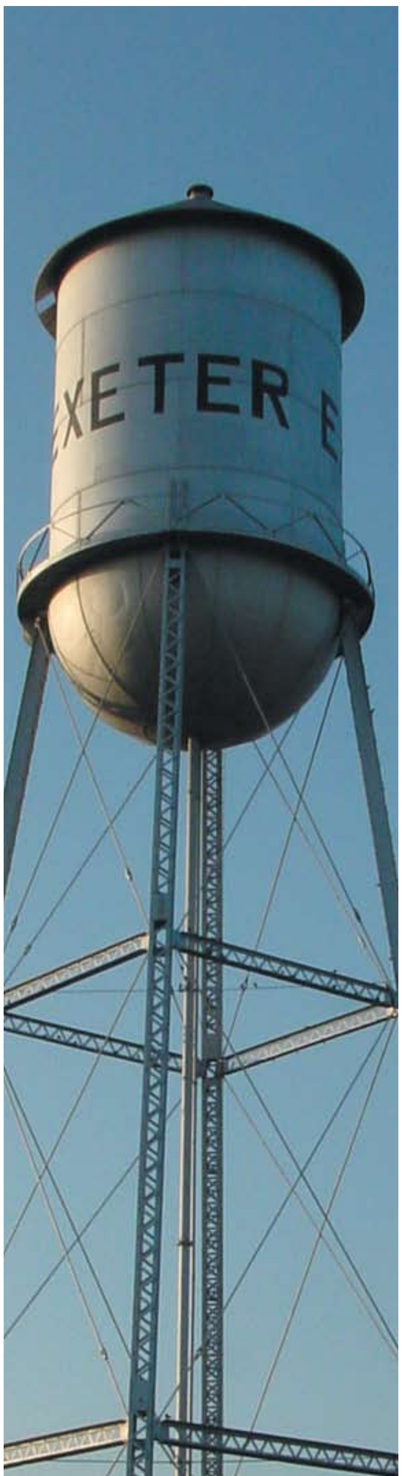
Sustainable Infrastructure for Small System Public Services:
A Planning and Resource Guide



RCAC

Sustainable Infrastructure for Small System Public Services: A Planning and Resource Guide

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Published by Rural Community Assistance Corporation (RCAC), a nonprofit organization dedicated to assisting rural communities achieve their goals and visions by providing training, technical assistance and access to resources. RCAC promotes quality, respect, integrity, cooperation and commitment in our work.

This material was funded under grants from the U.S. Department of Health and Human Services, the RCAP/EPA Drinking Water Technical Assistance and Training Program, and the RCAP/EPA Small Community Wastewater Project, which are Rural Community Assistance Partnership (RCAP) network projects.

RCAC is the Western RCAP

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i Introduction

Sustainable Infrastructure for Small System Public Services

A Planning and Resource Guide

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, aging infrastructure, increasing regulatory compliance pressures, volunteer burnout and many other factors. Coupled with the growth of sustainability as a measure of utility success the processes for incorporating green elements can further burden a small utility.

This Planning and Resource Guide is a starter for very small (fewer than 1,000 connections) to medium communities (up to 5,000 connections) to integrate and initiate green elements into 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 citizenry. 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 their immediate and projected needs, decrease pollution, and protect community health and well-being in a sustainable manner.

This planning and resource guide will assist a community identify very specific actions that can be taken to choose their next steps as they foster and promote 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 planning and resources guide includes a step-by-step process for utility decision-makers, staff and community members wanting to operate increasingly efficient utility systems. It offers a flexible approach to evaluating sustainable alternatives for utility operations.

What should you expect from this guidebook?

The first chapter of the guide 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 allows you to review your current energy consumption and provides you with tools and resources to become more energy efficient. The third chapter is focused on renewable energy. This chapter gives a thorough review of what this concept is, specific to small water and wastewater systems, and where the utility might be able to take advantage of resources depending on the geographic location and available natural resources.

Sincerely,

George Schlender
Environmental Programs Director
Rural Community Assistance Corporation
www.rcac.org

Through the efforts of many people, this planning and resource guide is a large step in our continuing mission to best serve the needs of rural communities as they achieve their goals and visions. Our intention is to continue to actively incorporate tenets of sustainability into our community work.

A special **Thank You** to the cross-cutting departments within RCAC who have put heart and soul into developing a wealth of materials to aid in planning and identifying resources for small rural communities that are beginning to green their infrastructure. Each person has contributed to the creation of this guide and in developing RCAC green resources. In alphabetical order, RCAC contributing staff include: Connie Baker-Wolfe, Kevin Baughman, Dale Burton, Victoire Chochezi, Dave Conine, Ellen Drew, Ramsey Gregory, John Hamner, David Harvey, Julia Helmreich, Bill Hogrewe, Steve Langstaff, Robert Longman, Chris Marko, Linda Martinez, Pauline Marzette, Jay Mashburn, Laurie McVay, Joe Mitschelen, Olga Morales, Kay Mulligan, Craig Nielson, Brian Phillips, Skip Rand, Jake Salcone, George Schlender, Art Seavey, Roland Shanks, Charlie Smith, Blanca Surgeon, Alvaro Toledo, Fred Warren, Sharon Wills, Jim Wilson and Neil Worthen.

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1 Water Conservation

Water Conservation Overview

Population growth, increased demand and the intensification of the hydrological cycle caused by climate change are likely to exacerbate the need for stringent water conservation measures. Researchers estimate that by 2025, half of the world's countries may face shortages of freshwater, while up to three-quarters of the world's population may experience freshwater 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 spurred by a number of factors that include:

- Growing competition for limited water supplies and increasing concerns regarding impacts of water withdrawals on stream flows, wetlands and other groundwater users
- Increasing costs and difficulties in developing new supplies
- Ability to delay or reduce capital investments in capacity expansion 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 the 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 missing from 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 to implement a water conservation program is to obtain detailed knowledge 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. System conservation plans should identify specific water conservations 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 major utility 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
- Application of 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 1-4).

Table 1. Current Systems Conditions Review [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 nonresidential 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)*				

[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 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 water audit goal is to help the public water supplier select and implement programs to reduce water works system losses. The public water supplier should perform the 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.

AWWA free water audit software is available at *http://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 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 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, 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.*

Water Audit Worksheet *(continued)*

Line	Item	Subtotal	Total Cumulative	Units*
TASK 3: MEASURE AUTHORIZED UNMETERED USE				
	11A. Fire fighting and fire fighting 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	Subtotal	Total Cumulative	Units*
TASK 4: MEASURE WATER LOSSES				
	14A. Accounting procedure errors *(e.g., 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.*

Now that you have a more complete picture of the customer base, the efficiency of the system and the impact to the 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 for leak detection and water audits: *http://www.mrsc.org/Subjects/Environment/water/wc-measures.aspx#Leakdetect*

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

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

- *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
- *Leak Detection and Repair*, VHS, 16 minutes, Order No. 65112

Based on the information gathered in the previous exercise, establish a reasonable and achievable goal to accomplish through the 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]:_______________________			

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]:___________________________			

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 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. The conservation program 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, as when customers change their water use habits. These savings can be difficult to estimate. 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).

But 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.

- ***Understandable water bill.*** Customers should be able to read and understand their water bills. An understandable water bill should identify volume of usage, rates and charges, and other relevant information.
- ***Information available.*** 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. Furthermore, 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 to previous bills and tips on water conservation can help consumers make informed choices about water use.
- ***Water bill inserts.*** Systems can include inserts in their customers' water bills that provide information on water use and costs. Inserts also can be used to disseminate tips for home 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 1-13) 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 (e.g., customers choose a higher rate to guarantee service), which may be more appropriate for your system.

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

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

example, an immediate change from a declining block rate structure to an inverted block rate structure would likely result in large cost increases to large quantity water users, but could result in lower rates to small quantity water users (which collectively is the largest water user group), inducing the group of small quantity water 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 1-10), use Table 5 (page 1-14) 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 • It 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 (camp-grounds, 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 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

Thus far, Chapter 1 has covered how utilities can proactively work to conserve water. However, homeowners also can adopt and implement water conservation practices and measures to help preserve the availability of fresh drinking water sources. The remainder of this chapter will address how homeowners can contribute to water conservation.

Outdoor water use

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 creating this higher demand for water. This increase in water demand comes at a time of year when there is less water naturally available in the environment due to warmer temperatures and plant uptake.

By implementing just a few minor changes in how you use water outdoors, you will find that you can maintain your existing outdoor activities using much less water. This will save money on your water and electric bill, and protect the environment by leaving more water for local rivers, wetlands and aquifers. In the case of outdoor lawn watering, using water more efficiently will actually improve the durability of your grass, reduce the need for chemical amendments 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 do have an initial capital cost and require customer participation. Utilities can assist residential and commercial customers through:

- Rebates or billing credits to water users that 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 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.

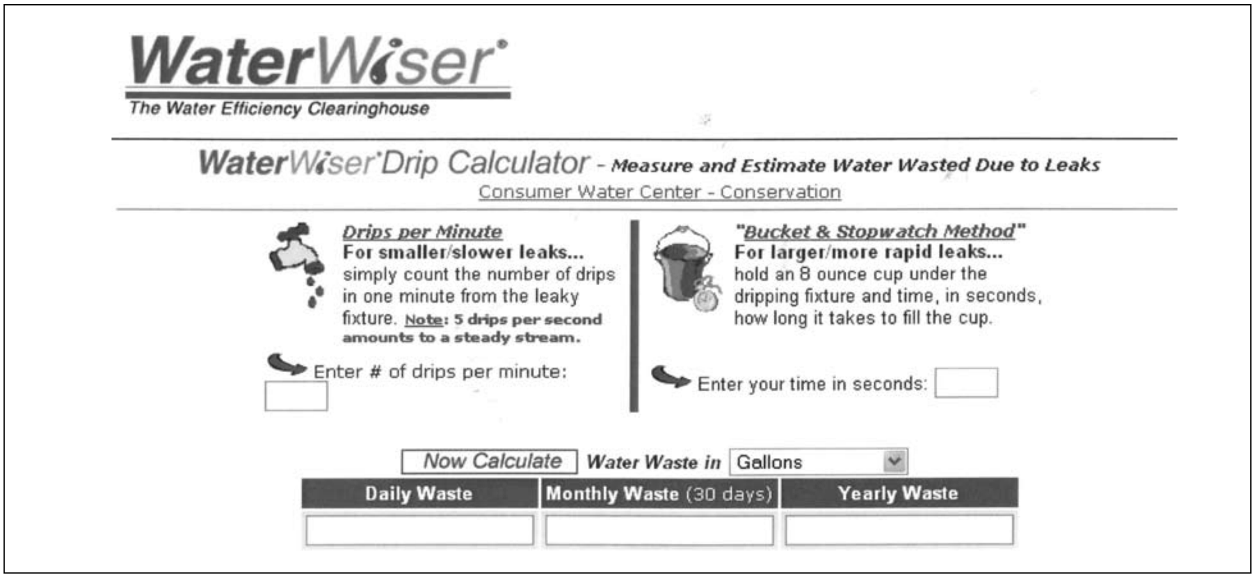
Water fixtures such as shower heads can also be retrofitted to conserve water. A regular shower head uses 5 gallons per minute. Low-flow shower heads use as little as 1.5 gallons per minute. Other fixtures, such as bathroom and

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

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 the AWWA water wiser drip calculator at *http://www.awwa.org/awwa/waterwiser/dripcalc.cfm* ■

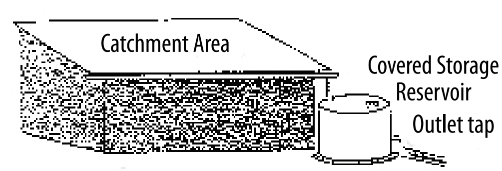


Rainwater Harvesting

Rainwater harvesting is an old idea that is popular again. The future of our nation's water depends, in part, on innovative approaches to water supply. 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.

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. 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.

Roof Catchment System [4]



[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*

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 for mosquito breeding. Any container capable of holding rain dripping from a roof or patio can be used as a rainwater harvesting system.

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

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 nation 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, properly designed, constructed and maintained systems that include disinfection steps have been successfully used for private domestic water supplies. Consult your local health department prior to constructing rainwater harvesting systems.

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./y.r) / 12 (in./ft.) = Cubic Feet of Water/Year

Cubic Feet/Year x 7.48 (Gallons/Cubic Foot) = Gallons/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.

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.
- Local people can be easily trained to construct and operate a system.
- Homeowners have full control of their systems.
- Operating costs are almost negligible.
- 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.
- Roof 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

Greywater

Any water that has been used in the home, except water from toilets, is called greywater. Dish, shower, sink and laundry water comprise 50-80 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 will 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 tank or treatment plant
- 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:

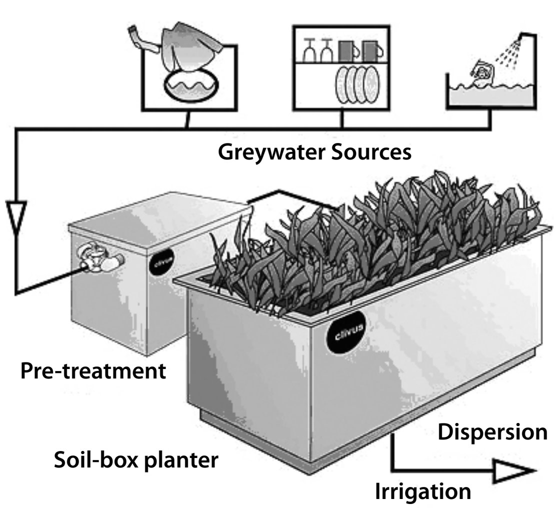
1. Provide irrigation water and some fertilizer to landscapes
2. Reduce wastewater loads to sewage systems
3. Improve the effectiveness of on-site wastewater disposal
4. Reduce pressure on limited potable water resources in some communities, especially during drought crises

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

The primary motivation for installing greywater 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 suitably used 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; *http://www.greywater.com*

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.

Greywater legalities to consider

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, http://www.epa.gov/owm/water-efficiency/index.htm

It takes a considerable amount of energy to deliver and treat the water you use everyday. 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 five 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.

Additional Information

If you have any questions about implementing a water conservation program, contact Rural Community Assistance Corporation (RCAC) at *http://www.rcac.org*.

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

Resources

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

Arizona statewide water conservation strategy manual
http://www.azwater.gov/dwr/drought/files/Statewide_Water_Conservation_StrategyFINAL100804.pdf

American Water Works Association (AWWA) bookstore
http://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 conservation for water suppliers resource is a site that discusses water audit methodology, how to get started and has free audit software
http://www.awwa.org/Resources/topicspecific.cfm?ItemNumber=3653&navItemNumber=32978

AWWA free water audit software
http://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, New Mexico
http://www.awwa.org/waterwiser/references/pdfs/PLAN_PROG_Maddaus_L_Highlights_from_WCDs_AWWA_Manual_M52.pdf

AWWA *WaterWiser* program
http://www.waterwiser.org/

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

California Department of Water Resources, *Guidebook to Assist Water Suppliers in the Preparation of a 2005 Urban Water Management Plan*, Jan. 18, 2005
http://www.owue.water.ca.gov/urbanplan/docs/GuidebookUrban.pdf

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

Florida, instructions for completing a water district water audit, 17 pages
http://sjr.state.fl.us/rules/pdfs/40C205902.pdf

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

Landscape conservation
http://www.californiagreensolutions.com/cgi-bin/gt/tpl.h,content=295

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

Massachusetts, water conservation overview, includes tools and resources for water wise community, examples of city plans and checklist formats
http://www.ipswichriver.org/waterwise/tool20.htm

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

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

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

State of Washington water audit and leak detection site, good examples and forms
http://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, New Mexico; Ashland, Oregon; Cary, North Carolina; Gallitzin, Pennsylvania; Gilbert, Arizona; Goleta, California; Houston, Texas; Irvine Ranch Water District, California; Massachusetts Water Resources Authority; Metropolitan Water District of Southern California; New York City; Phoenix, Arizona; and Santa Monica, California
http://www.epa.gov/watersense/docs/utilityconservation_508.pdf

USEPA presentation on water conservation
http://www.p2ad.org/files_ppt/wcw1-a.ppt#10

USEPA site includes Benjamin H. Grumbles, USEPA Acting Assistant Administrator for Water, Water Utility Council, AWWA, speech on water matters, Washington, DC, 2004. In this speech, he addresses monitoring the Safe Drinking Water Act, restoration of water sources, water conservation and efficiency, the Water Star project, labeling water efficient products and infrastructure issues.
http://www.epa.gov/ow/speeches/042204bg.html

USEPA's Water Efficiency Program
http://www.epa.gov/owmitnet/water-efficiency/index.htm

USEPA's *Water Sense*
http://www.epa.gov/watersense

References

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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.

2 Energy Efficiency

Sustainability

Reasons to Implement 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 implement 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:

- ☐ Facility neighbors
- ☐ 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 get different shareholder groups' opinions, 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 tally the surveys 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:** "Do the right thing." "Make the world a better place." 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:** Lessen your carbon footprint

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 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 can incorporate or build upon existing successes. For example, regionalization efforts are full of energy efficiency opportunities. Regionalizing is when geographically co-located communities share resources. Regionalization is often enacted to increase utility sustainability or reduce future costs so the connection to energy efficiency is not explicit. 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, 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 material transportation energy savings
- Increased spare stocks create personnel and equipment transportation energy savings

Regionalization project and program involvement does not imply increased energy efficiency for everyone involved. 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 a free ride. 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 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 damages caused, revenue lost, trust broken and expectations disappointed. The cost of risk can be measured in both probability of specific events and potential for spoiling customer goodwill required for future projects. The risks will not be the same for any two 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 also is 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 very important deserve attention first. Risks that are not likely to happen and not important do not deserve attention. You will not have the time or resources to mitigate all of your risks, so you should only address 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 that 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. Energy efficiency planning experience is an asset that will be useful for them to take back to their own organization.

No matter what the decision on energy efficiency efforts, ***a utility should never skip the energy efficiency 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. Future financial performance maximization 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 Probability it will happen			Mark just one option 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 makes a bad smell						
It makes a loud noise						
It makes a by-product that is difficult to properly dispose						
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 either be used for a point-by-point discussion outline or each group member can individually complete his/her own 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:

1. Aeration
2. Filtration
3. Disinfection
4. Pumping
5. Cleaning
6. Emergency energy supply
7. Excavation
8. System repairs
9. Heating water
10. Heating buildings
11. Cooling buildings
12. Instrumentation/controls
13. Communications
14. Lighting — indoor and outdoor
15. Transportation of equipment
16. Transportation of materials and supplies
17. Transportation of personnel

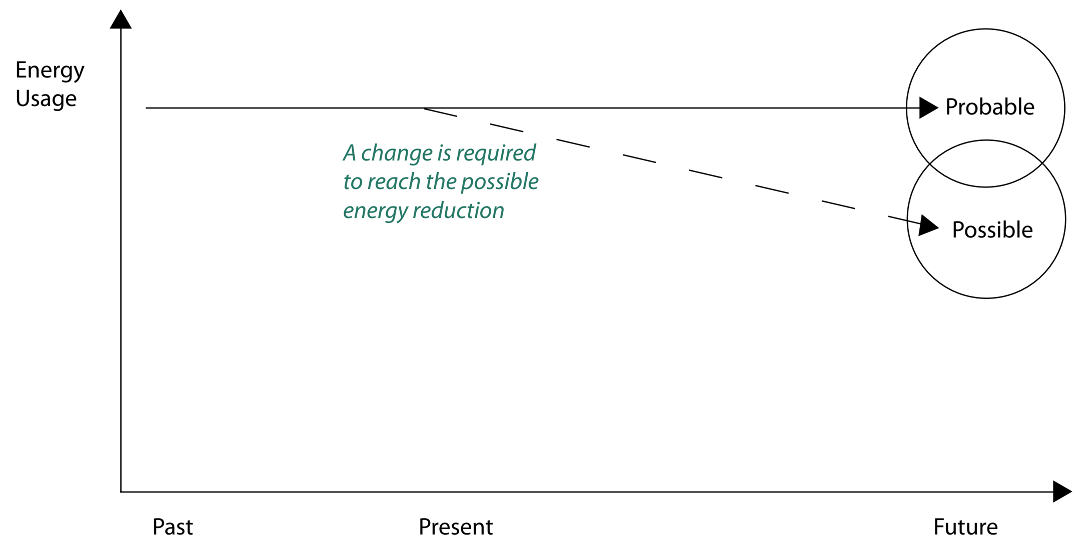
Then, graph current energy use in the different areas where you use energy (see graph on page 2-31 and visit USEPA's Energy Star Manager to begin using the free *http://energystar.gov/benchmark* tool). Energy use should be documented and graphed over time. There will be some seasonal fluctuations. There will be trends over time. Possible trends include slow increases, quick increases, remains 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 doing 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 teams 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 from 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:

1. Electricity
   a. Pumping uses
   b. Lighting uses
   c. Heating uses
2. Natural Gas
   a. Heating
   b. Vehicles
3. Gasoline/diesel
   a. Vehicles
   b. Emergency pumps
   c. Equipment

Energy Use Over Time



See Chart of Energy Efficiency Measures, page 2-32

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
(U.S. motor gasoline consumption in 2007)

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

1 cubic foot of natural gas = 1,028 BTU
(U.S. natural gas consumption in 2007)

1 gallon of propane = 91,000 BTU

1 short ton of coal = 20,169,000 BTU
(U.S. coal consumption in 2007)

1 kilowatt hour of electricity = 3,412 BTU

Comparison between different alternatives is best conducted 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 a new energy source. 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 should be 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
http://www.eia.doe.gov/basics/conversion_basics.html

Energy Efficiency Measures Chart

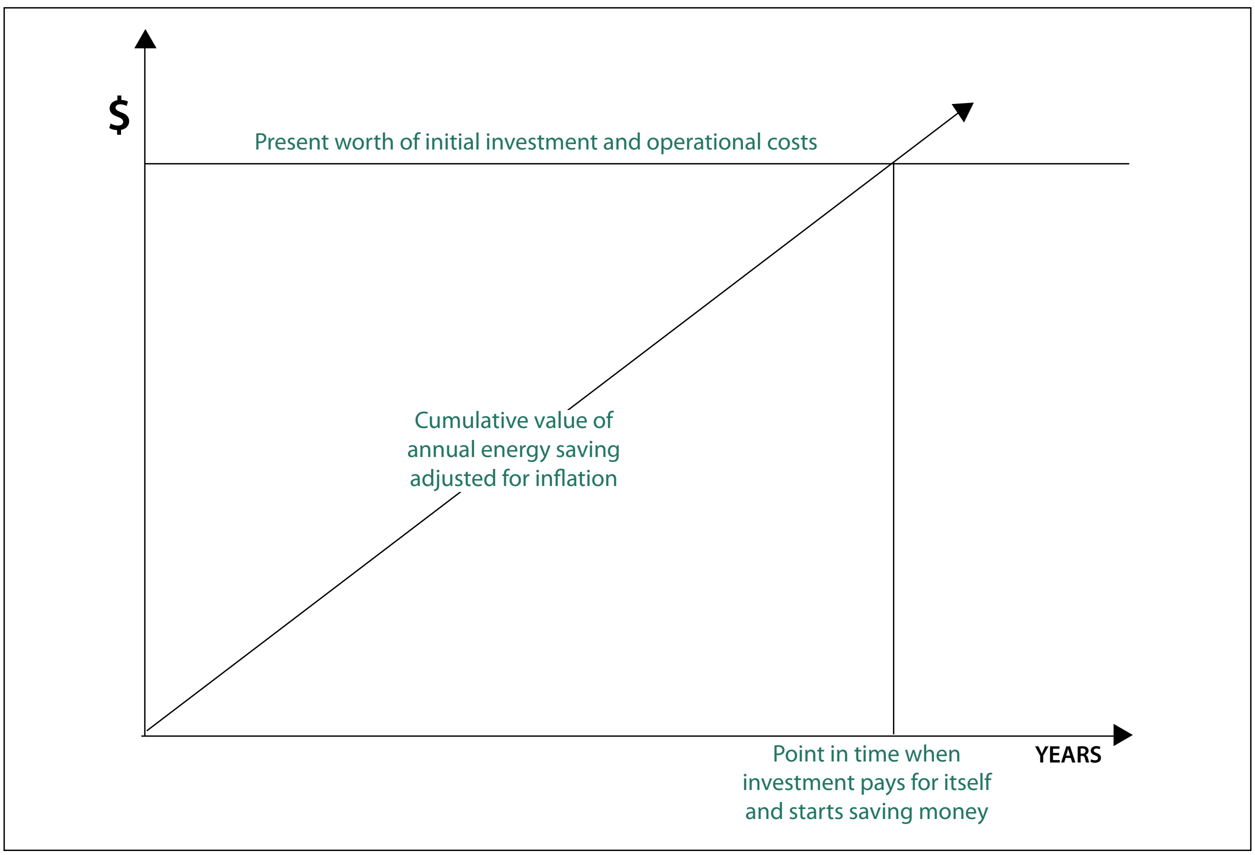
		Application	Benefit	Availability
Building heat	Passive solar building design			
	Geothermal heat pump			
	Increased wall and ceiling insulation			
	Programmable thermostat			
	Lowering room temperature in winter			
Building insulation	Increased insulation			
	Structural insulated panels			
	Blown in foam			
	Low emissivity windows			
Lighting	LED lighting indoors			
	LED lighting outdoors streets			
	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

Life cycle cost

What is life cycle cost?

Life cycle cost is the present worth of all cost and revenue 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 options with different lifespans can be compared.

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, $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

Time-value of money also works backwards:

- For example, $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:

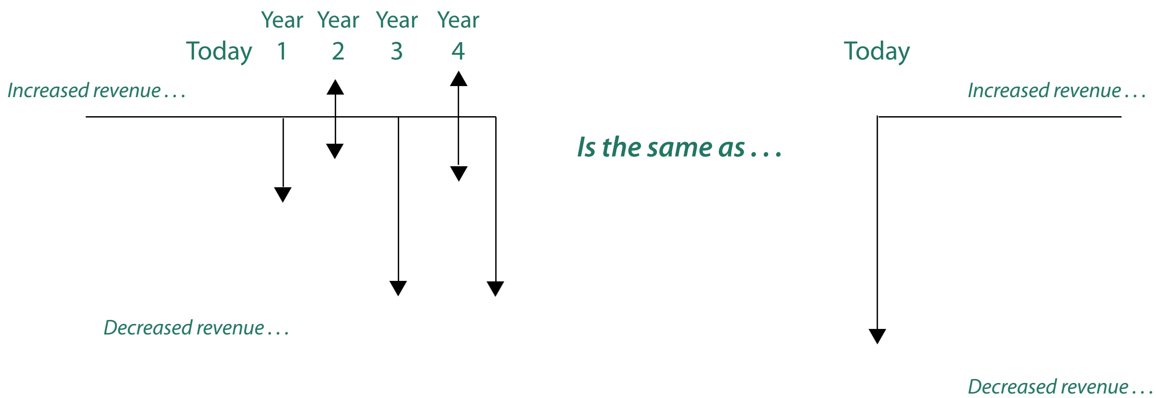
- $100 per year for 5 years is the same as $432.94 today (at 5 percent)

Figuring Costs and Revenues as a Present Worth

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

$$\frac{(\text{Annual Cost})\ (1=i)^{n}-1}{\text{I}\ (1=i)n}$$

Present Worth



Calculation of present worth

- Equations

  P= present work, 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. Identifying assets that do not have much useful life left is the right place to apply energy efficiency that can reduce the energy efficiency implementation costs. For example, if a piece of equipment is expected to operate only five more years before being replaced, it may not 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.

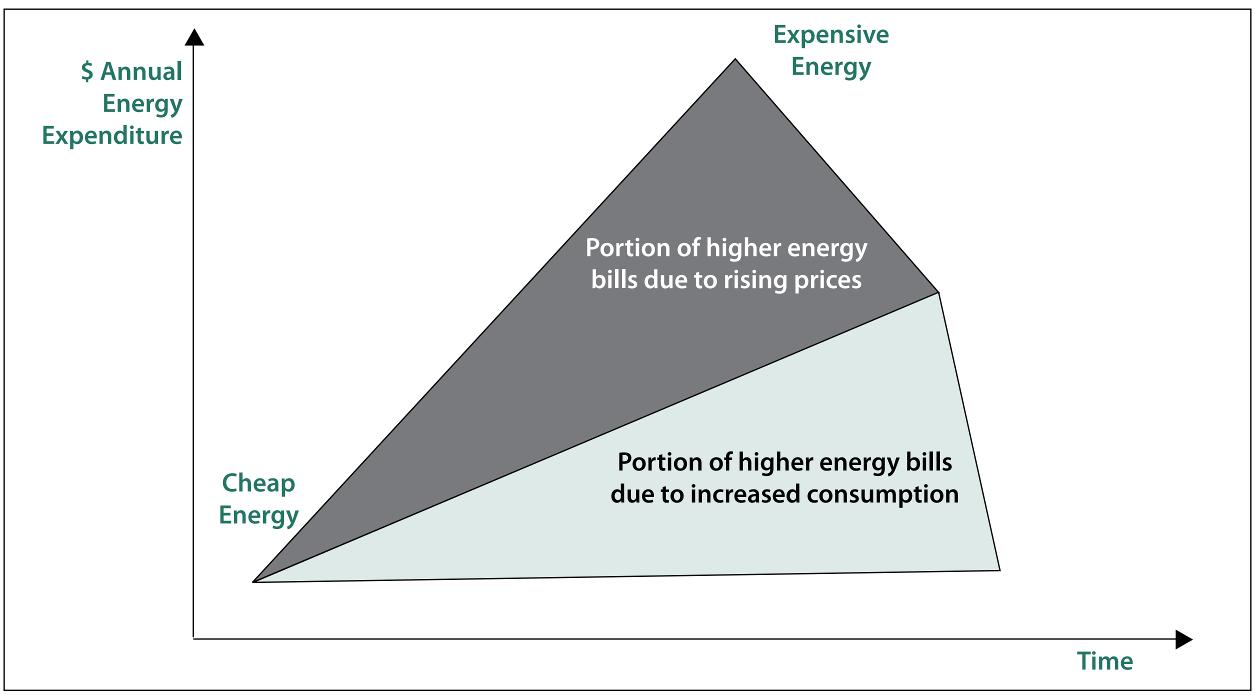
Identifying assets that do not have much useful life left is the right place to apply energy efficiency that can reduce the energy efficiency implementation costs.

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 laymen's 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, we can focus on energy use with minimum increase to the current workload. We then plan ways to make positive changes that will create the most bang for the energy buck. No matter how good the planning phase is, it will have no value until things actually get done in an 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 don't work. You may be pleasantly surprised at how this effort takes on a life and forms a culture of its own within your utility. Good luck and have fun with the process.

Utilities can document the increase in energy bills 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 for gasoline in your automobile. The increased amount you are paying is most likely not just because of gas price increases. The average American driver drove twice as many miles in the year 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, we 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 energy 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 below 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 to the implementation of an energy efficiency program. Review this list with your group, starting with the top ranked challenge/barrier and 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 those challenges.

Strategies for Success

Barrier: Aversion to risk of 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 advisors with relevant small system experience
- ☐ Not enough political will to overcome possible opposition
- ☐ Poor previous advice or design from professional consultants that 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

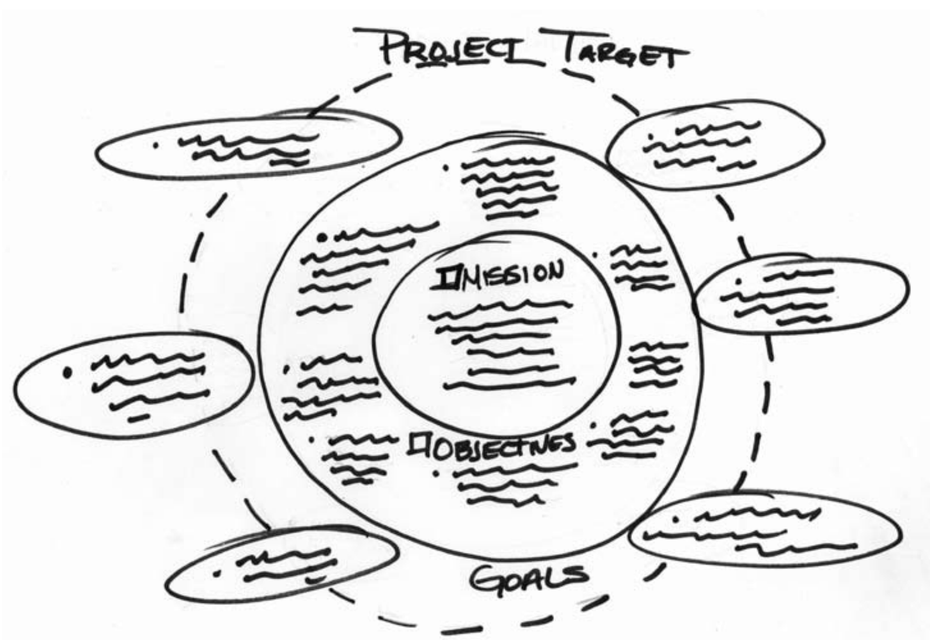
Goals and targets need to be challenging and meaningful. Energy efficiency program or project goals are needed to build consensus about the reasons to systematically work towards energy conservation. You may recruit multiple energy conservation partners. If each partner has a unique motivation or desired outcome, this may create conflict during project implementation. Energy efficiency goals also are 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[2] and Leadership in Energy and Environmental Design (LEED)[3] provides 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 for reaching each objective can be very useful. The matrix also should contain possible and probable barriers to reaching the objective.

(See Table 10, page 2-39: 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

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

[3] Source: *http://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				
Head loss due to friction	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
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 Face-book, websites, etc.)	Option 1				
	Option 2				
	Option 3				
Other:____________	Option 1				
	Option 2				
	Option 3				

Energy use plan

Gather teams to examine the different areas where you use energy and **graph current energy use** *(see sample graph on page 2-31)*. It is suggested that you chart actual quantities used as well as the money expended. The graphing 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
- Are inexpensive to start
- Are 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 out 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

(Please refer to Energy Efficiency Readiness Survey Checklist on page 2-26 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.*	*Our May 18th monthly meeting of our water board, she will report-out*
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*

By placing the above *Next Steps* in order by completion due date,
you now have a short action plan to improve your utility/facility to energy efficiency.

Worksheet: Rank Energy Efficiency Partners

More important

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

Less important

**NOTE: It may be easier to just 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 meeting sessions. We suggest that this be kept to a few minutes of explanation for each idea. The person(s) who originally comes up with the idea needs to explain their point of view to the group, giving an estimate of requirements to accomplish the change. It is recommended that each idea 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 part in this effort. It will keep them invested in the process, 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
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 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 *http://www.energystar.gov/benchmark* for an energy portfolio manager)**.** One of the best indicators that you are making this a useful effort is to 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 in 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 initially 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 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 employee recognition for energy savings
   d. Make this effort a contest with cash prizes (designate a percent 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, pass the word through company e-mails, 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 towards 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 garden hose spray nozzles that reduce consumption by limiting water flow and automatically shutting off when the hose is laid down.

   Keep others in your organization aware of conservation efforts:

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

Energy uses and efficiency teams

Program evaluation 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 energy efficiency program success. 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 us to determine whether what you intended happened or did not happen, so next time you can make effective changes. ■

CEDAR[4]

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.

- **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.
- **Efficiency**: reducing waste with investment-grade improvements in materials and equipment, saving another 25 percent of energy used.
- **Demand peak reduction**: upgrading efficiency at the power grid scale, with long-term moderating effects on utility rates.
- **Ancillary reductions** in 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. Aggregation of resources for communities, sharing, often referred to as regionalization or mutual aid.
- **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. ■

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

Resources

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

Baldwin, J. *The Community Energy Workbook/A Guide to Building a Sustainable Economy*, 1995, available from the Rocky Mountain Institute (RMI)
http://www.rmi.org

Building EnergyAudit
http://www.energyaudits.com/Content.aspx?p=1

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

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

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*
http://www.dsireusa.org

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

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

Homepower Magazine
http://www.homepower.com/home/

Lawrence Berkeley National Laboratory: Promoting Energy Efficiency in Water and Wastewater Treatment
http://water-energy.lbl.gov/node/23

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

National Renewable Energy Laboratory: *resources on the use of renewable energy and energy efficiency*
http://www.nrel.gov
http://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
http://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*
http://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.*
http://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
http://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 & tax incentives*
https://www1.eere.energy.gov/informationcenter/

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

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

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

USEPA's Sustainable Infrastructure for Water and Wastewater
http://www.epa.gov/waterinfrastructure/

USEPA's Sustainable Infrastructure for Water and Wastewater: A resource that identifies approaches to integrate energy efficient practices into daily management and long-term planning
http://www.epa.gov/waterinfrastructure/bettermanagement_energy.html

Notes

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 services. In the U.S., 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 cross-over 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 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 in your area. It provides you with activities to help 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 has 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 general outline is available at *http://www.energyfinder.org/images/other/CEOF_GuideTo EnergyEff.pdf.*

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 to create consensus and a shared vision during decision-making.

Step1: Recruit an energy management team

Step 2: Collect current energy usage data

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: Form a strategic plan

Step 8: Achieve project realization

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, making renewable energy in the most environmentally friendly manner.

CEDAR[1] revisited

The CEDAR protocol was covered in Chapter 2 (please refer to page 2-47). Before proceeding with a renewable energy project, be sure that you are energy efficient. A CEDAR approach provides a way to incorporate the use of renewable energy 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. Here is a brief review of CEDAR. ■

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

[1] CEDAR, 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 *http://www.nrel.gov/buildings/energy10.html.*

Conducting team activities helps you apply and retain energy efficiency practices while incorporating renewable ones. ■

Team Activity A

Project Definition

Put together a profile of the incentives available for your project in your state. Use the *www.dsireusa.org* website to print out the renewable energy incentives available for participants. The type of programs and the amount of incentives and resources vary from place to place. This is specific enough that it even varies from county to county within some states.

Divide participants into groups of five to seven people. 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: (Incentives availability sometimes vary 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 flipchart, 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 resources 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. Provide each group with a copy of the document, "A Plan for Building Community Prosperity Through Natural Capital" (see Appendix A). 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.

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 small water/wastewater utility possible uses for these technologies. Record all possible uses on a flipchart. 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 utilities costs, use of energy, impact on our environment and its role in your community. Consider these four questions, for your organization/utility, adapted from The Natural Step, *http://www.naturalstep.org*, the four system conditions, *http://www.naturalstep.org/the-system-condition*s:

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. U.S. EPA calls these the three pillars.

Visit Redefining Progress to explore what your ecological footprint is: *http://www.ecological footprint.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 3-58).
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 technology 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. Can they be further optimized?
   c. Can any of them be combined?
   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

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 the impacted and/or affected groups/stakeholders.

Team Activity F

Futures Wheel

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 they wanted to consider a wind farm, things to ask would include:

- How will it impact the community?
- Who will be impacted directly or indirectly?
- What kind of impacts will be experienced?
- This process looks at first, second and third order of impacts.

Instructions

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 impacts identified.
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 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?

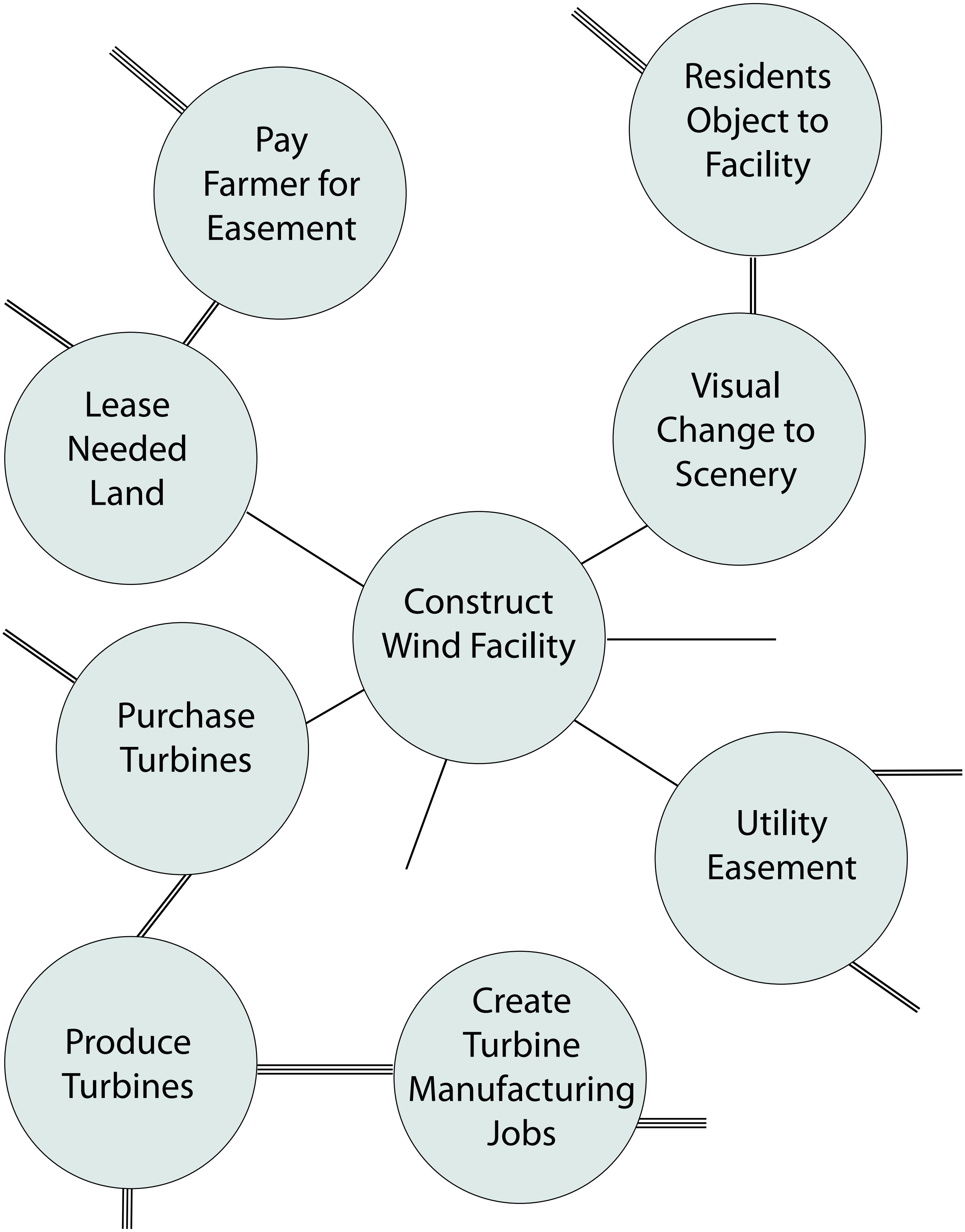
Activity Glossary:

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

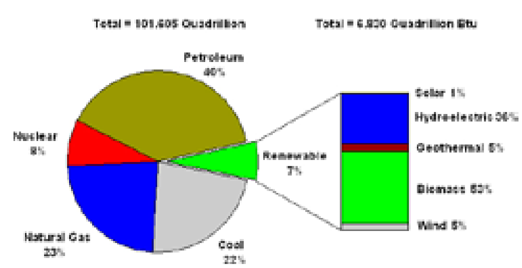
Renewable energy sources can be replenished in a short period of time. The five renewable sources used most often are:

- **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 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.

Renewable energy projects usually fit into one of the following three categories:

- **Personal scale**: home and/or individual use
- **Community scale**: a limited geographic areas use of mixed renewable options and portions to best fit a shared vision
- **Industrial scale**: large scale developer projects that may have different points of generation and use

Your small system/utility would fit into the community scale project category. A small utility would not be a personal scale project and the 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 prove to leverage a number of resources to best meet community 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.

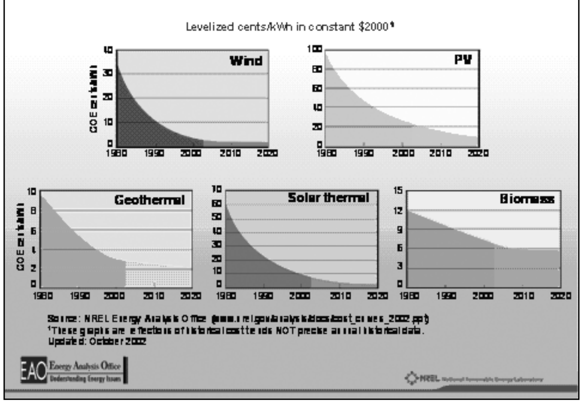
For example, many states are forming land owner associations to collectively negotiate with industrial scale wind and solar developers, in particular, in an effort to foster transparent projects consistent with their local needs. This is a fairly new approach for the unregulated industrial renewables 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 be impacting 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 working towards best management projects that represent their best interests, even when it concerns renewable energy projects.

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

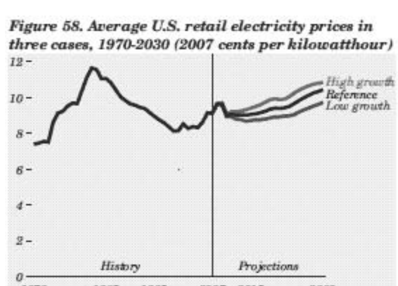
It is estimated that currently more than half of renewable energy goes to producing electricity. The next largest use is the production of heat and steam for industrial purposes. Renewable fuels, such as ethanol, are primarily used by the transportation industry to provide heat for homes and businesses.

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 energy generated 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 blows to drive wind turbines; and droughts reduce water availability to produce hydroelectricity).

Renewable Energy Cost Trends[3]



Average U.S. Retail Electricity Prices in Three Cases: 1920-2030[4]



(2007 cents per kilowatt hour)

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

[4]Source: Energy Information Administration, Official energy statistics from the U.S. Government

The up-front cost to implement 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 consideration. Some benefits may not be monetary and may not be immediately realized.

Renewable energy and its cost savings should be phased in on a situational basis with specific cost versus benefit consideration.

Life cycle analysis

The initial investment required to begin replacing a traditional energy source with a renewable energy source can seem expensive. However, when analyzing the cost over the new source's service life, we see that renewable energy sources are often more cost effective in the long-term. For more information, visit *http://www.howproductsimpact.net/*.

Life cycle energy analysis, sometimes called "cradle to grave" energy analysis, can be used to compare energy alternatives. Life cycle energy 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 environment, 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. For more information, go to *http://ies.jrc.ec.europa.eu/WTW.html*.

Research using this life cycle 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. ■

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 that 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.

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 fuel. Using biomass for energy can cut back on waste and support agricultural products grown in the U.S.

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 either burning MSW in waste-to-energy plants by capturing 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

RCAC Project Highlights

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 assists rural communities to achieve their goals and visions by providing training, technical assistance and access to resources.

RCAC is the Western affiliate of the Rural Community Assistance Partnership (RCAP). RCAP is a national network of regional nonprofit organizations that provide comprehensive, on-site technical assistance and training to help small, rural communities address their drinking water, wastewater, and other community development needs.

RCAC Works in Costilla County to Develop Biodiesel Facility in Mesita

Costilla County is one of the poorest counties in Colorado with 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 holistic and 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 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 our partner agency, USDA Rural Development (RD) 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 of south-central Colorado. Now the biodiesel plant is a welcome neighbor in the San Luis Valley because of the strong farming and ranching tradition.

For more information, contact:

Phone: 916/447-2854

E-mail: GSchlender@rcac.org

Web: ***www.rcac.org***

from their barns. Special specific 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 on their own. Using ethanol or biodiesel means you do not burn quite as much fossil fuel. Ethanol and biodiesel are usually more expensive than the fossil fuels that 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.

Biodisesel plant photo by Fred Warren, RCAC

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 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 municipal solid waste (MSW or garbage) and wood waste to produce energy, means that less of it needs to be buried in land-fills. Plants 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 does release 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 does have nitrogen oxide emissions that are about 10 percent higher though. 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). So, 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 hydrothermal 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 geothermal 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 the 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. ■

Tax Credit Summary

Excerpted, in part, from Department of Energy's website, *http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F: (visit this website for more details, and additional tax credit information)*

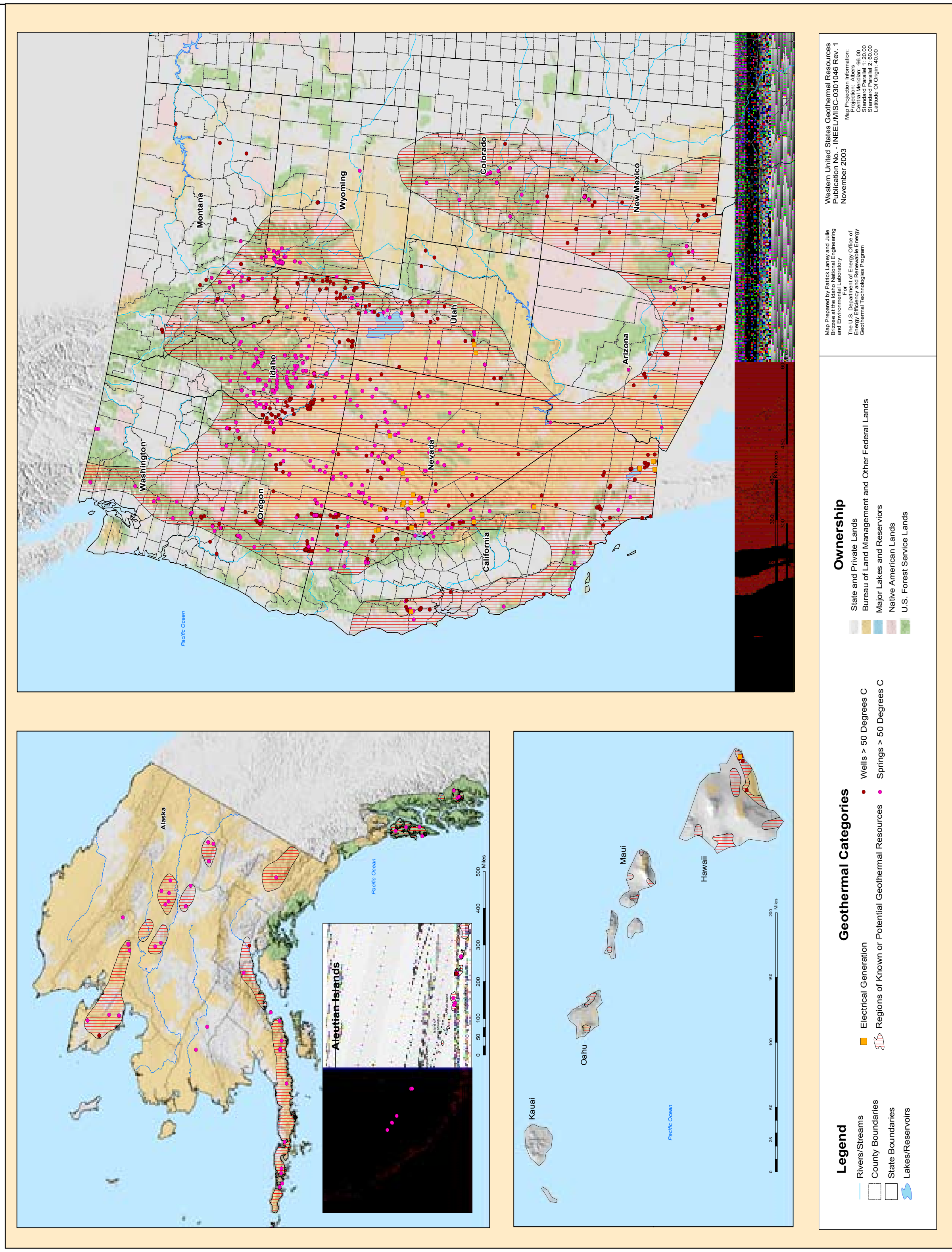
The federal business energy investment tax credit available under 26 USC § 48 was expanded by the Energy Improvement and Extension Act of 2008. This law extended the duration of the existing credits for solar energy, fuel cells and microturbines; increased the credit amount for fuel cells; established 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.

Western United States Geothermal Resources[5]



[5]Source: *http://www.nrel.gov*

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, 10 of these are in California and five are 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.

Photo courtesy of the City of Rifle, Colorado

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.

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 only produces 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 together in an array depends on the amount of power output needed.

The performance of a photovoltaic array is dependent upon sunlight. Climate 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, solid state devices that convert DC power to AC.

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.

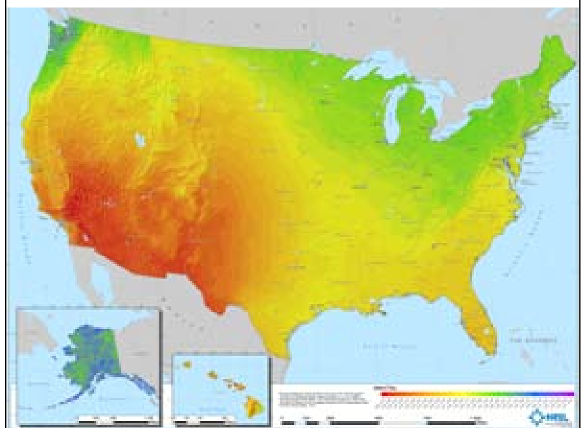
Passive solar

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, consideration of location and size of windows, orientation and size of overhangs, 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 on 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 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 heater 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, for example, less dense warm air tends to rise while more dense, 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.

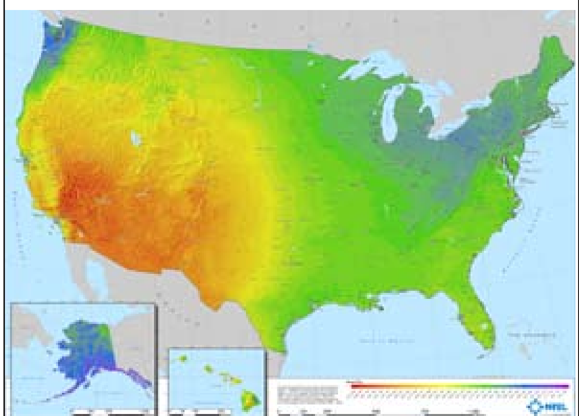
1. Non-concentrating collectors have a collector area (the area that intercepts the solar radiation) that is the same as the absorber area (the area absorbing the

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

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.

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 desert ecosystems if not properly managed.

Photo courtesy of The City of Rifle, Colorado

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

Water (Micro-Hydropower)

Micro-hydropower is generally considered generation of 300 kilowatts or less. However, some states define micro-hydropower as 3 megawatts (3000 kilowatts) or less. Micro-hydropower like geothermal and biomass can deliver reasonably constant power. This is an advantage over wind and solar power that provide intermittent power. Micro-hydropower performance is not dependent upon the weather. 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 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.

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 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 of the water and the amount of water. It is also influenced by other factors like how much sediment is being carried in the water and the variability of flow.

Illustration by Olga Morales, RCAC

Wind Energy

Wind is simple 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 on 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 available on the National Renewable Energy Laboratory website at *http://www.nrel.gov*.) ■

Following are case studies illustrating various model renewable energy uses.

Case Studies

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 percent

The City of Flagstaff is located in Coconino County, Arizona, with a population of about 50,000 (based on the 2000 US 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 for agricultural applications in the area. The city partnered with APS Energy Services to construct a biogas co-generation unit at the facility.

Wildcat Hill Wastewater 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, as well as 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 off of 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.

Southwestern Arizona Area Turns Trash To Cash
Somerton, Arizona 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: 7520
Median Income: $26,544
Percent of population below the poverty line: 75 percent

Rural residents struggling with how to economically dispose of their trash can take a lesson or two from the small own of Somerton, Arizona. 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 residents are painfully aware of the intricacies involved in their garbage removal. Residents of the small community of Somerton, Arizona, for example, were struggling with how to manage increasingly high costs associated with getting rid of their trash. Today, they are on the edge of the green revolution.

Rural Community Assistance Corporation (RCAC) has been working in Arizona for nearly 30 years. So when Somerton had a problem, the city 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 one way. As you can imagine, when 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 use the chips on playgrounds, bedding mulch and top fill around trees. For gravel and sand picked up by street cleaning, RCAC suggested purchasing a screen to separate dirt and rocks collected, and reuse the material in alleyways and other areas in the community. The town agreed and by re-using their street waste, they reduced the need to buy dirt and rock to make street repairs, as well as the need to make the 68-mile roundtrip journey to the landfill. Removing these wastes 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. Next phases include regional in-vessel composting of solid waste, green waste and wastewater.

Somerton, Arizona plant photo by Fred Warren, RCAC

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 comprising Anacapa, Santa Barbara, Santa Cruz, San Miguel, Santa Rosa Islands, and the surrounding mile of ocean.

The National Park Service protects the pristine resources at Channel Islands by conserving, recycling, using alternative fuel vehicles, applying 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/PV energy project on Santa Rosa, the largest of the Channel Islands National Park.

This system, which is now in the final stages of integration, will supply electricity to the ranger station, facilities and residence. It will essentially replace a 35-kW diesel generator that uses 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, Grundfos water pumping system, a 12 volt PV power system for research station, a Handar weather station, and a U.S. Navy 12 volt weather station. A new 2200 square foot ranger station was recently completed and incorporated a 900-W wind/PV power system, solar preheater, rainwater collection 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 light house 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 4000 gallons of diesel fuel annually. The system paid for itself in 3½ years and now operates cost free.

Environmental Benefits

One of the greatest 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 the ship to the tanker truck to the generators, and there is always the risk of a spill during any of these stages. Also diesel systems discharge many harmful pollutants into the atmosphere.

Economic Benefits

For every 2400 gallon 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. Resource restoration and facility repairs would add costs.

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

For more information , visit: *http://www.eere.energy.gov/*

National Small Flows Clearinghouse Case Study on Water Efficiency

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 percent

Stillaguamish Tribe in Arlington, Washington

The Stillaguamish Tribe in Arlington, Washington 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 the community use of drinking water from the tribe's system, which would subsequently reduce the amount of water loaded into the septic tank drain field system.

In 1991, the water conservation program included retrofitting the 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 average community 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.

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 percent

In 2006, the Triangle Wastewater Treatment Plant in Durham County, North Carolina completed the nation's first LEED certified wastewater administration building, setting a new standard for the future and environmental possibilities in public works.

Triangle Wastewater Treatment Plant is a rather small facility servicing only 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 LEED certification by using low energy, recycled and regionally manufactured materials in their construction.

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

Rifle Regional Wastewater Reclamation Facility and The Colorado River Raw Water Pump Station Rifle, Colorado

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 percent

Rifle is a rural community located along the I-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 MGD *(Charlie Stevens, Utility Director for the City of Rifle, personal communication on 3/11/09)*.

Photo by Don Ludwig, Colorado Water Journal

The city chose to implement a vast PV solar system to power the two new facilities with an output of 1.72 MW produced at the wastewater facility and another 600 kW produced by the pump station site. Over 10,000 single axis ground-mount tracker panels comprise the combined array and it is expected that the first year of operation will realize enough solar energy production to power over 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 off of electricity produced from traditional fossil fuels over a 20-year period.

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 courtesy of the City of Rifle, Colorado

Through innovative planning, design, engineering and funding strategies, the City of Rifle has demonstrated that small, rural communities can lead the pack 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, who financed and built the solar energy systems at no up-front capital costs to the city. Instead, the city will purchase the solar electricity from SunEdison at prices below retail for traditional energy sources.

Funding resources for public water and wastewater utilities are available.

See U.S. Department of Energy's *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 credit
Tax exemption	Utility rebate	Incentives
Loans	Grants	

Resources

American Council for an Energy Efficiency Economy: Water and Wastewater
http://www.aceee.org/industry/water.htm

California Energy Commission Energy Efficiency with Water
http://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 that 5 megawatts)
http://www.cwrpda.com

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

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

DSIRE: DOE database of state by state and federal incentives, such as net metering, rebates and tax credits, for renewable energy and energy efficiency
http://www.dsireusa.org

Energy Alternatives Ltd. Micro-hydropower calculator
http://www.energyalternatives.ca/content/Categories/MicroHydroInfo.asp

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

Energy Information Administration: energy price information, trend information from the U.S. Government
http://www.eia.doe.gov/oiaf/aeo/electricity.html

Energy Planet renewable energy directory of micro hydro-power resources
http://www.energyplanet.info/Micro_Hydro/

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

U.S. Environmental Protection Agency (USEPA): promoting energy efficiency in the water sector
http://www.epa.gov/waterinfrastructure/pdfs/memo_si_bengrumbles_nexus-between-water-energy_02142008.pdf

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

Lawrence Berkeley National Laboratory: promoting energy efficiency in water and wastewater treatment
http://water-energy.lbl.gov/node/23

National Renewable Energy Laboratory: renewable energy types of technology transfer via terms, energy analysis, research and product reporting for home and businesses
http://www.nrel.gov

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

State of Colorado, Governor's Energy Office, *Advancing Colorado's New Energy Economy*: resources on residential buildings, commercial buildings, electric and gas utilities, greening government, energy savings partners, renewable energy and the Colorado Carbon Fund
http://www.colorado.gov/energy

Sustainable Infrastructure for Water and Wastewater
http://www.epa.gov/waterinfrastructure/bettermanagement_energy.html

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

U.S. Department of Agriculture—Rural Development, Section 9006 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
http://www.rurdev.usda.gov/rbs/farmbill

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

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

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

RCAC Green Infrastructure related publication
Green Building Guide, Design Techniques, Construction Practices & Materials for Affordable Housing
http://www.rcac.org/assets/greenbuild/grn-bldg-guide_4-20-09.pdf

Notes

A 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 of 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 CA, 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.

   See *http://finder.rmi.org* for ways to plug energy leaks in your community.

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, Oregon, 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 direct 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 of 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% of construction costs on

an office and education building by partly dismantling and reusing an existing building. The finished building was 80% 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% 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 partner 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, Washington, 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, CA 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% 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

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Published Resources:

***Natural Capitalism**, Creating the Next Industrial Revolution,* by Paul Hawken and Amory Lovins and 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 where 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's 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 in locally, replacing imports, and by working to eliminate many subsidies and changing tax and trade laws that disempower communities. 270 pages. Free Press

***Real Towns**: Making Your Neighborhood Work b*y 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
http://www.planning.org

Center for Excellence in Sustainable Development
http://www.sustainable.doe.gov

Center for Compatible Economic Development
http://www.cced.org

Center for Livable Communities
http://www.lgc.org/clc

Citizen Planner Institute
http://www.citizenplanner.com

Communities by Choice
http://www.communities-by-choice.org

EDGE Program, University of Nebraska
http://www. nebraskaedge.unl.edu

Growth Management Institute
http://www.gmionline.org

Littleton, Colorado Business Retention Program
http://www.littletongov.org/bia/economicgardening

Natural Step
http://www.naturalstep.org

Port Angeles, Washington
http://www.portofpa.com/citizenship

Redefining Progress
http://naturalstep.org

Remanufacturing Industries Council
http://www.remanufacturing.org

Renew America
http://www.solstice.crest.org/environment/renew_america

Sonoran Institute
http://www.sonoran.org

Sprawl Watch Clearinghouse
http://www.sprawlwatch.org

Urban Images Envisioning Smart Growth
http://www.urban-advantage.com/index.htm

Zero Emissions Research Initiative
http://www.zeri.org

Who is RCAC?

Rural Community Assistance Corporation (RCAC) is a private, nonprofit organization that provides training, technical assistance and loans to assist rural communities with innovative solutions to the varied and complex problems affecting many rural locations. RCAC began with funding from the Rosenberg Foundation and the seemingly simple mission of helping community-based organizations and governments in rural areas implement housing and community development programs. RCAC's mission is to assist rural communities achieve their goals and visions by providing training, technical assistance and access to resources.

Today, RCAC is based in West Sacramento, CA, with more than 35 field offices located throughout its 13-Western state region. The organization's simple mission expanded in 1979 when RCAC became one of six federally-funded regional rural community assistance programs to operate rural water and wastewater assistance programs.

The Rural Community Assistance Partnership (RCAP), headquartered in Washington D.C., is a regional partnership of these six sister organizations serving all 50 states, the U.S. Virgin Islands and Puerto Rico. The RCAP national office engages in applied research, policy development, public education, and advocacy on rural issues, especially with respect to community infrastructure. In addition to RCAC, RCAP's partners include Midwest Assistance Program, Community Resource Group, Great Lakes RCAP, Southeast Rural Community Assistance Project and RCAP Solutions.

Capacity Development

RCAC works with communities and agencies to assess needs, develop potential solutions and select and implement the best plans. Working with local leaders to strengthen their facilitation, public speaking, strategic thinking and advocacy skills, the organization provides problem-solving tools and resources but leaves control within the local community.

Access to Resources

RCAC staff helps identify funding sources and assists with financial packaging and funding applications. Since 1988, RCAC's Loan Fund has provided suitable and innovative solutions to the financing needs of rural communities. In 1996, the U.S. Treasury certified RCAC as one of the first Community Development Financial Institutions in the country. RCAC successfully leverages funds from foundations, religious organizations, traditional financial institutions and government agencies for rural projects. Offering both long- and short-term financing, RCAC is a major lender for affordable housing, community facilities and environmental infrastructure.

Technical Assistance

RCAC offers technical assistance for community development projects. Such projects could include anything from affordable housing to forming a mutual aid organization for several water districts. RCAC lends hands-on, customized technical assistance to project staff, local officials and community volunteers.

Training

Training helps agencies and local governments to more effectively utilize community assets and address problems. RCAC provides practical, task-oriented training on a variety of management and technical subjects. Training can be provided to staff of a single agency or delivered at a conference attended by many agencies. To facilitate long-term success, RCAC believes training includes both explanation and hands-on experience.

Advocacy

Small populations and geographic isolation mean rural communities often have difficulty finding assistance and resources. RCAC believes that when rural communities and programs join together to coordinate efforts and share expertise, they become a formidable voice for rural issues. The organization works to facilitate such sharing and thereby strengthen the presence of local communities with state and federal agencies.

RCAC applies its core services to diverse community development programs that continue to evolve. Throughout RCAC's 30+ year history, changing needs of rural communities have served to dictate new and innovative programs that have integrated seamlessly into the organization's overall work.

In fact, innovation is a watchword respected and nurtured by RCAC board of directors, CEO, senior management team and staff. RCAC's vast array of community development offerings now include the following:

Housing and Health

RCAC works with mutual self-help housing agencies, community housing development organizations and other nonprofit organizations to develop affordable housing. In 2006, RCAC assisted 191 non-profit housing agencies develop over 1,600 units of affordable housing.

Housing Counseling

RCAC is a HUD-approved national intermediary. As such, RCAC provides technical assistance, training and financial support to a network of housing counseling agencies serving remote rural communities including tribal-based organizations. In fiscal year 2006, RCAC's efforts resulted in more than 8,200 people receiving housing counseling services.

Mutual Self-Help Housing

In the Mutual Self-Help Housing program, low income borrowers work together under the guidance of a nonprofit public housing entity to help build each others' homes. With a construction supervisor on site, individuals and families perform at least 65 percent of the construction work (known as "sweat equity") required on their new homes. In most cases, the entity also manages construction loans, develops the building site, provides homeownership training, offers building plans, qualifies borrowers and markets the program.

Under a U.S. Department of Agriculture (USDA) contract, RCAC provides assistance to USDA Section 523 Mutual Self-Help Housing Program grantees. RCAC coordinates all activities with USDA staff and regularly reports on each grantee's activity and performance production.

Accessing other project financial resources

RCAC provides additional resources through annual, regional self-help housing conferences and statewide meetings on land development, loan packaging, construction supervision and other related topics at the request of the grantees and USDA Rural Development.

Community Development Technical Assistance

RCAC provides technical assistance to Community Housing Development Organizations (CHDOs) recognized by the U.S. Department of Housing and Urban Development (HUD) in 10 Western states. Under a HUD contract, RCAC provides CHDOs with training, direct technical assistance services and pass-through funds.

RCAC provides training and technical assistance in housing development, project feasibility, real estate finance, housing management, resident ownership, board training, business and strategic planning and environmental review.

Water and Waste

Water in the West is a wild, unfolding story of climatic change, drought, fires, oil and gas production, increasing transportation charges and populations that alternately boom and bust. Most current infrastructure was built 40 to 60 years ago, meaning most rural infrastructure is in desperate need of upgrades or replacement. But, resources are scarce. Repairs to America's aging infrastructure are projected by EPA to cost between $300-500 billion before 2020 for water and wastewater alone.

Just three years ago, a small town might have received 80 to 100 percent of infrastructure improvement funds in the form of grants. Today, that number is closer to 20 percent received in grants and 80 percent available in the form of loans. Often, the communities are waiting in hopes of receiving more grant dollars which are now not available and won't be. Times have changed. The impacts to small communities from these funding changes are just beginning to be realized. Today's small community can be looking at millions of dollars in loans to upgrade or replace their water, wastewater and solid waste systems. Additionally, the regulatory requirements for maintaining safe water standards are increasing and often very costly for a community to remain in compliance with both federal and state standards.

RCAC's water and waste department focuses on three areas to help small communities work through the complex world of maintaining safe, reliable drinking water, wastewater and solid waste systems:

- **Technical**: staffing, operational and basic infrastructure of water and waste systems
- **Managerial**: managing water and waste systems that include volunteer board members, city and town council and staff that assist utility boards
- **Financial**: utility financial management including financial records, procedures and managing critical assets

In most cases, RCAC assistance is free to small communities — funded by state and federal contracts.

As with other environmental services, RCAC's solid waste efforts have included diverse projects including assisting the Kuha'o Business Center on the island of Moloka'i to stimulate creation of entrepreneurial businesses using recycled materials as feedstock; and working with the Blue Mountain Resource and Conservation District to develop a biomass project for the Fuels for Schools program in Dayton, Washington.

Loan Fund

RCAC's $65 million Loan Fund provides loans to small, rural communities and other nonprofit organizations. In 1996 the U.S. Treasure certified RCAC as a Community Development Financial Institution (CDFI). Among other financial products, RCAC provides short-term and interim financing for a variety of purposes including water and wastewater treatment facilities, community facilities and public buildings of all kinds and affordable housing — including mobile homes.

The Loan Fund also provides funds for green projects as well as gap funding for projects that may be waiting for permanent funding.

Circuit Rider Program: Water, Wastewater and Solid Waste

RCAC operates both a Tribal Circuit Rider Program and a Circuit Rider Program specific to Hawaii. In both instances, the goal is the same: to provide public health protections through capacity development of small, public water and wastewater entities, often located in isolated regions. RCAC serves over 100 tribal communities per year.

RCAC Green Services

RCAC is a proud partner in the growing national community greening and sustainability movement. As a leader in rural development in the West, RCAC's green initiative services help communities realize a future where healthy neighborhoods, a sustainable economy and responsible environmental stewardship can co-exist.

Green (or sustainable) practices promote building construction, infrastructure and community planning that is healthier for residents and the environment. These practices include using renewable energy, energy efficiency, water conservation, environmentally sensitive site planning, efficient building materials and attention to indoor environmental quality.

Going green strengthens and improves the quality and health of rural communities, enhances the bottom line of building projects, creates healthier living environments, conserves precious resources, lessens energy dependence and reduces the impact of national building trends.

RCAC green services provides rural communities access to viable and proven options and solutions to address common problems. RCAC also offers rural communities a variety of core services that promote green building, green lending, community sustainability, local based economic development, rural leadership, energy conservation, renewable energy, innovations in water/wastewater management, integrated neighborhood design and green meeting planning.

The following services are offered by RCAC:

Green Housing Development

Site Design, Green Building, Green Materials Purchase Program and Energy Efficient Performance Review

Services include sketch-plan through preliminary site-plan development, solar orientation/analysis, and advanced planning principles application (new-urbanism, clustering and smart growth), which all contain green site design elements. RCAC offers architectural design, passive and active solar specifications, material specifications, building system specifications, cost estimates and health/performance evaluations. RCAC also provides referrals to green building manufacturers and suppliers.

Community Sustainability

Sustainability Planning, Renewable Energy Development and Green Charrettes Facilitation

Services include assisting communities with planning and development strategies designed to conserve natural resources and preserve local capital while limiting the environmental and social costs normally associated with growth.

Green Infrastructure Development

Drinking Water, Wastewater, Storm Water and Solid Waste Systems

New, expanded or rehabilitated drinking water, wastewater, storm water or solid waste systems also could consider going green. These systems may consume considerable amounts of energy. In addition, wastewater, storm water and solid waste often have hidden resource value. RCAC can assist communities evaluate energy, efficiency and resource conservation options. A green infrastructure approach takes advantage of reuse and recycling (for wastewater and solid waste), which reduces costs and minimizes the use of natural resources.

Green Lending

Green Points Lending

In partnership with Wells Fargo Bank, RCAC is a CDFI green lender that provides green community development financing. RCAC staff provide assistance with the process of greening a project to ensure that it meets the criteria to qualify for a green housing, infrastructure or community facility loan.

Visit RCAC's website at www.rcac.org to contact a local RCAC field office for additional information, or contact:

- Ellen Drew at 575/421-0261, *edrew@rcac.org*
- Connie Baker Wolfe at 303/455-7882, *cbakerwo@rcac.org*

Creating the future just got a lot Greener!

Notes

RCAC

Creating opportunities in rural America

www.rcac.org

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