, control and/or mitigate impacts can be made.
- It allows you to define all of the impacted and/or affected groups/stakeholders.

The purpose of this exercise, as adapted from the Ford Institute Leadership Program curriculum, is to identify things that will happen, will be seen or will be in place if a project is implemented.

For example, if the community decided that it wanted to consider a wind farm, questions to ask would include:

- How will the project affect specific community members?
- Who will be impacted directly or indirectly?
- What kind of impacts will be experienced?
- When might impacts happen?

Instructions

This process looks at first, second and third order of impacts.

Step one: Draw a wheel

1. Tape two pieces of flip-chart paper together, side by side.
2. Draw a circle in the middle of the chart. Write a two- or three-word project/program description that contains a VERB.
3. Chart five to eight immediate (first-order) impacts, both positive and negative.
   a. Connect the impacts to the chart with a SINGLE LINE.
4. Chart secondary (second-order) impacts.
   a. Connect these impacts to the chart with DOUBLE LINES.
5. Chart other resulting impacts (third- and fourth-order) impacts.
   a. Connect them to the chart with TRIPLE and QUADRUPLE LINES.

Step two: Identify stakeholders

1. Brainstorm stakeholders affected by the identified impacts.
2. List each stakeholder or group of similar stakeholders on a separate sticky note.
3. List stakeholder names next to the specific impact that affects them.

Step three: Debrief

1. Post the wheel drawings on the wall, and have the entire group view all wheels via a gallery walk.
2. Discuss any comments and observations.
3. What are the things that can be changed, if any?
4. What can the community live with, short- and long-term?

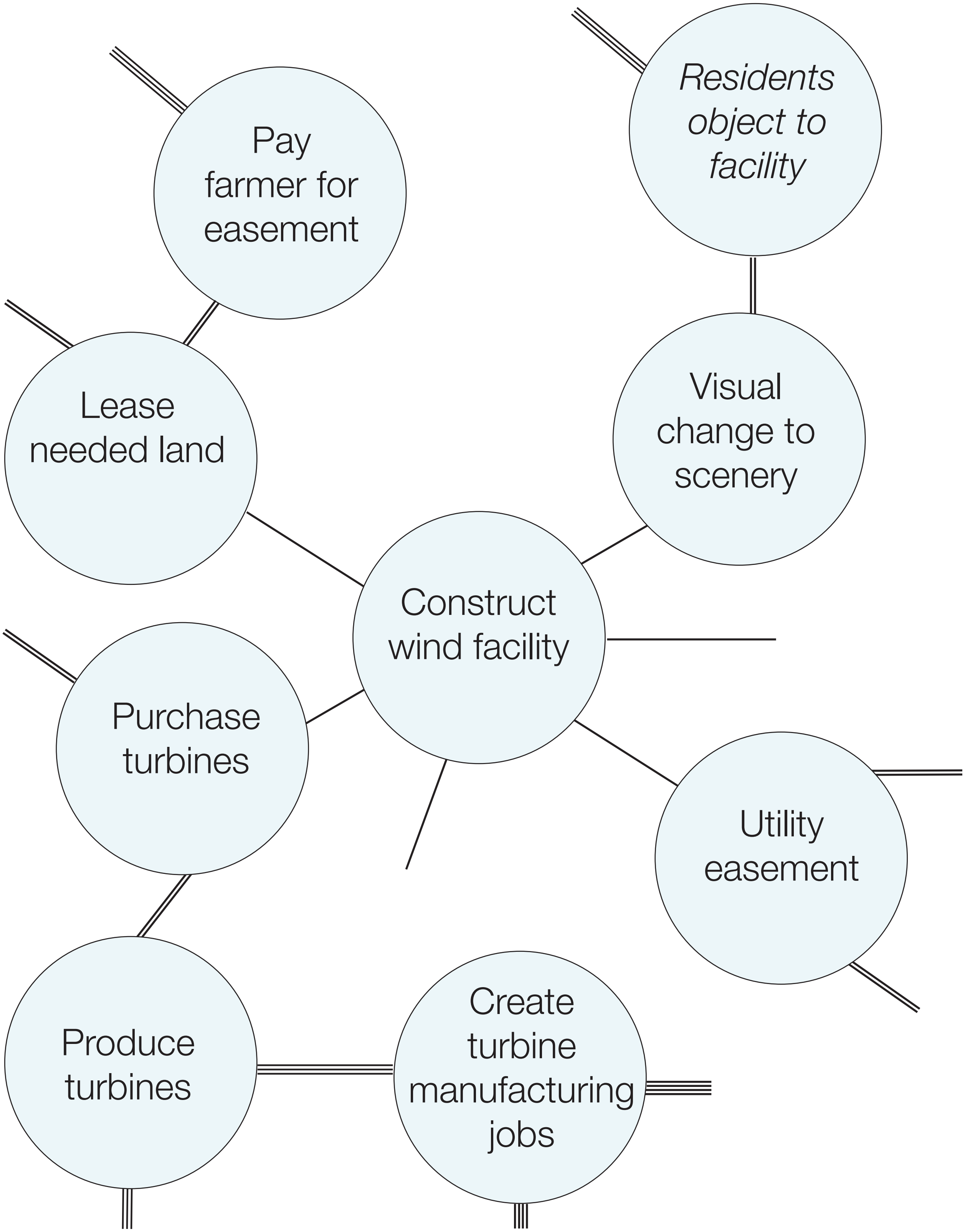
Activity terms:

Project/program description: a single sentence of the descriptive statement that is as specific as is practicable. It should contain a verb describing what is being done.

Impact: the good and bad things that will happen because of the project's existence

(See Futures Wheel example on next page)

Example Futures Wheel



RENEWABLE ENERGY SOURCES

Renewable Energy

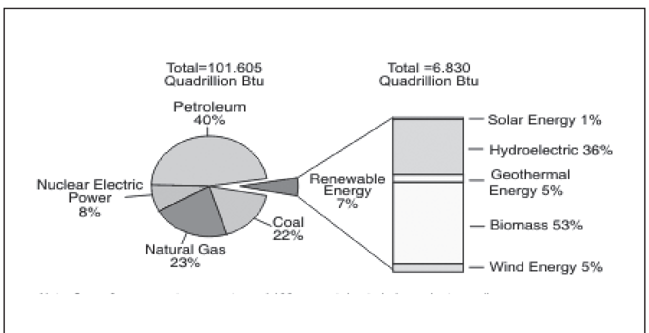
Many renewable-energy sources can be replenished in a short period of time. The five renewable sources used most often are:

- biomass: including wood and wood waste, municipal solid waste, landfill and biogas, ethanol and biodiesel
- geothermal
- solar
- water (micro-hydropower)
- wind

The use of renewable energy is not new. More than 150 years ago, wood, which is one form of biomass, supplied up to 90 percent of our energy needs. As the use of coal, petroleum and natural gas expanded, so did the need to identify new renewable resources and to find new ways to use them to help meet our energy needs.

Overall consumption from renewable sources in the U.S. totaled 6.8 quads (quadrillion BTUs) in 2007, or about 7 percent of all energy used nationally. Consumption from renewable sources was at its highest point in 1997, at about 7.2 quads.

The Role of Renewable Energy Consumption in the Nation's Energy Supply[2]



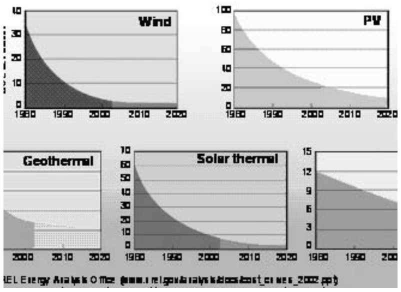
Renewable energy plays an important role in the supply of energy. When renewable energy sources are used, the demand for fossil fuels is reduced. Unlike fossil fuels, non-biomass renewable sources of energy (hydropower, geothermal, wind and solar) do not directly emit greenhouse gases.

It is estimated that currently more than half of renewable energy goes to producing electricity. The next largest use is the production of heat and steam for industrial purposes. Renewable fuels, such as ethanol, are primarily used by the transportation industry; biomass is used to provide heat for homes and businesses.

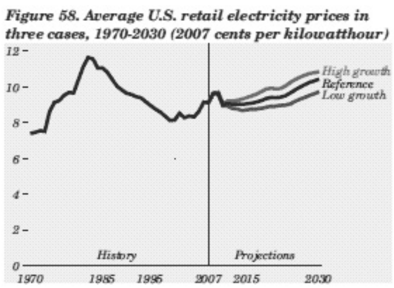
Renewable energy has many advantages, but it has generally been more expensive to use than fossil fuels due to the cost of production, transmission and/or transport. Renewable-energy sources are often located in remote areas. The cost to transport the generated energy to areas where these resources are needed has been a deterring factor. The use of renewable sources also is limited by the fact that they are not always available (for example, cloudy days reduce solar energy; calm days mean no wind to drive wind turbines; and droughts reduce water availability to produce hydroelectricity).

[2]Source: EIA, *Renewable Energy Consumption and Electricity Preliminary 2007 Statistics,* Table 1: U.S. Energy Consumption by Energy Source, 2003-2007 (May 2008)

Renewable Energy Cost Trends[3]



Average U.S. Retail Electricity Prices
in Three Cases: 1920-203



(2007 cents per kilowatt hour)

The up-front costs to switch to new sources and the residual value of existing infrastructure make an instantaneous conversion to renewable energy impractical. Renewable energy and its cost savings should be phased in on a situational basis with specific cost-versus-benefit considerations. Some benefits may not be monetary and may not be immediately realized.

Holistic energy planning

Many communities initially embark on managing the energy use by their water or wastewater utility in order to become increasingly efficient and save money on their energy bills. However, this is difficult to sustain. In a trend of ever-increasing energy consumption, the questions to consider are if your goal is to slightly slow the increase or to achieve the direct and indirect benefits of real reduction. A local water utility is on the front lines of protecting human health and the environment and needs a lot of energy to do this. A natural next step for small communities might be to consider holistic planning--beginning to educate residents in places such as local schools, community or senior centers, fire departments, clinics, and churches on how integral water infrastructure is to the health of the community. Water infrastructure is part of an interdependent web of infrastructure that also includes energy, transportation and land-use patterns.

Holistic energy planning is a process in which a community defines what is important for its residents and then determines the best mix of energy for the community based on best-available resources to achieve mutually agreed upon goals. This planning process can further create local jobs, involve academic institutions, businesses, government and nonprofits, foster energy savings and spur innovation. A cautionary note: The fact that private-sector businesses often take dependable community infrastructure for granted, combined with the high cost of relocation, means that holistic energy benefits will be long-term and not short-term. Job creation, for example, may be found in local businesses being able to expand or offer new services rather than the recruitment of new manufacturing facilities because of the new sewer project.

Holistic energy planning is a commitment to a sometimes frustratingly slow process of managing change in your community to achieve a consensus-driven “better world.” It is a process of aligning the community’s energy consumption with both the existing culture and the realities of existing funding, current usage trends, and potential energy resources.

Renewable-energy projects are usually on one of these scales:

- **personal:** home and/or individual use
- **community**: a limited geographic area’s use of mixed renewable options and portions to best fit a shared vision
- **industrial:** large-scale developer projects that may have different points of generation and use

[3]Source: Energy Analysis Office, National Renewable Energy Laboratory, U.S. Department of Energy

Your small system/utility would be on the community scale. A small utility would not be a personal-scale project, and industrial-scale projects often do not provide power to local communities, with power often being exported to other states. Coordinating your power needs with other local needs can leverage a number of resources to best meet your community's energy goals and objectives. Your community might have to address local education on the issues, mechanisms for communication, and processes for determining what actions you might choose to take next.

For example, many states are forming landowner associations to collectively negotiate with industrial-scale wind and solar developers, in particular, in an effort to foster transparent projects consistent with their local needs. This is a fairly new approach for the unregulated industrial-scale renewables industry. Communities need to ask questions about proposed projects in their neighborhood, community, county and state. Questions need to be asked regarding health issues, cultural issues, environmental impacts, and how the project might impact low-income communities. The issue is often one of siting projects near established transmission lines, whether it is the optimal project site for that technology, and/or geographic conditions. Communities need to be proactive when working toward best-management practices that represent their best interests, even when it concerns renewable-energy projects.

Distributed energy

When a small public utility or a small community looks at incorporating renewable energy, it needs to look closely at the mix of its electric-utility needs now and in the future. The utility needs to decide if it will be providing any of its power locally. When the electricity is produced near where it is used, this is called distributed power or distributed energy.

Historically, small local utilities have been using only transmission grid power, commonly produced a distance from the community, transported by interconnected, large transmission lines, and commonly made from coal, oil, natural gas, nuclear and hydro power. Now, many utilities are considering and purchasing small-scale technologies, such as capturing waste heat, biosolids and water conservation, especially incorporating energy efficiency and generating local power that is separate from the larger transmission grid. This distributed local power can be linked to the larger grid depending upon how the system is configured.

When energy is needed at a remote site for powering low-usage equipment, like SCADA, then an application of solar power can be much more cost-effective to install than conventional power. When larger amounts of power are needed for large-volume deep wells, some facilities have found onsite natural gas-powered generators to be more cost-effective than the installation of power lines. Some facilities have found that their capital investment can be quickly recovered and they begin saving money by installing onsite natural gas generators to lower their plant power demand just during peak-demand periods. The utility is thus able to see energy savings during the most expensive rate periods.

Utilities can:

- remain on 100 percent transmission grid-tied electricity
- begin to add distributed-power sources
- go to 100 percent distributed energy

Distributed generation can save money, increase jobs locally, and address climate-change adaptation and mitigation strategies.

Renewable energy and climate variability

Water and wastewater utilities have begun to identify and take advantage of renewable-energy resources specific to their geographic locations, creating savings opportunities. While in most cases renewable-energy infrastructure projects are cost-intensive, over the long run they can be a wise investment if your utility is flexible and prepared for potential variabilities in weather. While the technology to operate 50 horsepower pumps is not quite optimal yet, solar panels used to cool down pump houses or to run chlorine pumps are possible added value, depending upon your energy audit and profile-of-process use. Wastewater treatment plants have the potential to support a portion of their operations through methane generation and other alternative-energy sources. Being aware of potential greenhouse gas-reduction efforts as a component of your utility's operations may decrease vulnerability in addressing weather-related variables that might impact your utility.

Life-cycle analysis

The initial investment required to begin replacing a traditional energy source with a renewable-energy source can seem high. However, when analyzing the cost over the service life of the new source, you can see that renewable-energy sources are often more cost-effective in the long-term.

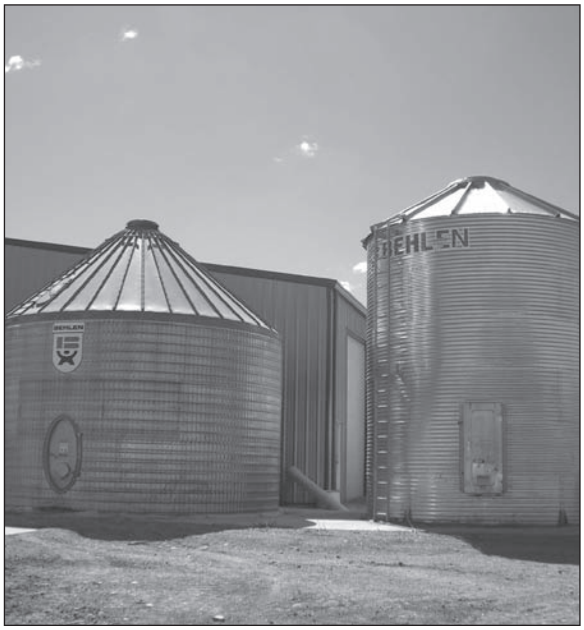
Life-cycle energy analysis, sometimes called "cradle-to-grave" energy analysis, can be used to compare energy alternatives. This analysis takes into account all of the energy required to produce, operate and then recycle or dispose of an item. An attempt should be made to include all external costs and benefits, including environmental, health, aesthetics and community culture to manage unintended consequences.

New European life-cycle energy analysis is "well-to-wheel" analysis, which is specific to automobiles. Well-to-wheel use of ethanol in automobiles makes sense as an additive to lower pollution emissions but no longer makes sense when used in high concentrations to replace gasoline. The embedded energy/fuel required to grow corn, make fertilizer, manufacture ethanol and then transport it changes the bottom line. Renewable-energy sources that have not undergone this type of analysis might provide little or no real benefit.

Research using the life-cycle analysis has found that turbocharged diesel engines require less energy than hybrid electric and gas vehicles. The additional energy embedded in extracting and then safely disposing of the minerals for the batteries when applied to the entire life cycle of the batteries makes the use of diesel more efficient.

The next section describes in detail the five major renewable-energy sources and their applications.

RCAC Works in Costilla County to Develop Biodiesel Facility in Mesita



Where:
Costilla County, Colorado

Problem:
A struggling rural town looks for economic development resources.

Solution:
RCAC helped find funding from USDA Rural Development to develop a biodiesel plant.

RCAC
www.rcac.org

RCAC is the Western affiliate of the Rural Community Assistance Partnership.

Costilla County is one of the poorest counties in Colorado. There is a tremendous need for sustainable economic development. RCAC has provided technical assistance to Costilla County for at least 10 years. In 2001, RCAC received funds to provide comprehensive community-development services for Partner Communities, including Costilla County.

RCAC first organized and conducted a needs-assessment forum involving funders, local elected officials, and interested citizens. The forum identified 12 priorities. Community leaders looked into alternative-energy options that could bridge their strong agricultural past to sustainable future economic development. Biodiesel was identified at the forum as one of the most promising energy sources because of the county's abundant use of diesel fuel. The idea was to create a community-scale facility to demonstrate the feasibility of biodiesel production—recognizing that private-sector capital is difficult to attract and bio diesel projects can carry risk and modest profit potential.

Two county commissioners wrote a concept, project scope and conducted design research. RCAC helped Costilla County successfully obtain financial assistance from its partner agency, USDA Rural Development in 2004. RCAC helped Costilla County identify biodiesel as a priority for economic development and leveraged resources to develop a new, cutting-edge biodiesel plant that employs four people in the small town of Mesita in south-central Colorado. Now the biodiesel plant is a welcome neighbor in the San Luis Valley because of the strong farming and ranching tradition.

RCAP

Biomass: Energy From Plant and Animal Matter

Biomass is organic material made from plants and animals. Biomass contains stored energy from the sun. Plants absorb the sun's energy in a process called photosynthesis. The chemical energy in plants gets passed on to animals and people who eat them. Biomass is a renewable-energy source because we can always grow more trees and crops, and waste will always exist. Some examples of biomass fuels are wood, crops, manure and some garbage.

When burned, the chemical energy in biomass is released as heat. If you have a fireplace, the wood you burn in it is a biomass fuel. Sometimes wood waste or garbage is burned to produce steam to make electricity or to provide heat to industries and homes.

Burning biomass is not the only way to release its energy. Biomass can be converted to other usable forms of energy, such as methane gas or transportation fuels like ethanol and bio-diesel. Methane gas is the main ingredient of natural gas. Smelly stuff, like rotting garbage, and agricultural and human waste, release methane gas—also called "landfill gas" or "biogas." Crops like corn and sugar cane can be fermented to produce the transportation fuel ethanol. Bio-diesel, another transportation fuel, can be produced from leftover food products, such as vegetable oils and animal fats.

Biodisesel plant photo by Fred Warren, RCAC

Biomass fuels provide about 3 percent of the energy used in the U.S. People in the U.S. are trying to develop ways to burn more biomass and less fossil fuels. Using biomass for energy can cut waste and support agricultural products grown in the U.S.

A new process for using biomass that is gaining momentum is biochar. Biochar is created by the pyrolysis (addition of low or high heat) of biomass. The pyrolysis process can be adjusted while making biochar to accommodate different feedstocks to produce different by-products. At the same time, the process also sequesters the biomass' carbon that is applied to soil to increase water holding and fertility for crop production. The carbon sequestration prevents the production of CO_2 and greenhouse gases.

Small biochar pilot projects are taking place across rural America. This technology seems especially relevant for small communities where biomass produced in agriculture and woodlands is most plentiful. The limiting factor that seems to be emerging for biochar is the cost of transporting the biomass feedstock and the biochar soil additive. Some small, rural communities will be located in the most efficient biochar production sites and should be looking at the possible benefits and impacts of a biochar facility.

Biochar's axiom is the same as the old real estate axiom: location, location, location. Feasibility is dependent upon the location of biomass feedstock, location of input resources like water, and location of the market for the end product. Rural water and wastewater systems are stakeholders in all three location questions.

Wood and wood waste

The most common form of biomass is wood. For thousands of years, people have burned wood for heating and cooking. Wood was the main source of energy in the U.S. and the rest of the world until the mid-1800s. Biomass continues to be a major source of energy in much of the developing world.

Many manufacturing plants in the wood and paper-products industry use wood waste to produce their own steam and electricity. This saves them money because they do not have to dispose of their waste products or buy as much electricity.

Municipal solid waste, landfill gas and biogas

Another source of biomass is our garbage, also called municipal solid waste (MSW). Trash that comes from plant or animal products is biomass. Food scraps, lawn clippings and leaves are all examples of biomass trash. Materials that are made out of glass, plastic and metals are not biomass because they are made out of non-renewable materials. MSW can be a source of energy by burning MSW in waste-to-energy plants that capture biogas. In waste-to-energy plants, trash is burned to produce steam that can be used either to heat buildings or to generate electricity.

In landfills, biomass rots and releases methane gas, also called biogas or landfill gas. Some landfills have a system that collects the methane gas so that it can be used as a fuel source. Some dairy farmers collect biogas from tanks called “digesters” where they put all of the muck and manure from their barns. Special loan and grant funding is available for these types of projects.

Biofuels: ethanol and biodiesel

Biofuels are transportation fuels like ethanol and biodiesel that are made from biomass materials. These fuels are usually blended with petroleum fuels—gasoline and diesel fuel—but they also can be used alone. Using ethanol or biodiesel means you burn less fossil fuel. Ethanol and biodiesel are usually more expensive than the fossil fuels they replace, but they also are cleaner-burning fuels, producing fewer air pollutants. Some experts question the net carbon impact of ethanol.

Biodiesel is an excellent niche renewable-energy fuel source where plant-oil stock is available. A new, emerging oil source is oil-producing algae, which has been successfully grown on some wastewater streams. Other biodiesel oil-producing seed stocks, such as soybean and canola seeds, have high protein by-products that can be sold as animal feed to increase the plant’s financial feasibility.

Biodiesel is a fuel made with vegetable oils, fats or greases, such as recycled restaurant grease. Biodiesel fuels can be used in diesel engines without changing them. It is the fastest-growing alternative fuel in the U. S. Biodiesel, a renewable fuel, is safe, biodegradable and reduces the emissions of most air pollutants.

Ethanol is an alcohol fuel made from the sugars found in grains, such as corn, sorghum and wheat, as well as potato skins, rice, sugar cane, sugar beets and yard clippings. Scientists are working on cheaper ways to make ethanol by using all parts of plants and trees. Most of the ethanol used in the U. S. today is distilled from corn.

Biomass and the environment

Biomass can pollute the air when it is burned, though usually not as much as fossil fuels. When burned, biomass does release carbon dioxide, a greenhouse gas. But when biomass crops are grown, a nearly equivalent amount of carbon dioxide is captured by them through photosynthesis. Each of the different forms and uses of biomass impact the environment in a different way.

Burning municipal solid waste (MSW) or wood waste

Burning MSW and wood waste to produce energy means that less of it needs to be buried in landfills. Facilities that burn waste to make electricity must use technology to prevent harmful gases and particles from coming out of their smoke stacks. The particles that are filtered out are added to the ash that is removed from the bottom of the furnace. Because the ash may contain harmful chemicals and metals, it must be disposed of carefully. Sometimes the ash can be used for road work or building purposes.

Ethanol

Since the early 1990s, ethanol has been

blended into gasoline to reduce harmful carbon monoxide emissions. Blending ethanol into gasoline also reduces toxic pollutants found in gasoline but causes more "evaporative emissions" to escape. To reduce evaporative emissions, the gasoline requires extra processing before it can be blended with ethanol. When burned, ethanol releases carbon dioxide, a greenhouse gas. But growing plants for ethanol may reduce greenhouse gases, since plants use carbon dioxide and produce oxygen as they grow.

Biodiesel

Biodiesel is much less polluting than petroleum diesel. It results in much lower emissions of almost every pollutant: carbon dioxide, sulfur oxide, particulates, carbon monoxide, air toxics and unburned hydrocarbons. Biodiesel has nitrogen oxide emissions that are about 10 percent higher, however. Blending biodiesel into petroleum diesel can help reduce emissions. Biodiesel contains almost no sulfur and can help reduce sulfur in diesel fuel used throughout the country. European automobile technology has developed a diesel passenger car designed to optimize use of biodiesel fuel.

Geothermal Energy

The word geothermal comes from the Greek words *geo* (earth) and *therme* (heat). Therefore, geothermal energy is heat from within the earth. Steam and hot water produced inside the earth can be used to heat buildings or generate electricity. Geothermal energy is a renewable-energy source because the water is replenished by rainfall and the heat is continuously produced inside the earth.

Geothermal energy locations

Most geothermal reservoirs are deep underground with no visible clues showing above ground. Geothermal energy can sometimes find its way to the surface in the form of volcanoes, fumaroles (holes where volcanic gases are released), hot springs and geysers.

The most active geothermal resources are usually found along major plate boundaries where earthquakes and volcanoes are concentrated. Such hydrothermal resources have two common ingredients: water (hydro) and heat (thermal). Naturally occurring large areas of hydro-thermal resources are called geothermal reservoirs. Geologists use different methods to look for geothermal reservoirs. Drilling a well and testing the temperature deep underground is the only way to be sure a geothermal reservoir really exists. Most of the geothermal reservoirs in the U.S. are located in the Western states of Alaska and Hawaii. California is the state that generates the most electricity from geo-thermal energy. The Geysers dry-steam reservoir in northern California, located on the southwest side of the Clear Lake volcanic field, is the largest known dry-steam field in the world. The field has been producing electricity since 1960.

Uses of geothermal energy

Some applications of geothermal energy use the earth's temperatures near the surface, while others require drilling miles into the earth. The three main uses of geothermal energy are:

1. **Direct use**, which uses hot water from springs or reservoirs near the surface.
2. **Electricity generation**, which in a power plant, requires water or steam at very high temperatures (300 to 700 degrees Fahrenheit). Geothermal power plants are generally built where geothermal reservoirs are located within a mile or two of the surface.
3. **Geothermal heat pumps** use stable ground or water temperatures near the

earth's surface to control building temperatures above ground.

Geothermal power plants

Geothermal power plants use hydrothermal resources that have two common ingredients: water (hydro) and heat (thermal). Geothermal plants require high temperature (300 to 700 degrees Fahrenheit) hydrothermal resources that may come from either dry steam wells or hot water wells. These resources are used by drilling wells into the earth and piping the steam or hot water to the surface. Geothermal wells are one to two miles deep. There are three basic types of geothermal power plants.

1. **dry-steam plants** use steam piped directly from a geothermal reservoir to turn generator turbines. The first geothermal power plant was built in 1904 in Tuscany, Italy at a place where natural steam was erupting from the earth.
2. **flash-steam plants** take high-pressure hot water from deep inside the earth and convert it to steam to drive generator turbines. When the steam cools, it condenses to water and is injected back into the ground to be used over and over again. Most geothermal power plants are flash plants.
3. **binary-power plants** transfer the heat from geothermal hot water to another liquid. The heat causes the second liquid to turn to steam, which is used to drive a generator turbine.

Geothermal heat pumps

While temperatures above ground change from day to day and season to season, temperatures in the upper 10 feet of the earth's surface hold nearly constant, between 50 and 60 degrees Fahrenheit. For most areas, this means that soil temperatures are usually warmer than the air in winter and cooler than the air in summer. Geothermal heat pumps use the earth's constant temperatures to heat and cool buildings. They transfer heat from the ground (or water) into buildings in winter and reverse the process in the summer.

According to U.S. EPA, geothermal heat pumps are the most energy-efficient, environmentally clean and cost-effective systems for temperature control.

Solar Energy

The sun has produced energy for billions of years. Solar energy is the sun's rays (solar radiation) that reach the earth. Solar energy can be converted into other forms of energy, such as heat and electricity.

Solar energy can be converted to thermal (or heat) energy and used to:

- **heat water:** for use in homes, buildings or swimming pools
- **heat spaces**: inside greenhouses, homes and other buildings

Solar energy can be converted to electricity in two ways:

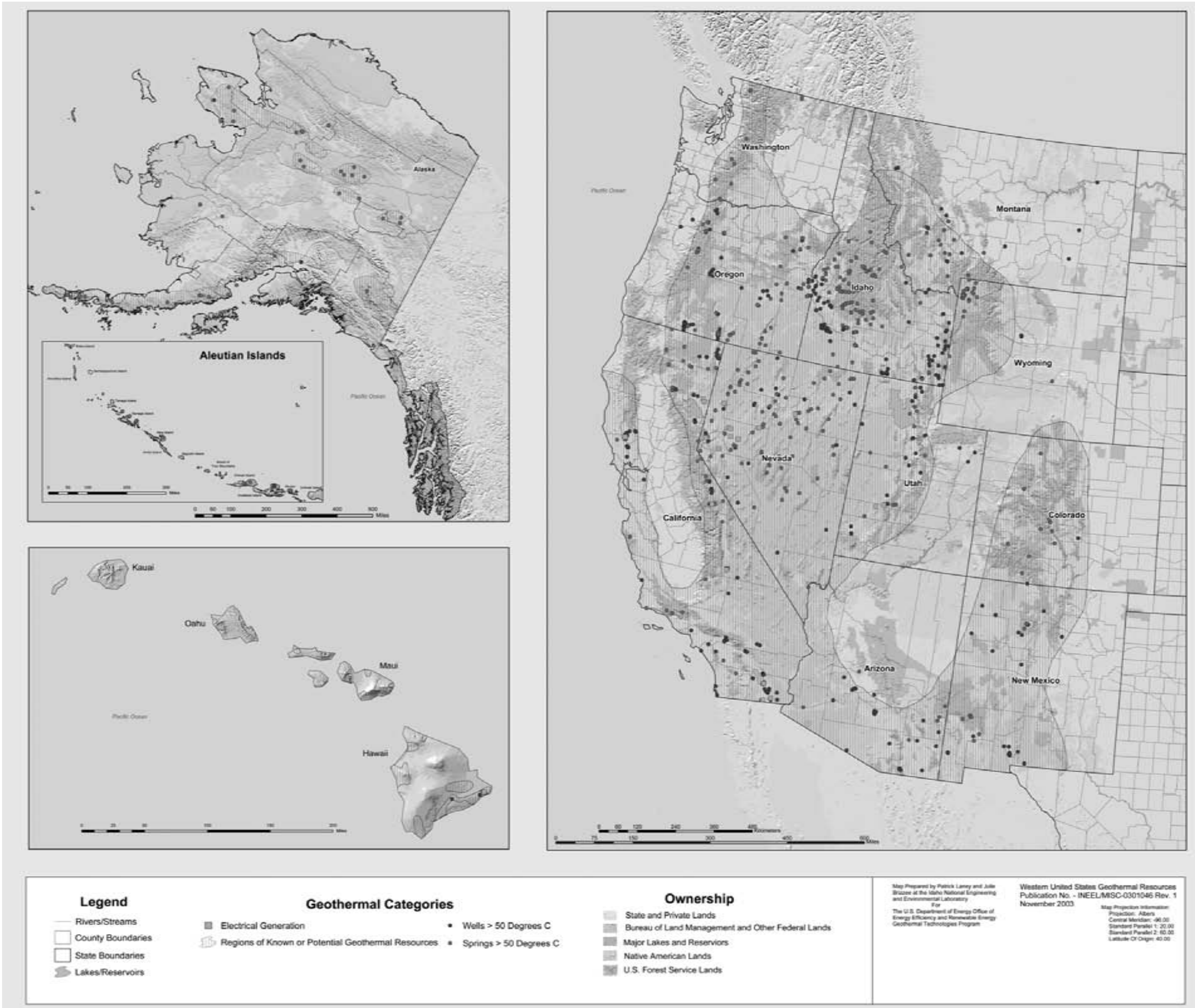
- Photovoltaic (PV devices) or "solar cells" change sunlight directly into electricity.
- PV systems are often used in remote locations that are not connected to the electric grid. They also are used to power watches, calculators and lighted road signs.

Solar power plants indirectly generate electricity when heat from solar thermal collectors is used to heat a fluid, which produces steam that is used to power generators. Out of the 15 known solar electric-generating units operating in the U.S. at the end of 2006, ten were in California and five were in Arizona. Statistics are not being collected on solar plants that produce less than 1 megawatt of electricity, so there may be smaller solar plants in a number of other states.

The major disadvantages of solar energy include:

- The amount of sunlight that arrives at the earth's surface is not constant. It depends on location, time of day, time of year and weather conditions.
- Because the sun does not deliver much energy to any one place at any one time, a large surface area is required to collect large amounts of energy at a useful rate.

Western United States Geothermal Resources[5]



Tax-credit Summary

Excerpted from the Department of Energy's website, *www.dsireusa.org/incentives/index.cfm (visit this website for more details and additional tax-credit information)*

The federal business energy-investment tax credit available under 26 USC § 48 was expanded by the Energy Improvement and Extension Act of 2008. This law extended the duration of the existing credits for solar energy, fuel cells and microturbines; increased the credit amount for fuel cells; established new credits for small, wind-energy systems, geothermal heat pumps, and combined heat and power (CHP) systems; extended eligibility for the credits to utilities; and allowed taxpayers to take the credit against the alternative minimum tax (AMT), subject to certain limitations. The credit was further expanded by The American Recovery and Reinvestment Act of 2009, enacted in February 2009. In general, credits are available for eligible systems placed in service on or before December 31, 2016.

Solar. The credit is equal to 30 percent of expenditures, with no maximum credit. Eligible solar-energy property includes equipment that uses solar energy to generate electricity, to heat or cool (or provide hot water for use in) a structure, or to provide solar-process heat. Hybrid solar-lighting systems, which use solar energy to illuminate the inside of a structure using fiber-optic distributed sunlight, are eligible. Passive solar systems and solar pool-heating systems are not eligible.

Small Wind Turbines. The credit is equal to 30 percent of expenditures, with no maximum credit for small wind turbines placed in service after December 31, 2008. Eligible small wind property includes wind turbines up to 100 kW in capacity.

Geothermal Systems. The credit is equal to 10 percent of expenditures, with no maximum credit limit stated. Eligible geothermal energy property includes geothermal heat pumps and equipment used to produce, distribute or use energy derived from a geothermal deposit. For electricity produced by geothermal power, equipment qualifies only up to, but not including, the electric transmission stage.

Photovoltaic energy

Photovoltaic energy is the conversion of sunlight into electricity. A photovoltaic cell, commonly called a solar cell or PV, is the technology used to convert solar energy directly into electrical power. A photovoltaic cell is a non-mechanical device usually made from silicon alloys.

Sunlight is composed of photons, or particles of solar energy. These photons contain various amounts of energy corresponding to different wavelengths of the solar spectrum. When photons strike a photovoltaic cell, they may be reflected, pass right through, or be absorbed. Only the absorbed photons provide energy to generate electricity. When enough sunlight (energy) is absorbed by the material (a semi-conductor), electrons are dislodged from the material's atoms. Special treatment of the material, which surfaces during manufacturing, makes the front surface of the cell more receptive to free electrons, so the electrons naturally migrate to the surface.

When the electrons leave their position, holes are formed. When many electrons, each carrying a negative charge, travel toward the front surface of the cell, the resulting imbalance of charge between the cell's front and back surfaces creates a voltage potential like the negative and positive terminals of a battery. When the two surfaces are connected through an external load, electricity flows.

The photovoltaic cell is the basic building block of a photovoltaic system. Individual cells can vary in size from about 1 centimeter (1/2 inch) to about 10 centimeters (4 inches) across. However, one cell produces only 1 or 2 watts, which is not enough power for most applications. To increase power output, cells are electrically connected into a packaged weather-tight module. Modules can be further connected to form an array. The term array refers to the entire generating plant, whether it is made up of one or several thousand modules. The number of modules connected in an array depends on the amount of power output needed.

The performance of a photovoltaic array is dependent upon sunlight. Climactic conditions, such as clouds and fog, have a significant effect on the amount of solar energy received by a photovoltaic array and, in turn, its performance. Most current technology photovoltaic modules are about 10 percent efficient in converting sunlight. Further research is being conducted to raise this efficiency to 20 percent.

The photovoltaic cell was discovered in 1954 by Bell Telephone researchers examining the sensitivity of a properly prepared silicon wafer to sunlight. Beginning in the late 1950s, photovoltaic cells were used to power U.S. space satellites. The success of PV in space generated commercial applications for this technology. The simplest photovoltaic systems power many of the small calculators and wrist watches used everyday. More complicated systems provide electricity to pump water, power communications equipment, and even provide electricity to our homes.

Some advantages of photovoltaic systems include:

- Conversion from sunlight to electricity is direct, so bulky mechanical-generator systems are unnecessary.
- PV arrays can be installed quickly and in any size required or allowed.
- Requires no water for system cooling and generates no by-products.

Photovoltaic cells, like batteries, generate direct current (DC), which is generally used for small loads (electronic equipment). When DC from photovoltaic cells is used for commercial applications or sold to electric utilities using the electric grid, it must be converted to alternative resources using inverters, which are solid-state devices that convert DC power to alternating current (AC).

Photo courtesy of the City of Rifle, Colorado

Historically, PV has been used at remote sites to provide electricity. In the future, PV arrays may be located at sites that also are connected to the electric grid, enhancing the reliability of the distribution system.

Net metering

Net metering functions as legislation for customer generators of electric utilities. Net metering allows customers to sell excess power back to the electric provider. Excess power is surplus of what is being produced over what is being used. Being able to sell this excess back to the electric company saves the cost of purchasing, operating and maintaining power-storage equipment (batteries).

Check with your electric utility to see if net metering is available. Legislation for net metering is being conducted state by state. Net metering establishes the price you will get for surplus electricity that you are selling back to the utility.

Passive solar

Passive solar design can be the most cost-effective type of energy. Passive solar has a construction or design cost but little or no operational costs. Passive solar is most efficiently incorporated into a project in the design phase. Passive solar maximizes the use of natural lighting, solar thermal gain and shade, for example. Passive solar is incorporated into the building site, considering location and size of windows, orientation and size of overhangs, and use of skylights and incorporation of heat-gaining construction materials. Passive solar design has experienced new advancements, such as air-warming units that can be incorporated in rooms or adjacent to spaces, which are heated by sunlight hitting a metal panel and warming the air. These heating units are often a way to keep small spaces like pump houses or treatment buildings above freezing temperatures during winter without incurring operational costs.

Solar water heat

Active solar water heaters have been used in the U. S. longer than the electric and gas water heaters that we now think of as traditional. Solar water heaters are a cost-effective way to collect and use solar energy. There are numerous types of solar water heaters–some that use additional fluids to boost efficiency and some that are very simple and easy to construct.

Photovoltaic Solar Resource of the United States[6]

Solar thermal heat

Solar thermal (heat) energy is often used for heating swimming pools, heating water used in homes, and space heating in buildings. Solar space-heating systems can be classified as passive or active.

Passive space heating is what happens to your car on a hot summer day. In buildings, the air is circulated past a solar heat surface(s) and through the building by convection, a process by which less-dense, warm air tends to rise while denser, cooler air moves downward. No mechanical equipment is needed for passive solar heating.

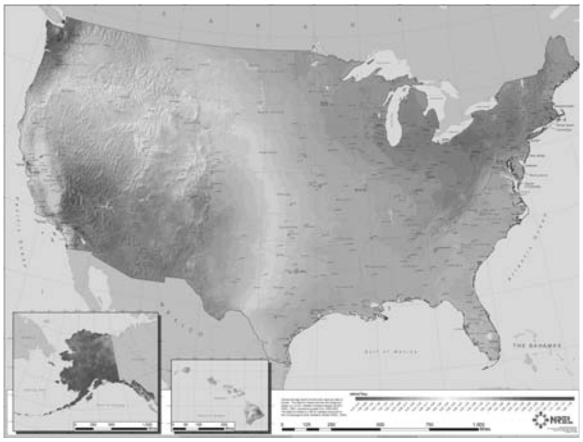
Active heating systems require a collector to absorb and collect solar radiation. Fans or pumps are used to circulate the heated air or heat-absorbing fluid. Active systems often include some type of energy-storage system.

Solar collectors can be either non-concentrating or concentrating:

1. Non-concentrating collectors have a collector area (the area that intercepts the solar radiation) that is the same as the absorber area (the area absorbing the radiation). Flat-plate collectors are the most common and are used when temperatures below about 200 degrees Fahrenheit are sufficient, such as for space heating.
2. Concentrating collectors are where the area intercepting the solar radiation is greater, sometimes hundreds of times greater, than the absorber area.

[6] Billy Roberts, Author, 2008. Map produced by the National Renewable Energy Laboratory for the U.S. Department of Energy, *www.nrel.gov*

Concentrating Solar Resource of the United States[7]



Solar thermal power plants

Solar-thermal power plants use the sun's rays to heat a fluid, from which heat-transfer systems may be used to produce steam. The steam, in turn, is converted into mechanical energy in a turbine and into electricity from a conventional generator coupled to the turbine. Solar-thermal power generation works essentially the same as generation from fossil fuels, except that instead of using steam produced from the combustion of fossil fuels, the steam is produced by the heat collected from sunlight. Solar-thermal technologies use concentrator systems due to the high temperatures needed to heat the fluid. The three main types of solar-thermal power systems are:

- parabolic—the most common
- solar dish
- solar-power tower

Solar energy and the environment

Solar energy is free, and its supplies are unlimited. Harvesting solar energy produces no air or water pollution, but does have some indirect impacts on the environment. For example, manufacturing the photovoltaic cells used to convert sunlight into electricity consumes silicon and produces waste products. In addition, large solar thermal facilities also can harm ecosystems if not properly managed.

Water (Micro-Hydropower)

Micro-hydropower extracts energy from passing water to spin a wheel or propeller that is connected to a shaft. A generator is then able to create electricity from the shaft's spinning force. Placing a hydropower unit in a waterway stretch, with a high gradient and as close to the load as possible, will create the greatest efficiency.

Micro-hydropower is generally considered generation of 300 kilowatts or less. However, some states define micro-hydropower as three megawatts (3,000 kilowatts) or less. Micro-hydropower, like geothermal and biomass, can deliver reasonably constant power. This is an advantage over wind and solar power, which provide intermittent power. Micro-hydropower performance is not dependent upon the weather.

[7]Billy Roberts, Author, 2008. Map produced by the National Renewable Energy Laboratory for the U.S. Department of Energy. *www.nrel.gov*

Photo courtesy of The City of Rifle, Colorado

There are two types of micro-hydropower: high-head and low-head. High-head micro-hydropower uses a small amount of water at a high pressure to generate electricity. Water utilities are more likely to have applications of high-head hydropower places in the transmission or distribution system where water changes elevation downward. Low-head micro-hydropower uses a larger amount of water at low pressure. In-stream micro-hydro turbines can be installed in rivers. In-stream turbines are similar to wind turbines with smaller blades and capture energy from the water as it passes.

Micro-scale hydropower works well for isolated power needs. Distributed-energy applications are an ideal fit for micro-hydropower. In a single-supply and single-load configuration controllers need to be installed to keep the power that is generated matched to the load required. Micro-hydropower can also be safely connected to the grid but needs to be exactly matched to the grid with a controller.

Micro-hydropower typically captures kinetic energy from moving water and converts it to electricity with very little environmental impact. Micro-hydropower does not need to affect the entire flow of a river like large-scale hydropower. Therefore, it does not have the same impacts on fish migration and range. Simple mitigation steps can protect in-stream wildlife from harm by the slow-moving blades used for micro-hydropower. Micro-hydropower applications within a system's transmission or distribution systems will not affect fish or aquatic wildlife. Micro-hydropower does not need a large dam or reservoir necessitating a large change in land use or flora. A micro-hydropower generation unit has a very small physical footprint, creating very little construction impact to the environment. The type of generator used for a hydropower generator will depend upon the pressure and the amount of water. It is also influenced by other factors, such as how much sediment is being carried in the water and the variability of flow.

Micro-hydropower can take just 10 percent as much capital investment per watt hour as solar power. This makes it worth considering as a renewable energy option, if at all possible. Some states have special loan programs for micro-hydropower projects. These loans can cover all pre-development costs and provide the capital to get a micro-hydropower project off the ground.

Wind Energy

Wind is simply air in motion. It is caused by the sun unevenly heating the earth's surface. Because the earth's surface is made of very different types of land and water, it absorbs the sun's heat at different rates. During the day, the air above the land heats up more quickly than the air over water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating winds. At night, the winds are reversed because the air cools more rapidly over land than over water. Today, wind energy is mainly used to generate electricity.

Wind machines

Like old-fashioned windmills, today's wind turbines use blades to collect the wind's kinetic energy. Turbines work because they slow down the speed of the wind. The wind flows over the airfoil-shaped blades causing lift, like the effect on airplane wings, causing them to turn. The blades are connected to a drive shaft that turns an electric generator to produce electricity.

With the new turbines, there is still the problem of what to do when the wind isn't blowing. At those times, other types of power plants must be used to make electricity. Wind electricity is considered intermittent power.

Wind power plants

Wind power plants, or wind facilities, are clusters of wind turbines used to produce electricity. A wind facility usually has dozens of wind machines scattered over a large area. Unlike power plants, many wind facilities are not owned by public utility companies. Instead, they are owned and operated by business people who sell the electricity produced at the wind facility to electric utilities. These private companies are known as independent power producers.

Operating a wind power plant is not as simple as just building a windmill in a windy place. Wind-facility owners must carefully plan where to locate their turbines. One important thing to consider is how fast and how much the wind blows.

As a rule, wind speed increases with altitude and over open areas with no windbreaks. Good sites for wind plants are the tops of smooth, rounded hills, open plains or shorelines, and mountain gaps that produce wind funneling.

Wind speed varies throughout the country. It also varies from season to season.

(See wind resource maps on the National Renewable Energy Laboratory website at *www.nrel.gov*.)

Increase income-generating opportunities, increase demand for labor

Business retention and expansion. As mentioned previously, local utilities are business operations. Maintaining local control of utility services is a way of retaining jobs and income in the local economy. And maintaining reliable and affordable utility services is a way of retaining and growing other businesses. Utility businesses and other businesses are mutually dependent.

New business creation. As with retention and expansion of existing businesses, new business creation requires services from utilities. Poorly maintained utilities or exorbitantly expensive services will hinder creation of new businesses.

Entrepreneurial development. Is your community's waste stream full of garbage or gold? Do the wastewater system's biosolids end up in the local landfill or in a composting operation? Many so-called waste materials can be recycled as feedstock for local businesses, where they will create jobs and income for local residents, while at the same time reducing hauling and disposal costs for the utilities that manage them. Entrepreneurial opportunities are not limited to the waste stream. Does your community's water system produce water of exceptional purity and taste? If so, market it! At the very least, marketing may draw curious sightseers to town, who will, of course, be directed subtly to the business district.

Business recruitment. Recruitment of new businesses to a community has long been a core economic-development strategy. Again, there is a direct relationship between availability and cost of utility services and the ability of a community to attract new businesses.

Import substitution. Your community's utilities may be a source of leakage for the local economy. One solution is import substitution, or replacement of imported products and services with local products and services. Where are chemical supplies purchased? Is there a local source? If the local source is more expensive, is there a win-win solution in which suppliers and buyers can help each other for the benefit of the entire community? Labor is one of the biggest costs for many businesses, including utilities. Do utility executives live in the community or in a management company's home community? Locally owned and operated utilities can increase the multiplier effect.

Share resources. Many communities are regionalizing. Finding collaborative, cooperative ways of collectively determining their future through the increased economies of scale. Sharing resources will actually open up jobs for communities involved.

Improve labor supply

Job linkage and placement. Don't let good jobs sit empty for lack of applicants. Set up formal and informal mechanisms for getting the word out, identifying qualified candidates and getting positions filled. Vacant positions don't contribute anything to the local economy.

Technical skills training. Utilities provide a broad range of employment opportunities, from field labor to technical operations to management and executive positions. Many utilities are currently experiencing difficulty recruiting employees. A local or regional effort to recruit and train system operators could help keep jobs in the community and prepare residents to take advantage of employment opportunities. Community colleges are one possible source of technical-skills training. If you cannot afford to pay industry-standard operator wages, organize your system's operations to allow for new operator to work for a while building experience and then move on. This means that systems need to be set up for a short institutional memory and redundancy is needed for staff with limited experience.

Use your utility as a vocational school to help transform community members into employment candidates. If new business arrives in or near your town, do residents have the skills to perform the work? Businesses moving to rural communities often bring employees in from somewhere else because they cannot find the skills that they need during the start up.

Food for Thought

1. List at least three potential renewable-energy resources in your community (from Team Activity D, page 69):
   - ☐ Industrial wind
   - ☐ Distributed wind
   - ☐ Industrial solar
   - ☐ Distributed solar
   - ☐ Biomass
   - ☐ Bioenergy
   - ☐ Heat pumps
   - ☐ Hydro and micro-hydro
   - ☐ Other ______________________________

2. How might renewable energy bring jobs to your community? Can include education.

   ____
   ____
   ____
   ____

3. In my community, renewable-energy jobs might include:
   - ☐ Electrician
   - ☐ Renewable-energy design
   - ☐ Contractors
   - ☐ Educators
   - ☐ Local utility positions
   - ☐ Local and county positions
   - ☐ Cement workers
   - ☐ Operations and maintenance
   - ☐ Other ______________________________

4. To increase our local economy, I think we could incorporate the following idea(s) for renewable energy: ______________________________

   ____
   ____

5. Possible partners related to renewable energy might include:
   - ☐ Governor's energy office
   - ☐ Chambers of Commerce
   - ☐ Academic institutions
   - ☐ County managers
   - ☐ Local utilities
   - ☐ Local renewable-energy associations
   - ☐ Council of governments
   - ☐ Local nonprofits
   - ☐ Other ______________________________

CASE STUDY

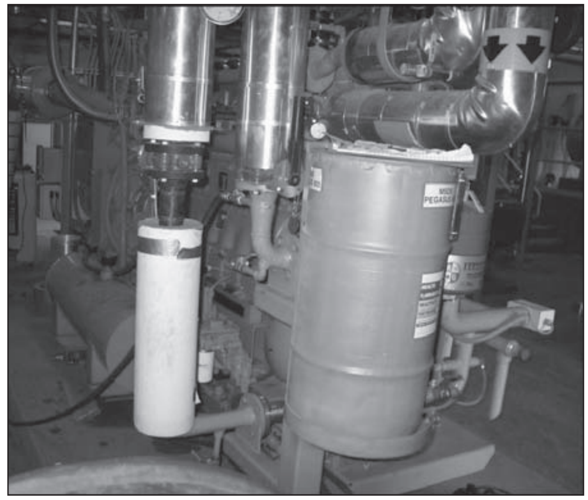
City of Flagstaff's Wildcat Hill Wastewater Treatment Facility

Reprinted, in part, with permission from The Water Infrastructure Finance Authority of Arizona

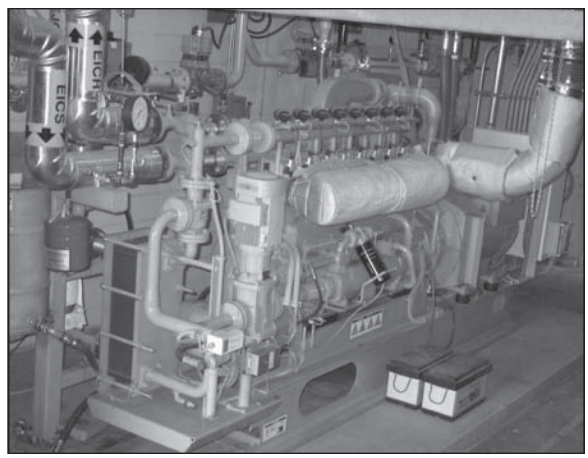
Demographics
Population: 53,894
Median Income: $37,146
Percent of population below the poverty line: 17.4

The City of Flagstaff is located in Coconino County, Arizona, and has a population of about 50,000 (based on the 2000 U.S. Census). The Wildcat Hill Wastewater Treatment Facility has a total advanced treatment capacity of 6 MGD. The facility processes include screening, primary sedimentation, bio-filtration, secondary sedimentation, disinfection, and filtration to produce A+ quality effluent, which is used for irrigation of agriculture in the area. The city partnered with APS Energy Services to construct a biogas co-generation unit at the facility.

The treatment plant added a GE-Jenbacher biogas reciprocating engine to the facility fueled by biogas produced through the anaerobic digester units. The engine is capable of producing approximately 292 kW of electricity at a 7,000-foot elevation at full load. The co-generation unit also has the mixing capability to blend natural gas and digester gas to supplement supplies in the event the volume of digester gas alone falls below levels required to efficiently operate the reciprocating engine, therefore providing sufficient redundancy and reliability in operations. The unit also includes a digester-gas conditioning skid to remove excess moisture and siloxanes from the digester gas prior to fueling the engine, which reduces operational and maintenance costs and prolongs the life of the unit itself. The recoverable thermal output from the engine jacket and exhaust is enough to effectively offset the use of natural gas to heat the boilers used in the digester process as well as for heating the building itself.



Photos courtesy of the City of Flagstaff, Arizona



The City of Flagstaff is currently able to power 30 percent of the Wildcat Hill Wastewater Treatment Plant with energy produced from the co-generation unit alone, translating into a substantial cost savings, improved energy efficiency, and reduced carbon and greenhouse-gas emissions. The anticipated annual savings is estimated at $1,192,526 and 2,300,000 kWh. This project serves as a testament to the city's continuing commitment to energy conservation and sustainable operations in public works.

CASE STUDY

Southwestern Arizona Area Turns Trash into Cash
Town Reduces Waste, Cuts Costs

By Fred Warren, RCAC rural development specialist, Arizona, and Victoire S. Chochezi, RCAC's RURAL REVIEW *editor; reprinted, in part, from an article that appeared in the October 2008* RURAL REVIEW

Demographics
Population: 7,520
Median Income: $26,544
Percent of population below the poverty line: 75

Rural residents struggling with how to economically dispose of their trash can take a lesson or two from the small town of Somerton, Ariz. Somerton turned its problem waste into a profit. Now the area is trying to expand its cost savings to the whole region. The area is exploring a host of green ideas, including composting, bio-diesel, wind and solar energy.

Rural Community Assistance Corporation (RCAC), the Western RCAP, has been working in Arizona for nearly 30 years. So when Somerton had a problem, the town's officials and the local U.S. Department of Agriculture (USDA) Rural Development staff called RCAC. They enlisted RCAC to help reduce Somerton's costs for hauling solid waste to a transfer station, which is a 34-mile trek away. As fuel prices began to climb, the need to reduce costs became more acute.

Initial Success

RCAC accepted the challenge and began collecting data on recent costs of handling Somerton's waste material. Then, using demographic information and standard estimates of solid-waste characteristics, RCAC figured household, commercial and public-works waste contributions in pounds per category.

There was no plan to separate and reuse green waste or street-cleaning waste. Two categories that the analysis highlighted were green waste (yard and tree trimmings) and street-cleaning waste (dirt and rocks). Following RCAC's suggestion, the town purchased a chipper to cut the green waste and now uses the chips on playgrounds, as bedding mulch and as top fill around trees. For gravel and sand picked up by street cleaners, RCAC suggested purchasing a screen to separate dirt and rocks and reusing the material in alleyways and other areas in the community. The town agreed, and by re-using the street waste, it has reduced its costs of buying dirt and rock for street repairs and has eliminated its long trips to the landfill. Removing these items from the solid-waste stream cut yearly costs by a third.

Thus RCAC helped Somerton successfully eliminate approximately 580 tons annually of its solid waste, street-cleaning waste and green-waste disposal, saving the community approximately $35,000 per year. The next phases include regional in-vessel composting of solid waste, green waste and wastewater.

Somerton, Ariz., plant photo by Fred Warren, RCAC

RENEWABLE ENERGY SOURCES

CASE STUDY

Renewable Energy at Channel Islands National Park

U.S. Department of Energy Technical Assistance Case Study
Reprinted, in part, with permission from the U.S. Department of Energy Federal Energy Management Program

Demographics
Population: 3,142
Median Income: $58,306

Channel Islands National Park is located off the coast of southern California and comprises Anacapa, Santa Barbara, Santa Cruz, San Miguel, Santa Rosa Islands, and the surrounding ocean.

The National Park Service protects the pristine resources at Channel Islands by conserving, recycling, using alternative-fuel vehicles, using renewable energy, and using resources wisely. It also seeks to replace conventional fuels with renewable energy wherever possible.

Santa Rosa Island

In September 1995, a grant from the U.S. Department of Energy's Federal Energy Management Program (FEMP) allowed the park to implement a hybrid wind/photovoltaic (PV) energy project on Santa Rosa, the largest of the islands in the park.

This system was expected to supply electricity to the ranger station, facilities and residence. It essentially replaced a 35-kW diesel generator that used 17,500 gallons of diesel fuel and 120 gallons of motor oil each year.

San Miguel Island

San Miguel Island currently boasts several renewable-energy projects, including a ranger station with a 12-volt DC hybrid wind/PV system, a Grundfos water-pumping system, a 12-volt PV power system for a research station, a Handar weather station, and a U.S. Navy 12-volt weather station. A new, 2,200-square-foot ranger station was added and incorporated a 900-W wind/PV power system, solar preheater, rainwater collector for toilet flushing, low-flush toilets, nine solar-tube skylights, three Sunfrost refrigerators, and low-volt fluorescent lighting.

Anacapa Island

Anacapa Island has the park's highest visitation rate. In 1983, a 10-kW PV array was installed on its old fuel building; the array was reconfigured in 1987. Until 1992, a lighthouse and navigational aids were powered by 10-kW diesel generators. The U.S. Coast Guard reconfigured the lighthouse, implemented conservation measures, and converted the system to operate as a stand-alone PV system. The system cost $17,498 and had a 3½-year payback.

These measures have reduced the island's total diesel fuel consumption from more than 14,700 gallons annually to 263 gallons in 1996.

Santa Barbara Island

Santa Barbara Island is the park's smallest island. It includes a visitor's center, a four-person bunkhouse and a two-bedroom apartment for a resident ranger. The station incorporates a 5-kW stand-alone PV array that consists of 80 siemens m-57 modules, 48 trojan-105 batteries, an SES controller, and a Westec 5048 inverter. The system provides the entire electrical supply to the station and has no backup generator. It displaces approximately 4,000 gallons of diesel fuel annually. The system paid for itself in 3½ years and now operates cost-free.

Environmental Benefits

One of the biggest environmental concerns about using fossil fuels in the Channel Islands is that these fuels must be shipped in from the mainland. They must be transferred from a ship to a tanker truck and then to the generators, and there is always the risk of a spill during any of these transfers. Also, diesel systems discharge many harmful pollutants into the atmosphere.

Economic Benefits

For every 2,400 gallons of fuel delivered to the islands, the required boat trip consumes 350 gallons of diesel and takes 36 employee hours. These hidden costs mean that the Channel Islands' fuel is 57 percent more expensive than mainland fuel. Also, if one catastrophic oil spill should occur, the cleanup alone would cost $1 million to $1.5 million. Restoring natural resources and repairing facilities would add even more costs.

Preserving natural resources with renewable ones makes sense for the Channel Islands, and the National Park Service continues to find ways to use clean, renewable energy to meet its needs.

For more information, visit:
www.eere.energy.gov

CASE STUDY

Washington State Tribe Adopts Water-efficiency measures

National Small Flows Clearinghouse Case Study

Project funded by the U.S. Environmental Protection Agency under Assistance Agreement No. CX824652
Reprinted, in part, with permission from the U.S. Environmental Protection Agency

Demographics
Population: 11,713
Median Income: $46,302
Percent of population below the poverty line: 7.2

The challenge

The Stillaguamish Tribe in Arlington, Wash., developed a water-conservation program to help alleviate problems associated with a failing community septic tank and drain field system. Originally, five separate drain fields and two community drinking water wells were constructed to serve 30 homes on 20 acres of land. However, within 5 years, two of the five drain fields had to be replaced because of failure.

The goal of the water-conservation program was to reduce residents' consumption of drinking water that came from the tribe's system, which would subsequently reduce the amount of water put into the septic tank-drain field system.

In 1991, the water-conservation program included retrofitting standard toilets with ultra low-flush toilets, installing flow-restriction devices on all faucets, and implementing a water-conservation education program for the homeowners in the development. In 1992, failing water meters were replaced, which allowed for individual water use to be measured and leaks to be discovered within the water-distribution system.

The water-conservation program reduced the community's average water use from 250,000 to 200,000 gallons per month. Water usage dropped about 35 percent per home for the first 9 months after the water-conservation program was adopted. In addition, there was a reduction in operation and maintenance costs for the two water-supply wells due to the reduced water demand, and surfacing septage in the tribe's drain fields has not been a problem since the water-conservation program was implemented.

CASE STUDY

LEED in Action

Reprinted, in part, with permission from The Water Infrastructure Finance Authority of Arizona

Demographics

Population: 223,314
Median Income: $53,223
Percent of population below the poverty line: 13.4

In 2006, the Triangle Wastewater Treatment Plant in Durham County, N.C., completed the nation's first LEED-certified wastewater administration building, setting a new standard for the future and demonstrating environmental possibilities in public works. LEED stands for Leadership in Energy and Environmental Design and is an internationally recognized certification system for energy-efficient and environmentally friendly buildings.

The treatment plant is a small facility servicing about 8,000 people and was originally constructed in 1960. After experiencing significant system failures due to aging infrastructure, the facility was redesigned and retrofitted to meet the LEED certification by using low-energy, recycled and regionally manufactured materials.

The wastewater generated by the building itself is treated, recirculated to the HVAC system and used in low-flow toilets, ultimately reducing the facility's potable water use to 32 percent (Trent, 2006).

Triangle Wastewater Treatment Plant
Photo courtesy of Durham County Engineering Department

CASE STUDY

Rifle Regional Wastewater Reclamation Facility and the Colorado River Raw-water Pump Station in Rifle, Colo.

Reprinted, in part, with permission from The Water Infrastructure Finance Authority of Arizona

Demographics
Population: 6,784
Median Income: $42,734
Percent of population below the poverty line: 6.4

Rifle is a rural community located along the Interstate 70 corridor in western Colorado. With a population of 8,700, Rifle may be small in size but is big on sustainable, green infrastructure. The city is poised to become one of the first "energy villages" in the nation, combining co-generation facilities, biofuels production, solar and geothermal energy supply, and an environmental education center designed to showcase the community's commitment to clean, renewable, independent energy use and production in concert with the promotion of sustainable practices.

The Rifle Regional Wastewater Reclamation Facility and the Colorado River Raw-water Pump Station site are the first working pieces of this planned energy village. The wastewater facility is located on approximately 12 acres and will be capable of producing 5 million gallons of Class B+ treated wastewater per day, with future expansion capabilities to 10 million gallons.

The city chose to install a vast photovoltaic solar system to power the two new facilities. The power system has an output of 1.72 MW produced at the wastewater facility and another 600 kW produced by the pump station site. More than 10,000 single-axis ground-mount tracker panels comprise the combined array, and the first year of operation was expected to realize enough solar-energy production to power more than 7,000 homes for an entire year. In addition, projections indicate that the combined solar arrays will offset more than 152 million pounds of carbon dioxide that would have been produced if the facilities had continued to operate with electricity produced from traditional fossil fuels over a 20-year period.

Photo courtesy of the City of Rifle, Colo.

In addition to harnessing renewable energy alternatives like solar, geothermal, and biofuel production from algae-growing operations, the wastewater facility also demonstrates its commitment to the watershed approach by water-recycling practices that include on-site landscape irrigation and non-potable process uses within the facility itself.

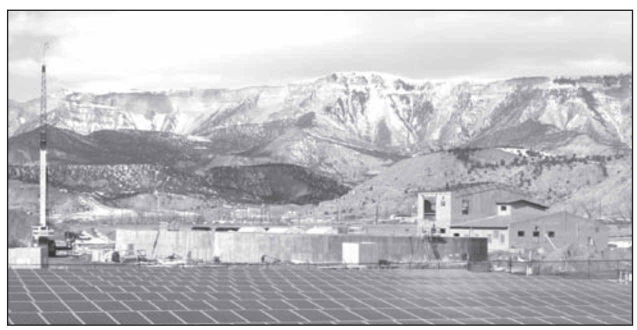


Photo by Don Ludwig, Colorado Water Journal

Through innovative planning, design, engineering and funding strategies, the City of Rifle has demonstrated that small, rural communities can be leaders in deploying reliable off-grid power that directly benefits the environment and the local economy. This project was made possible through a public-private partnership with SunEdison, North America's largest solar-energy services provider, which financed and built the solar-energy systems with no up-front capital costs to the city. Instead, the city will purchase the solar electricity from SunEdison at below-retail prices.

RCAR

Funding resources for public water and wastewater utilities are available.

See the U.S. Department of Energy's website at *www.dsireusa.org* for details on specific state and federal programs. There are federal, state, county and special, targeted-area programs for:

Fee waivers	Tax abatement	Tax credits
Tax exemption	Utility rebates	Incentives
Loans	Grants	

Resources

American Council for an Energy Efficiency Economy: Water and Wastewater
www.aceee.org/topics/water-and-wastewater

Applied Solutions
www.appliedsolutions.org

Applied Solutions supports counties and cities to identify and implement advanced technologies, policies and services through integrated systems to build resilient, healthy and stable local economies and communities.

AWWA resource book *The Green Utility: A practical guide to sustainability*, by Cheryl Welch
www.awwa.org

- What does sustainability mean to a water utility?
- Why would a water utility want to be more sustainable?
- Sustainability status, progress and planning
- What sustainability opportunities exist at a water utility?
- Who do we talk about sustainability?
- Core principles of Soft Path Analysis

The California Energy Commission energy efficiency with water
www.energy.ca.gov/process/water/eff_water.html

Colorado Water Resources and Power Development Authority: feasibility grants and construction loans to cities, towns and districts for development of micro-hydropower (less than 5 megawatts)
www.cwrpda.com

DSIRE: Department of Energy (DOE) database of state and federal incentives, such as net metering, rebates and tax credits, for renewable energy and energy efficiency
www.dsireusa.org

Energy Alternatives Ltd. micro-hydropower calculator
www.energyalternatives.ca/SystemDesign/hydro1.html

Energy Information Administration: an in-depth description of energy efficiency and how it is measured
www.eia.doe.gov/emeu/efficiency/contents.html

Energy Information Administration: energy price information, trend information from the Energy Planet renewable energy directory of micro hydro-power resources
www.energyplanet.info/Micro_Hydro/

Energy Star for Wastewater Plants and Drinking Water Systems
www.energystar.gov/index.cfm?c=water.wastewater_drinking_water

Geothermal resource maps
www1.eere.energy.gov/geothermal/maps.html

National Renewable Energy Laboratory (NREL): renewable energy, technology transfer—terms, energy analysis, research and product reporting for home and businesses
www.nrel.gov

National Renewable Energy Laboratory (NREL): In My Backyard tool—estimates the electricity you can produce with a solar photovoltaic (PV) array or wind turbine at your home or business. Homeowners, businesses, and researchers use IMBY to develop quick estimates of renewable energy production at locations throughout the continental United States, Hawaii and northern Mexico.
www.nrel.gov/eis/imby

National Renewable Energy Laboratory (NREL): State and local governments, Indian tribes and U.S. territories may apply to receive technical assistance from NREL for understanding and deploying energy efficiency and renewable-energy technologies.
www.nrel.gov/analysis/pdfs/40780.pdf

Renewable-energy cost trends
www.nrel.gov/analysis/analysis_tools_benefits.html

Rural Community Assistance Corporation (the Western RCAP): *Green Building Guide, Design Techniques, Construction Practices & Materials for Affordable Housing*
www.rcac.org/assets/greenbuild/grn-bldg-guide_4-20-09.pdf

Solar America
A guide to community solar: utility, private and nonprofit project development
In communities across the United States, people are seeking alternatives to conventional energy sources. Whether they aim to increase energy independence, hedge against rising fuel costs, cut carbon emissions, or provide local jobs, they are looking to community-scale renewable-energy projects for solutions. Advances in solar technology, an increase in federal and state tax incentives, and creative new financing models have made solar projects, including community solar projects, more financially feasible.
http://solaramericacommunities.energy.gov/resources/

State of Colorado, Governor's Energy Office: resources on residential buildings, commercial buildings, electric and gas utilities, greening government, energy savings partners, renewable energy and the Colorado Carbon Fund
www.rechargecolorado.com

Toward a Sustainable Community: A Toolkit for Local Government
www4.uwm.edu/shwec/publications/cabinet/reductionreuse/SustainabilityToolkit.pdf

U.S. Department of Agriculture—Rural Development Energy Programs: funding is available yearly as grants and guaranteed loans to assist rural small businesses and agricultural producers with renewable-energy and energy-efficiency projects
www.rurdev.usda.gov/Energy.html

Application process guidance is available at:
http://www.rurdev.usda.gov/rbs/busp/9006grant.htm

U.S. Department of Energy (DOE): best-practices library of resources and new-technologies information
www1.eere.energy.gov/industry/bestpractices

U.S. Department of Energy: Wind Energy for Municipal Water Supply
www1.eere.energy.gov/windandhydro/municipal_water_supply.html

U.S. Environmental Protection Agency (USEPA) Combined Heat and Power Partnership: Municipal Wastewater Treatment Facilities
www.epa.gov/chp/markets/wastewater.html

U.S. Environmental Protection Agency (USEPA): promoting energy efficiency in the water sector
www.epa.gov/WaterSense

U.S. Environmental Protection Agency (USEPA): Sustainable infrastructure for water and wastewater
http://water.epa.gov/infrastructure/sustain/index.cfm

U.S. Government
www.eia.doe.gov/oiaf/aeo/electricity.html

Wind Powering America: maps of wind resources and wind projects
www.windpoweringamerica.gov/where_is_wind.asp
www.nrel.gov/wind/resource_assessment.html

NOTES

Appendices

Building Community Prosperity Through Natural Capitalism

Reprinted with permission from The Rocky Mountain Institute, www.rmi.org

Every community has untapped potential that can create living-wage jobs, plus increased income, business, and saving. Listed below are dozens of ways communities are tapping this potential today through Natural Capitalism. Many of these actions are well-known, others innovative. They distribute benefits widely across the community, and they're compatible with the environment. Most require little or no community expansion. While not all apply to every community, the length of this list highlights the undeveloped wealth-generation power in virtually every community. Often, community-development decisions are made behind the scenes. In contrast, Natural Capitalism is most effective when people from all walks of life choose their community's future collaboratively and base their choices on practicality and compatibility with the community and its environment.

I. Invest in Resource Productivity

by "plugging the leaks"

A local economy might be compared to a bucket that the community would like to keep full. Business recruitment and community expansion are attempts to pour more money into the bucket. While these strategies may have succeeded in the past, today they often fail or generate more costs than benefits to the community. Focusing entirely on more ways to fill the bucket ignores vast opportunities for "plugging leaks." Economic buckets invariably have holes through which pounds or dollars leak every time local resources are used inefficiently. Smart communities seek profitable ways to keep the bucket full by plugging unnecessary leaks through one or more of the techniques listed below. As a result, their economies are more resilient and less vulnerable to the influences of the global economy. This strategy is good news for communities that have little hope for expansion. It's equally encouraging for those in which expansion is creating problems. Instead of relying on the hope of continuous expansion, that is also imposing large costs, rapidly expanding communities now have many alternatives.

As you read the following examples, think about similar or quite different ways to plug your community's leaks. (For more business examples, see Rocky Mountain Institute's new book Natural Capitalism or its website *www.naturalcapitalism.org.*)

1. Energy-efficiency programs create local jobs and save millions of dollars in any community. Sacramento Calif., invested $59 million to save electricity. This enabled utility customers to save nearly that same amount. The program created 880 direct jobs and increased regional income by $124 million. Though energy is a small portion of total costs, saving energy will provide a significant contribution to profits and economic progress.
2. Local ownership increases the wealth-creating power of each local transaction. Land trusts, coops, and employee stock ownership can ensure permanent local ownership of many businesses by buying local buildings and renting only to residents (at cost).

   Example: The Green Bay Packers are owned by a corporation whose majority stockholders are from Wisconsin.
3. Import substitution replaces "imports" with local products and services. Simple example: Locally bottled water in Tropic, Utah, replaced imports and established a new business.
4. Local sourcing links local-business buyers with local suppliers. An early program in Eugene, Ore., created 100 jobs in its first year without any physical expansion of the city.

5. Water efficiency: The grassroots Mothers of East Los Angeles marketed a low-flush-toilet retrofit program that installed 270,000 toilets in three years, returned $4 million to the neighborhoods in jobs, water-bill savings, and community programs, and saves over 3.4 billion gallons of water every year.

6. Downtown revitalization reduces economic leakage, builds pride, encourages infill, preserves culture, celebrates history, reuses resources, and reduces traffic.

7. Entrepreneurial training: Since 1993, the Nebraska EDGE training courses have assisted more than 1,250 individuals, entrepreneurs, small business owners and their partners start and improve their businesses.

8. Community-supported agriculture: CSAs are local farms that increase productivity, reduce costs, and sell specialty crops directly to consumers and restaurants.

9. Business mentoring: Veteran business people “adopt” start-up businesses—giving rookie proprietors someone to talk with when things go wrong, helping them understand and avoid pitfalls.

   Such programs significantly reduce the high failure rate of start-ups.

10. Community cash flow can be captured through such community enterprise as locally based credit cards, debit cards and phone service. South Orange, New Jersey’s municipal credit card funds downtown revitalization.

11. Local currency: Ithaca, New York’s currency is accepted by 1,200 businesses and can’t be spent out of town.

12. Microcredit: Many low-income or impoverished people have the skills but lack the credit to start a business. Tailored to very small, often home-based, start-up businesses, micro-loans are too small for conventional banks.

    Usually offered by nonprofit organizations in conjunction with basic business training, microcredit often provides a way out of poverty and off welfare.

13. Business “visitation” programs enlist local leaders to visit businesses to determine needs and concerns. Proprietors get the chance to offer suggestions to local governments and organizations regarding changes that could benefit local business.

II. Shift to Biologically Inspired Economic Models (Biomimicry)

In the economic climate of the 21st century, competitiveness requires lean business practices that, like biological systems, reduce and eventually eliminate waste. To be competitive, communities must pursue development strategies that analyze local material, energy, and waste streams; identify business opportunities; and match those opportunities with local businesses. Multiple benefits include more businesses and jobs, reduced resource inputs (and, therefore, lower costs), prolonged life of the local landfill, and reduced pollution. The transition to bio-entrepreneurship has begun:

14. Waste matching (or industrial symbiosis): Computer networks can make virtual industrial ecosystems by matching waste with potential buyers; examples under development include numerous state programs such as New Hampshire and Michigan.

    ReMaDe in Essex, England is a five-year project to create new markets and secondary uses for recycled materials.

15. Building salvage—Rather than demolish a building, dismantle and reuse its components. Southern California Gas saved $3.2 million or 30 percent of construction costs on an office and education building by partly dismantling and reusing an existing building. The finished building was 80 percent made of recycled materials, keeping 350 tons of material out of the landfill.

16. Remanufacturing creates businesses and

jobs and reduces resource inputs. This new "industry" is now larger than the steel industry. In Telford, England, old Ricoh photocopiers are reconditioned instead of being dumped in landfill sites. 90 percent of parts are reused.

17. Advanced business retention and expansion programs mimic biological systems by enhancing adaptation, competition, interrelationships, and information flow. Littleton, Colorado's program created jobs at six times the rate of its earlier recruitment efforts by offering such services as problem research, competitor analysis, industry-trend monitoring, video conferencing, training, and market mapping. Such local policies enhance quality of life and intellectual infrastructure.
18. Flexible business networks: Several small businesses partners bid on contracts too big for any one of them, not unlike coyotes who usually hunt on their own, but run in packs when seeking larger game.
19. Storm-water capture saves money, recharges groundwater, and reduces pollution by helping rain soak in the ground where it falls rather than collecting it into expensive centralized systems, which, in some areas, overwhelms sanitary sewage systems resulting in significant pollution. (Example: Permeable parking lot material.)

III.Reinvest in Natural Capital

Everyone knows that living systems provide us with products, such essential natural resources as oil, water, trees, fish, soil, and air. Living systems also provide us with equally essential services. These ecosystem services include:

- Cooling (shade trees)
- Flood control (root systems)
- Purification of water and air (wetlands)
- Storage and recycling of nutrients (roots)
- Sequestration and detoxification of human and industrial waste (wetlands and ground filtration)
- Pest and disease control (by insects, birds, bats, and other organisms)
- Production of grasslands, fertilizers, and food
- Storage and cycling of fresh water
- Formation of topsoil and maintenance of soil fertility

These services are essential to doing business (and maintaining human life).

Worldwide, however, these services are declining. Many of them have no known substitutes at any price. The future's strongest competitors will be businesses and communities that recognize these facts and invest accordingly:

20. Restore natural ecosystems: In Port Angeles, Wash., an estuary-restoration project is saving the local lumber mill $150,000 yearly through more efficient logistics. It created space for expanding the mill and improved the town's tourism.
21. Create urban ecosystems: Supported by these systems, birds, bats, and frogs eat pesky insects. Also, property values increase, for example near San Francisco's Golden Gate Park, by $500 million to $1 billion, which generates an additional $5-$10 million in property taxes. In inner-city South Central Los Angeles, a park restored from an old industrial site is "like a grain of sand in an oyster, creating an economic development pearl."
22. Foster eco-tourism to create local jobs while protecting important environmental values.
23. Maintain wetlands for waste treatment, storm-water retention, and wildlife habitat. Arcata, Calif., restored 154 acres of wetlands and used it to treat city wastewater. The resulting marsh is now a wildlife habitat in which salmon are reared. The cost was a fraction of the costs for a conventional energy-intensive wastewater treatment system.

One researcher estimated the economic

benefits generated by single acre of wetland at $150,000 to $200,000. Barns Elms reservoirs near London, England have been transformed from 43 hectares of concrete basins into diverse wetlands, which attract visitors.

24. Maintain watersheds for flood control and drinking water.
25. Protect and enhance vegetative cover.
26. Protect ground water from chemical contamination.
27. Restore aquatic habitat.
28. Reduce carbon dioxide emissions: Through energy and water efficiency in city operations, Regina, Saskatchewan reduced its CO^2 emissions by 10 percent while saving $393,000.

Note: The list of ecosystem services in this article do not include such services as noise abatement and peaceful sanctuary because some may regard them as non-essential. Neither does it include such services as climate stabilization, protection against harmful cosmic radiation, distribution of fresh water, and regulation of the chemical composition of the atmosphere because some may argue that the depletion of these services is caused by factors too distant for community action. However, an increasing number of communities and businesses are implementing policies to make themselves "climate neutral" because doing so will save money and enhance shareholder value.

Building Community Capacity

Leaders can help their communities take charge of the future and be a part of the new economy. Alternatively, they can try to keep decisions to themselves, publicly attack people who discuss innovative ideas and, in so doing, allow their communities to be tossed by the winds of rapid change. Those who choose the first option develop Natural Capitalism.

How can a community implement Natural Capitalism? How does it start on the road to a more sustainable development strategy? These and other questions are explored in the companion text, "Framework for Community Sustainability."

Business Believes in Natural Capitalism

Don't be surprised if Natural Capitalism sounds unfamiliar. The book describing it came out only recently. But already its ideas are being adopted by business. Here's what corporate leaders are saying:

"Your book is hugely important and ought to be on the nightstand of every CEO."

—Thomas Petzinger Jr, Millennium Edition Editor the *Wall Street Journal*

"As the industrial arm of modern society's larger body struggles to come to terms with the mounting evidence of the damage it is inflicting on the body itself and the body's home, Earth, Natural Capitalism provides some crucially important guidance. Looking for available philosophical starting point? Here it is. Looking for hard evidence to validate that philosophy? Here it is. Looking for peace of mind? Start here."

—Ray C. Anderson, Chairman and CEO, Interface, Inc.

"Three of the world's best brains have…created a work that future historians may look back upon as a milestone on our way to a new, sustainable economy. In this book you will find a wealth of constructive, forward-looking ideas and suggestions, based on solid scientific research."

— Tachi Kiuchi, Managing Director of Mitsubishi Electric Corporation, Chairman of the Future 500

"This book is a 'must-read' for those leaders in government and business who do not believe that sustainability is necessary or practical. It shows both the need and the way to all those who are not yet ready to do what we must do to leave a livable world to our grandchildren."

— Murray Duffin, Vice-president Total Quality and Environmental Management, STMicroelectronics

Contact:
Rocky Mountain Institute
1739 Snowmass Creek Rd.
Snowmass CO 81654
970/927-3851
www.rmi.org

Published Resources

Natural Capitalism: Creating the Next Industrial Revolution: by Paul Hawken, Amory Lovins and L. Hunter Lovins.

The book describes innovative principles and practices for increasing competitiveness in ways that reduce waste and increase productivity. A summary article that appeared in the Harvard Business Review can be found at *www.naturalcapitalism.org.*

Green Development: Integrating Ecology and Real Estate, by Wilson, Uncapher, McManigal, Lovins, Cureton, and Browning. Describes an exciting new field in which environmental considerations are viewed as opportunities to create fundamentally better buildings and communities. 522 pages.

Economic Renewal Guide: A Collaborative Process for Sustainable Community Development, by Michael Kinsley. This field-tested manual describes how a few energetic people can help steer their community toward development that is sensitive to local values and the environment. 225 pages.

Taking Sustainable Cities Seriously: Economic Development, the Environment, and Quality of Life in American Cities, by Kent E. Portney, 284 pages, MIT Press, Cambridge, MA.

Communities by Choice: An Introduction to Sustainable Community Development, by Mountain Association for Community Economic Development, Berea, KY.

Going Local: Creating Self-Reliant Communities in a Global Age by Michael Shuman. Details how dozens of communities are gaining control over their economies by investing locally, replacing imports, and working to eliminate many subsidies and changing tax and trade laws that disempower communities. 270 pages. Free Press.

Real Towns: Making Your Neighborhood Work, by Harrison Bright Rue and the Local Government Commission. Gives local leaders the tools needed to apply the "New Urbanist" principles of traditional neighborhood design to their communities.

A Few Key Web Resources To Help You Get Started

American Planning Association
www.planning.org

Center for Livable Communities
www.lgc.org/center

NebraskaEDGE program, University of Nebraska
http://nebraskaedge.unl.edu

Littleton, Colo., "Economic Gardening"
www.littletongov.org/bia/economicgardening

The Natural Step
www.naturalstep.org

Philadelphia Citizens Planning Institute
www.citizensplanninginstitute.org

Port Angeles, Wash.
www.portofpa.com/about/economic-development.html

Remanufacturing Industries Council
www.remancouncil.org

Renewable Energy Policy Project
www.repp.org

Sonoran Institute
www.sonoran.org

Sprawl Watch Clearinghouse
www.sprawlwatch.org

Smart Communities Network
www.smartcommunities.ncat.org

Zero Emissions Research and Initiatives
www.zeri.org

Partnering for Progress

Onsite power for water providers is a matter of cooperation

By Paul Hull

More and more water districts, communities, and private companies are undertaking to use renewable power (so far, it's been mostly solar or wind) for some, or all, of their operations. Renewable power onsite and under local control brings with it an independence that some communities thought they would never see again. Communities or private purveyors of water must change their power sources to meet new state regulations and operate their businesses as their customers wish. Although switching to onsite renewable power may sound expensive and technically unfeasible, in reality, many communities (served both by public or private water purveyors) have been tasked with altering their current power sources to meet new regulations and/or customer needs. As a result, onsite power for water purveyors is no longer a fringe option but rather a mainstream solution. And when it comes to using renewable sources for onsite power, water districts and utilities are leading the way.

The driving force behind this nationwide move to using more renewable energy, rather than energy-based on fossil fuels, comes from the communities and states (equals we the people!) who want better things for their future, their children, and grandchildren. That driving force is not a sales ploy from companies who happened to have developed new technologies. It is a genuine concern for the future of our nation, especially when the frequency and cost of outages in the traditional systems of power are forecast to get worse. One of the leading solar power companies, Solar Power Partners, has more than 40 successful systems in operation already. It was financed by solar power purchase Aareements (PPAs). Those are the practical means by which even your community or utility can stop shrugging shoulders and advance with others.

"One should always check the availability of local subsidies," observes Kevin Ross, Senior Project Development Manager at SunPower Corporation, a company that has led the progress in renewable-energy programs for some years. SunPower focuses on the water industry, including the irrigation-water nexus. "There are federal programs for tax credits, and different states have different structures for renewable-energy credits. More than half of our states have an RPS requirement." RPS stands for renewable portfolio standards. One of the simplest ways for a community to start the momentum is to offer a number of acres for building a power plant. The public authority may have to make some basic preparations on the land (dozing, grading, etc.), but the benefits from that simple start can be huge for the community. People who live in big, crowded cities may not see where there are five acres of public land available, but there are thousands of communities that do enjoy such potential wealth.

"There are different financial structures for water utilities," adds Ross, with PPAs perhaps the most popular today. "A developer such as SunPower, with financial strength and design-build capability, can work out a development plan that brings no capital cost to the user. A long-term agreement would be 20 years for such a contract." Yes, there are different levels of solar power, and you should research the technical side of this subject. SunPower, for example, claims the most powerful solar available, thanks to its proprietary solar cell, and can produce over a 30-year period 43 percent more total energy than comparable photovoltaic (PV)-based solar energy systems and about 105 percent more than thin-film solar systems. SunPower tends to concentrate on customers who require bigger systems as it has excellent resources for land-use issues. A typical 1-MW system, ground-mounted, would take up 5 to 9 acres.

More than 25 water agencies in the western states have used SunPower solar systems, including a 3.5-MW system on four sites for the Inland Empire Utilities Agency, which anticipates savings of $200,000 in electricity costs in the first year! There is also a 2.2-MW system for Lake County Sanitation District in California. That is expected to save residents up to $5 million over the next 20 years.

"Why California?" you may be asking. Under Assembly Bill 32, greenhouse gas emissions must be reduced statewide by 2020 to what they were in 1990. With this mandate, industries (such as water) will face penalties for non-compliance with the statewide greenhouse gas emissions reporting and monitoring. Implementing solar-power systems allows water agencies to receive bill credits for the electricity generated by a renewable-generating facility. The extended and expanded 30 percent federal investment tax credit for solar also provides the financial support and incentive for water agencies to install solar-power systems. That is, it makes good financial sense for a community. Why California? Don't shrug again and say you don't live in California. It does not have to be California. What are the mandates and incentives in your state? Several states, on all corners, coasts, and centers, have similar programs in which you must meet the rules but with the delightful addendum that there are ways for you to meet the rules with little or no financial disruption.

How Important Is the Size of the Project?

A common and often justified reaction to all new technologies is: "That's fine for those who are big enough to afford it, but what about us?" Let's look at two programs in onsite power for water purveyors that serve customers perceived as very different in size but equally important to their customers. Consider American Water, the largest investor-owned purveyor of good water in the U.S. One of the most knowledgeable and helpful persons I have spoken with about water and power is Mark LeChevallier, who works at American Water in New Jersey as Director of Innovation & Environmental Stewardship. Among his duties, LeChevallier directs a staff of 18 for both research and environmental compliance programs for American Water. That includes the development of environmental-management plans for more than 1,000 operating centers, environmental audits to ensure compliance, development of a national cross-connection control program for the company, and implementation of environmental stewardship and greenhouse gas control programs. American Water, with more than 7,000 employees, provides drinking water, wastewater, and other related services to some 15 million people in 32 states and Ontario, Canada. (When you read this, they will probably have entered three more states.)

In December 2009, American Water, which delivers about 1 billion gallons of water per day, announced it had set a goal to lower its greenhouse gas emissions per volume of water produced by 16 percent by 2017. This goal is part of the company's commitment to the Environmental Protection Agency's Climate Leaders partnership. The company plans to achieve its goal by reducing the amount of energy it uses, including the development of greater water-pump efficiency. "The water industry has always been a 'green' business," notes Don Correll, president and CEO of American Water. "Protecting our water resources is essential to the service we provide, and, since there is a correlation between carbon emissions and water resources, this initiative is a logical next step for our company. By improving air quality, we reduce the climate change that impacts weather patterns, which, in turn, impacts water resources."

This initiative isn't a sudden decision! American Water uses 100 percent wind power at its Yardley, Pa., plant, and the Canal Road plant in Somerset, N.J., uses solar panels for about 20 percent of its energy requirements.

Thirteen to 15 additional plants with savings in the renewable-energy mode are already planned. It is most helpful, of course, that Public Utility Commissions in New Jersey have good incentive programs for those who'd like to use solar energy for community benefits.

So there's a BIG water purveyor already leading the way to the use of renewable energy. Is there anybody who helps solve the smaller water distribution problems around the world? WorldWater & Solar Technologies Inc. has been solving problems related to renewable energy and drinking water worldwide. Mobile MaxPure (MMP) is its product, and it has more than 50 systems to show its merit. Customers vary from the U.S. Marines and residents in the Euphrates and Tigris River Valleys to displaced people in Darfur. Perhaps the company's best-known success in the U.S. was its prompt and valuable help as first responders to the Katrina disaster in Mississippi. Of that effort, Alan H. Morrell, Director, Morrell Foundation, comments: "The Mobile MaxPure unit operated flawlessly for the seven months it was deployed in Waveland. During this time, all potable water for thousands of people at our relief camp came to this unit. It never let us down. It met or exceeded all advertised performance expectations."

This is a stand-alone, patented solar-power product that extends its reach to places where no infrastructure is available and a continual supply of diesel is impractical. The modularity of MMP allows for flexible system design to meet the drinking water needs from a small village community to a town. Each system produces 30,000 gallons of potable water per day from freshwater sources, enough for about 6,000 people. You could use multiple systems in one region to include filtration of freshwater, brackish water, or seawater sources. The potable water produced costs about one cent per gallon over the first year, providing 30,000 gallons per day, 24 hours per day, seven days a week. After year 1, the costs goes down to fractions of a penny per gallon of water because the capital outlay has been paid off. The system lasts for 25 years or more. The sun is its source of energy. Annual expenses for filters and other useables average less than $5,000 per year per system. It has no dependence on fossil fuels … and no noise! A system is pre-assembled, ships by land, sea, or air, and takes about 30 minutes to set up at the site. It's a small system, yes, but one can imagine many circumstances where such a mobile, solar-powered solution could be a godsend.

Applications and Experts

It's always interesting to read or hear of communities that have already chosen to make the onsite power choice to give added momentum to our national advance in using renewable energy. In Capella, Calif., the Redwood Valley Water District worked with Solar Power Partners (SPP) to develop a 99.2-kW solar-energy system. They used a solar PPA—with a term of 15 years with buyout option at fair market value—under whose terms there was no up-front capital required from the water district. This system produces enough renewable energy per year to offset 102 metric tons of carbon dioxide, or the equivalent to emissions from 11,578 gallons of gasoline consumed. It took about three years to find a way to incorporate solar energy without significant up-front capital or the added costs of maintaining and operating the system. (SPP does that.) Under the terms of the solar PPA, the water district buys power at a set rate, and future critical upgrades to the system are not incurred by the water district. Advance Power Inc. was the installation partner for SPP on this project, which is fixed-ground, mount-style and produces an annual estimated 143,372 kWh.

The Valley Center Municipal Water District has a 1.1-MW solar power system, also developed in partnership with SPP through a solar PPA. This system will provide 2.1 million kWh per year of electricity, enough to offset about 20 percent of the electricity required by the district's largest pumping station. The installation is a single-axis, ground-tracking style, and the purchase agreement is for 25 years with a buyout option at fair market value. "Valley Center Water District is proud to have a 'double-green' solar project, one which reduces power costs for our customers and benefits the environment," commented Gary Arant, General Manager for the Valley Center Water District. "SPP did a great job helping us oversee the quality during construction and now monitoring the system for optimal performance. We had no up-front costs, and a portion of our energy costs are stabilized for years. This is a win-win for SPP, our district, and our ratepayers." SPP partnered with WorldWater and Solar Technologies Corp. to install the ground-mounted, single-axis tracking system. That style allows automated panel tilting to harvest the most sun.

Not everybody in the offices (or even the management) of a water utility claims to be an infallible expert in every aspect of the work required, so it is sensible and practical to seek outside help for the solution of some problems. Many experts work for vendors, and it may bother some public employees that the advice of vendors may be always prejudiced in favor of their employers, using the premise of "They just want to sell us something." Such a conclusion is not necessarily true. In speaking with representatives of different solar-power equipment suppliers, I have been impressed by their honesty in assessing the merits of competitors, and their bluntness is telling me that their own product may not be best for such-and-such a situation. The true expertise in these matters seems to be a knowledge of what is available and, coupled with that essential, an understanding of what would suit your community in the best way. To achieve the ideal goal for onsite power for your water utility, you should know what you want, what you don't want, and what will work best for your customers (or community) for several years. To answer all your questions accurately, you may need help from outside sources.

Understanding from its vast experience in the water industry that the financing of solutions such as onsite power is often the greatest stumbling block for a community, Black & Veatch has introduced a series of free industry forums to serve water utilities and the water financing community. Disruptions in the municipal bond market in the last two years impacted the ability of water utilities to obtain capital financing for urgently needed projects. Many capital projects have been slowed down or brought to a painful halt. "Today's water utilities face unprecedented circumstances and ever-changing capital markets," advises Michael Vann, who is on the advisory board for Black & Veatch's Enterprise Management Solutions (EMS) division. Vann is the former general manager of the Birmingham Water Works Board. Another well-known person helping in this endeavor is John Huber, retired President and CEO of Louisville Water Company. "Black & Veatch is fortunate to have a number of former water-utility executives on our management consulting team," notes Rodger Smith, President of the EMS division. "They understand how water utility CEOs, CFOs, and general managers are struggling with current financing issues. Black & Veatch is pleased to host these teleconferences as a public service to the industry, a non-commercial effort to provide answers from leading authorities on current financing topics." If you would like to be added to the invitation list for future events of this nature, please send your name (and the names of others in your enterprise, if you wish) and e-mail addresses to Gary Layton, at *LaytonGE@bv.com.*

More Sources for Renewable Power

It would be easy and wrong to think of solar power as the only onsite power to help you improve your water distribution without fossil fuels and reliance on the established electric sources and in compliance with your state regulations. There are other sources of onsite power. Wind power has been popular for some water districts. Like solar power, wind power comes from a free source. At the Hartford, Conn., Water Pollution Control Facility, the largest of four wastewater treatment plants operated by the Metropolitan District Commission of that city, the steam produced from incinerators will power a turbine and produce an estimated 1.5 MW of electricity per hour, about 40 percent of the facility's annual electricity consumption. "By harnessing energy produced onsite and utilizing it as a renewable-energy source, the facility will remain an environmentally sound and socially responsible one with more flexibility and efficiency, and less dependence on oil and other non-renewable energy resources," observes Dan McCarthy, President and CEO of Black & Veatch's global water business. That company is designing and overseeing construction of this large energy-recovery project.

In Wisconsin, the Milwaukee Metropolitan Sewerage District will use a 17-mile pipeline to carry landfill gas from Muskego to the Jones Island sewerage treatment plant on Lake Michigan. The project should save the district, its customers, and the taxpayers almost $150 million in the next two decades. The landfill gas at Muskego is between 50 percent and 55 percent methane and will replace natural gas (which would be about twice the price!) for 12 sludge dryers. The target date for completion of this project is the beginning of 2011. Landfill gas is surely an onsite source of power in many communities.

Like sunshine, wind is a free commodity. It may seem to benefit rural, heartland communities more than others, but that could change quickly. The obvious financial benefit for rural counties will come from land-lease payments and tax revenues; the latter could be more than $1.5 billion annually by 2030. Recently there have been giant strides in understanding the advantages and benefits of offshore wind power, which would benefit coastal communities especially. How many U.S. residents live within 50 miles of a coast? More than half the population, and indications are that more and more people are moving to one coast or another.

At the moment, the greatest results from wind power seem to be in Midwestern states like Minnesota and Iowa, and those results include wind power for water utilities in communities like those served by the Iowa Lakes Regional Water district. This district, which expanded its customer base 20 years ago to include more homes and farms, partnered with and received valuable help from a local community college, the Iowa Lakes Community College, which has a Wind Energy and Turbine Technology program, the two-year Associate in Applied Science to help meet the demand for skilled technicians in Iowa's rapidly growing use of wind turbines.

Back to the sun to finish. "About half of all water used in this country is used to produce energy," advises Tom Rooney, CEO of SPG Solar, one of the largest photovoltaic solar companies in North America. "In California, 20 percent of the energy is used to move, heat, and treat water. But not all energy produces the same water footprint. Biodiesel can consume more than 100 gallons of water for each gallon of fuel. On average, it takes one or two gallons of water to create one kilowatt-hour of energy [enough to run a medium-sized air-conditioner for an hour]. At Virginia Tech, researchers determined that it took eight to 16 gallons of water to burn one 60-watt light bulb for 12 hours a day. That's 3,000 to 6,300 gallons of water a year. Solar photovoltaic energy creates almost no water footprint because it does not need to be cooled."

SPG Solar has proved its point in an impressive customer base of schools, churches, movie theaters, office buildings, wineries, and ponds. Those are not huge, multi-million-dollar projects, and they all help to conserve and distribute our precious water.

The more you investigate renewable power or onsite power, the more you notice that every project is a success from more than one source, with the very essence of the community important to what is designed for equipment and operation. Could renewable onsite power help your community to conserve energy, gain power independence and stability of expenditures in its water distribution? It is worth more research, and it may cost much less than you always thought.

Salineville Wastewater Treatment Facility Energy Audit

Excerpted and reprinted with permission from Deb Martin, Ohio RCAP progam at WSOS Community Action Commission, Inc.

The Village of Salineville is a small, rural community located in eastern Ohio, with a population of 1,397 people (2000 Census). The village has a total median household income of $27,473. The community is served by the village-owned wastewater treatment facility (WWTF).

Representatives from the Ohio Rural Communities Assistance Program (Ohio RCAP) conducted a Level II energy audit for the Salineville WWTF in November 2009 to identify potential energy-conservation opportunities.

Ohio RCAP's goal was to identify a minimum of 20 percent energy conservation for this facility. It estimated that a 61 percent energy-cost savings for Salineville was possible with an improvement cost of $29,970 and could be realized with a simple payback period of just 2.03 years. The savings of $14,760 per year not only offsets the improvement cost, but there is also a compounding effect that must be taken into consideration.

Energy-use History and Utility Analysis

Monthly electric-utility costs were provided by Salineville for the WWTF. In a 12-month period, the total electricity cost was estimated to be $23,745. The average cost per kWh was $0.058 (including demand charges). The total energy use for the facility in this period was 416,800 kWh.

Based on an estimated annual wastewater load of about 29.6 million gallons (0.081 MGD), energy-use indices for electricity are 14,098 kWh/MG-yr. The total annual electric cost per million gallons is $817.67. The energy-use index and cost per gallon are higher than would be expected for a facility of this size operating far below its peak conditions. The largest energy user at a wastewater facility is typically the aeration treatment, usually between 50 and 60 percent of the energy use.

Energy-conservation Opportunities (ECO)

This section presents [a summary of] energy-efficiency opportunities identified during the survey. (An estimate of annual energy savings and implementation cost was originally provided for each project, along with an approximate simple payback period. The savings and cost estimates were based on limited information gathered during the survey.)

ECO 1: Evaluate demand management with load shifting and shedding

Demand management can substantially lower energy costs by reducing and/or avoiding extensive energy use during on-peak periods.

ECO 2: Install energy-efficient interior lighting

ECO 3: Install interior-occupancy sensors

Annual cost savings: $41; estimated project cost: $300; simple payback: 7.3 years

ECO 4: Install LED exit-lighting fixtures

Annual cost savings: $28; estimated project cost: $80; simple payback: 2.8 years

ECO 5: Address building envelope and climate-control issues

The replacement for energy reasons alone is not favorable to the owner. Simple maintenance of the existing windows, as opposed to complete replacement, is advisable.

ECO 6: Address exterior lighting controls

Annual cost savings: $ 100; estimated project cost: $ 50; simple payback: 0.5 year

ECO 7: Install Premium-Efficiency Motor (50-hp blower motor)

Annual cost savings: $929; estimated project cost: $4,500; simple payback: 4.8 years

ECO 8: Install premium-efficiency motor (7.5-hp raw-sewage pump)

Annual cost savings: $53; estimated project cost: $1,800; simple payback: 34 years

ECO 9: Install VFDs on all raw-sewage pumps

If a VFD were installed, it will allow for the pumps to operate at multiple flows and partial loading, thereby optimizing the energy use.

ECO 10: Replace coarse bubble with fine-bubble aeration

Annual cost savings: $13,265; estimated project cost: $16,000; simple payback: 1.2 years

Sustainable Energy Opportunities

An evaluation of sustainable design concepts is proposed for the owner to review and evaluate. These include community initiatives, renewable-energy alternatives, and village policies that may be able to improve the facilities' environmental impact.

Personnel behavior changes: The staff and personnel at the facility will have the most significant impact with respect to energy use. Encouraging positive changes to climate control, use of lighting and use of electronic equipment will result in increased energy savings at the facility.

Buy 'green': Select products that minimize environmental impacts.

Facility vehicle fuel options: The village should consider hybrid or alternative fuel models.

Solar renewable energy: Install solar panels to produce additional energy and offset the overall energy costs at the facility.

Wind renewable energy: Install small wind turbines to allow production of additional energy and offset the overall energy costs at the facility.

Additional Energy-conservation Opportunities

- Facility day lighting where appropriate
- Installation of wind break/shade opportunities
- Periodic replacement of air filters
- Lowering the temperature of the hot water heater
- Energy tracking and SCADA equipment
- Equipment operation and maintenance
- Proper insulation of walls and ceilings
- Minimize the effects of infiltration and inflow (I&I)
- Replace incandescent lamps with compact fluorescent lamps

What is the Next Step?

This report outlines multiple opportunities for Salineville to implement at its Waste-water Treatment Facility. It is imperative that the facility continue to meet all safety and permit requirements with no exceptions. Quality treatment must never be sacrificed. There is no cost-saving measure that is worth compromised treatment quality.

Cadiz Water Treatment Facility Energy Audit

Excerpted and reprinted with permission from WSOS Community Action Commission, Inc.

The Village of Cadiz is a small, rural community located in eastern Ohio. With a total population listed at 3,308 people (2000 Census), the village has a total median household income of $29,518. The community is served by the village-owned water treatment facility (WTF), which has a total of 1,382 connections, and 45 of the connections are not serviced by municipal wastewater.

Representatives from the Ohio Rural Communities Assistance Program (Ohio RCAP) conducted a Level II energy audit for the Cadiz WTF in November 2010. The purpose of the audit was to gain an understanding of the facility processes and of the major end uses, with an ultimate objective of identifying potential energy-conservation opportunities.

Energy-use History and Utility Analysis

For the time period audited, the total energy costs for operating and maintaining the facility amounted to $69,810 per year. The conservatively estimated 19.4 percent of energy savings identified in this audit was possible, with a projected improvement cost of $10,300 and could be realized with a simple payback period of 0.75 years. The projected savings of $13,625 per year would not only offset the improvement cost but there would also be a compounding effect should be taken into consideration. This savings would allow the Village of Cadiz to plan for plan for capital improvements, manage emergency events, and establish a long-term asset for the community.

The energy-use index and cost per gallon were higher than the average groundwater facility of similar size, which is expected for a surface-water facility. In addition, with the facility's age, relatively efficient equipment, SCADA system, and the knowledgeable staff, there were not many non-operational opportunities for energy savings. However, we did have several opportunities identified that warranted review by the owner for potential savings. The largest energy user at a water facility is the pumping, both raw and distribution, and is typically between 60 and 80 percent of the energy use for the total utility.

Energy-conservation Opportunities (ECO)

This section presents energy-efficiency opportunities identified during the survey. (An estimate of annual energy savings and implementation cost was originally provided for each project, along with an approximate simple payback period. The savings and cost estimates are based on limited information gathered during the survey.)

ECO 1: Billing tariff reclassification

The village should be aware of the ramifications of reclassification should they pursue those directions.

ECO 2: Evaluate demand management with load shifting and shedding

Annual cost savings: $1,630; estimated project cost: $0; simple payback: 0.0 years

ECO 3: Install energy-efficient interior lighting

Annual cost savings: $982; estimated project cost: $4,600; simple payback: 4.7 years

ECO 4: Install interior-occupancy sensors

Annual cost savings: $895; estimated project cost: $500; simple payback: 0.6 years

ECO 5: Install LED exit lighting fixtures

Annual cost savings: $104; estimated project cost: $200; simple payback: 1.9 years

ECO 6: Address building envelope and climate-control issues

The replacement for energy reasons alone is not favorable to the owner. Thus, simple maintenance of the existing windows, as opposed to complete replacement, is advisable.

ECO 7: Address exterior lighting controls

ECO 8: Install premium-efficiency motor (60-hp high-service motor)

Annual cost savings: $739; estimated project cost: $5,000; simple payback: 6.8 years

ECO 9: Modify lead high-service pump

Annual cost savings: $9,275; estimated project cost: $0; simple payback: 0 years

ECO 10: Install VFDs on raw and high-service pumps (sample only)

To install a VFD for the raw pump:
Annual cost savings: $9,580; estimated project cost: $20,000; simple payback: 2.1 years

To install a VFD for the high-service pump:
Annual cost savings: $6,090; estimated project cost: $20,000; simple payback: 3.3 years

Sustainable-energy Opportunities

An evaluation of sustainable design concepts is proposed for the owner to review and evaluate. These include community initiatives, renewable-energy alternatives, and village policies that may be able to improve the facilities environmental impact.

Personnel behavior changes: The staff and personnel at the facility will have the most significant impact with respect to energy use. Encouraging positive changes to climate control, use of lighting and use of electronic equipment will result in increased energy savings at the facility.

Buy 'green': Select products that minimize environmental impacts.

Facility vehicle fuel options:
The village should consider hybrid or alternative-fuel models.

Solar renewable energy: Install solar panels to produce additional energy and offset the overall energy costs at the facility.

Wind renewable energy: Install small wind turbines to allow produce additional energy and offset the overall energy costs at the facility.

NOTES

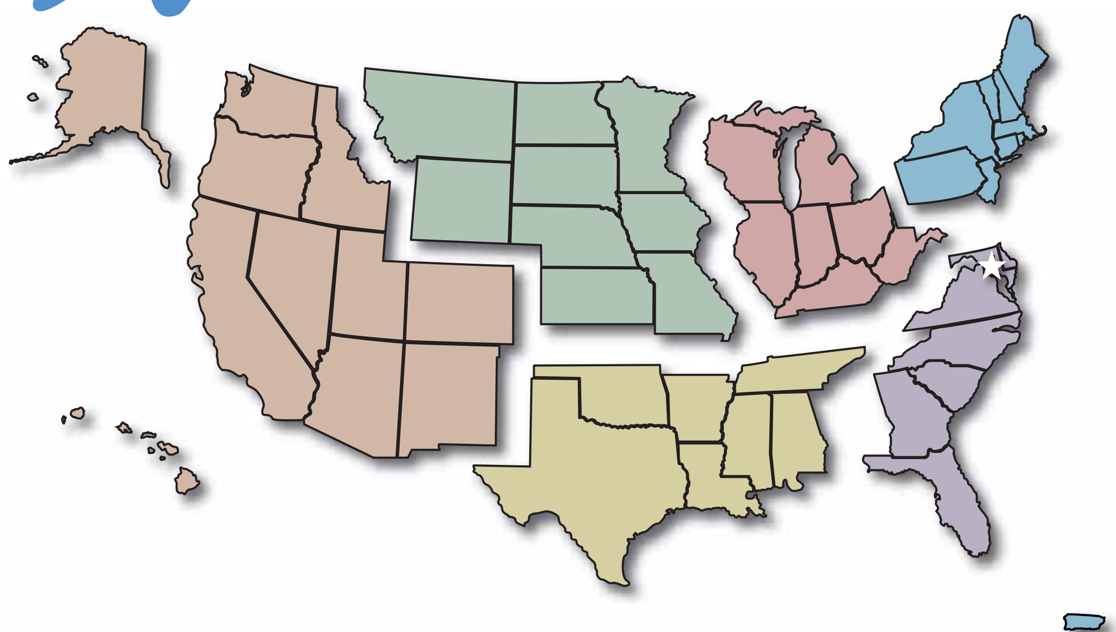
APPENDICES

Need help with your community's water or wastewater system?

The Rural Community Assistance Partnership (RCAP) is a national network of nonprofit organizations working to ensure that rural and small communities throughout the United States have access to safe drinking water and sanitary wastewater disposal. The six regional RCAPs provide a variety of programs to accomplish this goal, such as direct training and technical assistance, leveraging millions of dollars to assist communities develop and improve their water and wastewater systems.

If you are seeking assistance in your community, contact the office for the RCAP region that your state is in, according to the map below. Work in individual communities is coordinated by these regional offices.

Rural Community Assistance Partnership



Western RCAP
Rural Community Assistance Corporation
3120 Freeboard Drive, Suite 201
West Sacramento, CA 95691
(916) 447-2854
www.rcac.org

Midwest RCAP
Midwest Assistance Program
P.O. Box 81
212 Lady Slipper Avenue NE
New Prague, MN 56071
(952) 758-4334
www.map-inc.org

Southern RCAP
Community Resource Group
3 East Colt Square Drive
Fayetteville, AR 72703
(479) 443-2700
www.crg.org

Northeast RCAP
RCAP Solutions
P.O. Box 159
205 School Street
Gardner, MA 01440
(800) 488-1969
www.rcapsolutions.org

Great Lakes RCAP
WSOS Community Action Commission
P.O. Box 590
219 S. Front St., 2nd Floor
Fremont, OH 43420
(800) 775-9767
www.glrcap.org

Southeast RCAP
Southeast Rural Community Assistance Project
P.O. Box 2868
347 Campbell Ave. SW
Roanoke, VA 24016
(866) 928-3731
www.southeastrcap.org

★ **RCAP National Office** ★
1701 K Street NW, Suite 700 • Washington, DC 20006
202/408-1273 • 800/321-7227
www.rcap.org

Rural Community Assistance Partnership, Inc.
1701 K St. NW, Suite 700
Washington, DC 20006
202/408-1273
800/321-7227 (toll-free)
info@rcap.org

www.rcap.org

Visit our website for other publications, electronic and print periodicals, and ways your community can get assistance with its water and wastewater system.