

PHOENIX GREEN

Designing a Community Tree Planting Program for Phoenix, Arizona

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This report was prepared by Western Resource Advocates as part of its efforts to promote clean energy resources, including energy efficiency. It was funded by a grant from Edwards Mother Earth Foundation.

The report was prepared by David Berry with contributions from Sandy Bahr (Sierra Club). Preparation of the report also benefited from comments and advice from Doug Koppinger (Trees for Tucson), Greg Levine (Trees Atlanta), Greg Peterson (Phoenix Permaculture Guild), and John Nielsen, Nicole Theerasatiankul, and Anita Schwartz (Western Resource Advocates). Sketches were prepared by Valarie Vousden.

The report is dedicated to Dr. Thomas A. Reiner. Tom was professor of Regional Science at the University of Pennsylvania, author of The Place of the Ideal Community in Urban Planning, and a thoughtful and considerate advisor.

Western Resource Advocates' mission is to protect the West's land, air, and water.

Our lawyers, scientists, and economists:

1) advance clean energy to reduce pollution and global climate change
2) promote urban water conservation and river restoration
3) defend special public lands from energy development and unauthorized off-road vehicle travel.

We collaborate with other conservation groups, hunters and fishermen, ranchers, American Indians, and others to ensure a sustainable future for the West.

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EXECUTIVE SUMMARY

Phoenix, Arizona, one of the largest metropolitan areas in the country, has a huge demand for air conditioning because of its very high summer temperatures. Electric utilities serving the Phoenix area must obtain hundreds of megawatts of additional power generation capacity every few years and burn large quantities of natural gas to fuel their intermediate and peak generation resources to run air conditioners.

Reducing the air conditioning load with shade trees reduces fuel and operating costs for power generation. Unfortunately, the Phoenix area has a meager tree canopy. While some older neighborhoods have fairly dense vegetation, many houses and commercial buildings bake in the summer sun with little or no shade.

Three mature shade trees on the west, east, or south sides of a house would reduce air conditioning load and save on average about 642 kilowatt-hours (kWh) of electricity per year — approximately what a refrigerator uses — or about 4.6% of average annual household electricity consumption. For each 10,000 shade trees planted in the Phoenix area, carbon dioxide emissions from power plants would decline by about 15,000 metric tons over a 30-year period. Yard trees, park trees, and street trees would also add to the community's visual and environmental resources.

In order to shade the Phoenix area expeditiously, it will be necessary to plant at least 10,000 drought-tolerant shade trees per year, on average, over an extended time period. Taking into account growth rates and survival rates, planting 10,000 shade trees at residential sites in the Phoenix area each year for 10 years would result in annual savings of about 14,000 megawatt-hours (MWh) after the trees mature. Planting trees can also help achieve other goals, such as restoring or improving habitat, increasing public participation in neighborhood issues, improving the appearance of streets, improving walkability along sidewalks and trails, and sequestering carbon dioxide.

Obtaining the energy savings and other benefits from shade trees requires a well-organized effort. To date, the Phoenix area has lacked a large-scale community tree planting organization. This report draws on the experience of 24 community tree planting organizations to provide a framework for designing and operating a sustained tree planting effort in Phoenix.

Outreach to the community is essential. Homeowners must participate in tree planting programs in large numbers. Moreover, volunteers comprise much of the workforce for tree planting, especially on public property, and individuals must be recruited, trained, and retained.

Education is a critical component of a tree planting program. Participants and volunteers must be provided with information on how to plant and care for new trees. Follow-up inspections are useful in determining tree survival rates and whether trees are actually shading

buildings.

Many community tree programs rely on local businesses and individuals for donations, and on grants from state or federal programs or from private foundations. If a tree planting program focuses on energy savings from shade trees, the local electric utility can be a key funding source.

With regard to organizational structure, most community tree planting enterprises are nonprofits. They typically have an executive director and a board of directors, who provide leadership and raise funds. An effective volunteer coordinator is necessary and larger organizations employ professional arborists, urban foresters, landscape architects, and finance directors.

INTRODUCTION

Shade trees save energy by reducing the demand for electricity to air condition buildings. They also provide numerous other environmental benefits and enhance the aesthetic quality of a community.

The Phoenix metropolitan area has relatively few trees and therefore does not take full advantage of the cooling effects and energy savings trees provide. Only about 13% of the Phoenix area has plant cover.[1] In contrast, American Forests has recommended the following tree canopy goals for metropolitan areas in the Southwest and dry West:[2]

- Average tree cover counting all zones 25%
- Suburban residential zones 35%
- Urban residential zones 18%
- Central business districts 9%

This report provides a basis for establishing a community tree planting organization in the Phoenix area. It reviews the energy savings that could result from planting shade trees in this area and presents a framework for designing and sustaining a community shade tree program based on the experience of other tree planting organizations.

Community tree planting organizations play a central role in the greening of cities. They are typically nonprofit organizations that pursue programs to plant hundreds or thousands of trees each year, recruit volunteers to plant trees, educate the public, and develop and implement neighborhood, city-wide, or regional plans for urban vegetation. While they often work with municipal governments, foundations, other organizations, and electric utilities, they are not, in general, established by municipal ordinance and generally do not have regulatory authority in their communities.[3]

This report covers the following topics:

- Tree canopy and energy use
  - Energy savings from shade trees in the desert Southwest
  - Energy savings from large-scale tree planting programs
  - Water use impacts of shade trees
  - Other benefits of urban trees

1 Memo from Dale Larsen, Acting Director, Parks and Recreation Department, to Rick Naimark, Deputy City Manager, "Tree and Shade Task Force Overview," prepared for City Council Work Study Session, May 26, 2009. The U.S. Forest Service estimated that there are about 54 million urban trees in Arizona and that about 11.4% of the urban area is covered by tree canopies. The urban area is defined as areas with at least 50,000 people and a minimum population density of 384 people per square kilometer, plus unincorporated and incorporated places having at least 2,500 people. John Dwyer, David Nowack, Mary Noble, and Susan Sisinni, *Connecting People with Ecosystems in the 21st Century: An Assessment of Our Nation's Urban Forests*, General Technical Report PNW-GTR-490, Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 2000.

2 American Forests, "Setting Urban Tree Canopy Goals," http://www.americanforests.org/resources/urbanforests/treedeficit.php (accessed October 9, 2009). For more humid areas of the country, the recommended percentages are higher. For comparison, Las Vegas has set a goal to double its tree canopy from 10% to 20% by 2035; see City of Las Vegas, "Urban Forestry Initiative," 2008.

3 Many communities have tree boards or commissions established by ordinance, which are responsible for public programs dealing with tree planting and maintenance, especially on public property. See Tree City USA web site, http://www.arborday.org/programs/treeCityUSA/index.cfm. Additionally, many cities plant trees on public property or as part of a neighborhood improvement program.

- Designing and sustaining shade tree programs
  - Visionary planning
  - Goals, focus, scale, and location
  - Outreach networks
  - Logistics of large-scale tree planting efforts
  - Funding levels
  - Management
- Conclusions

The appendices present additional material:

- Economics of shade trees
- Other resources for tree planting programs
- Planting and care instructions

ENERGY SAVINGS FROM SHADE TREES IN THE DESERT SOUTHWEST

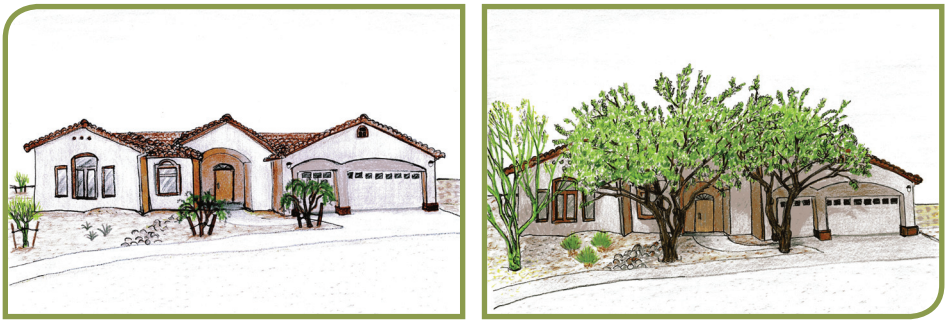
In 2008, 4.3 million people lived in the Phoenix, Arizona, metropolitan area. High temperatures during June, July, and August average above 100° F and nighttime minimum temperatures have been steadily increasing.

The result is a huge air conditioning load on the electric supply system, especially in the afternoon and evening. Arizona Public Service Company and Salt River Project, which serve most of the Phoenix area, have pronounced summer peak demands because of the air conditioning load. Consequently, they must obtain hundreds of megawatts (MW) of additional power generation capacity every few years and burn large quantities of natural gas to fuel their intermediate and peak generation resources.

Reducing the air conditioning load with shade trees reduces fuel and operating costs for power generation. Shade trees are one of many measures that can improve energy efficiency and cut the demand for electricity. But unlike some other urban areas, the Phoenix area does not have a large-scale shade tree planting program. Some older neighborhoods have fairly dense vegetation, but many houses and commercial buildings bake in the summer sun with little or no shade.

Shade trees save energy by reducing the heat gain in the shaded building during the summer, thereby reducing the need for air conditioning. Trees also counteract the urban heat island effect by cooling surface air temperatures through both shade and evapotranspiration.[4]

Table 1 summarizes energy savings for mature, medium-sized residential trees in the desert Southwest, as estimated in several studies. The studies measured the effects of one to four trees per house. The savings reported in *Table 1* are the average savings per tree, which may differ from the savings from planting an additional tree in a yard. The median savings estimate is 214 kWh per year per mature tree and 0.056 kW of peak demand per mature tree, measured at the customer's premises.



Caption to go here...

4 The urban heat island effect results, in part, from buildings and pavement absorbing heat during the day and radiating the stored heat, primarily at night. Consequently, the atmospheric temperatures of urban areas are often several degrees higher than nearby rural areas, and nighttime minimum temperatures increase over time. Additionally, the reduced vegetation and greater presence of impervious surfaces in urban areas, relative to rural areas, result in higher surface and air temperatures in urban areas. See U.S. Environmental Protection Agency, *Reducing Urban Heat Islands: Compendium of Strategies, Urban Heat Island Basics,* http://www.epa.gov/heatisland/resources/pdf/BasicsCompendium.pdf, no date listed; and Anthony Brazel, Nancy Selover, Russell Vose, and Gordon Heisler, "The Tale of Two Climates – Baltimore and Phoenix Urban LTER Sites," *Climate Research* 15 (2000): 123-135.

Table 1. *Estimates of Energy Savings Due to Residential Shade Trees*

STUDY[5]	STUDY AREA	COOLING DEGREE DAYS	CONFIGURATION	KWH SAVINGS PER MATURE TREE PER YEAR	KW SAVINGS PER MATURE TREE
McPherson, 1993	Tucson	3,017	Air conditioning savings due to one deciduous tree on west side of energy-efficient, two-story home	400 for 24-foot tree	0.50 for 24-foot tree
Clark and Berry, 1994, 1995	Phoenix	4,355	Residential customer savings in houses that received an average of three medium-sized trees to shade sun-struck sides of houses	270 for average house with dual cooling 319 for inefficient house with dual cooling 12 for average house with air conditioning only 128 for inefficient house with air conditioning only	0.007 for average house with dual cooling 0.12 for inefficient house with dual cooling 0.017 for average house with air conditioning only 0.057 for inefficient house with air conditioning only
Akbari and Konopacki, 2005	Phoenix	4,355	Four deciduous shade trees near south and west walls of 2,000-square-foot residential buildings	153 for pre-1980 house with electric heat (net savings) 99 for 1980 or newer house with electric heat (net savings)	0.068 for pre-1980 house 0.044 for 1980 or newer house
Arizona State Land Dept., 2004	Desert Southwest		0-year-old, medium-sized residential yard tree (cooling savings): savings reduced to account for tree deaths	388 for west orientation 291 for south orientation 334 for east orientation Average = 338	Not reported
Simpson and McPherson, 1996	El Centro, CA	3,952	Cooling savings from two trees on the west side and one on the east side of an energy-efficient house	214	0.15
Median savings			**Median calculated using average savings value from Arizona State Land Dept. study**	**214**	**0.056**

There is a large range in the values of savings estimates. In part, this range is due to assumptions about house and occupant characteristics, and in part it is due to different study methods. In general, savings will be greater if shade trees are planted near less energy-efficient

5 Study references: E. Gregory McPherson, "Evaluating the Cost-Effectiveness of Shade Trees for Demand-Side Management," *The Electricity Journal* 6, no. 9 (November 1993): 57-65. Kim Clark and David Berry, "Targeting Residential Conservation Measures," *Home Energy* (September/October 1994): 14-15. Kim Clark and David Berry, "House Characteristics and the Effectiveness of Energy Conservation Measures," *Journal of the American Planning Association* 61, no. 3 (Summer 1995): 386-395. H. Akbari and S. Konopacki, "Calculating Energy-Saving Potentials of Heat-Island Reduction Strategies," *Energy Policy* 33, Issue 6 (April 2005): 721-756. Arizona State Land Department, Natural Resources Division, Urban & Community Forestry Section, and Arizona Community Tree Council, Inc., *Desert Southwest Community Tree Guide,* 2004, Appendix A. James Simpson and E. Gregory McPherson, "Potential of Tree Shade for Reducing Residential Energy Use in California," *Journal of Arboriculture* 22, no. 1 (January 1996): 10-18. Cooling degree data in the table pertain to the period 1971 to 2000 and are reported for a base of 65° F.

homes, such as older homes or homes with single-pane windows or more south-facing glass. Thus, savings levels could be increased by selecting less efficient homes to receive shade trees.[6] Studies of some other southwestern cities, such as Albuquerque, are not shown in the table because these cities are not as hot as Phoenix, as measured by cooling degree days.

The average residential customer of Arizona Public Service Company used about 14,000 kWh in 2007.[7] Thus, if a house saved 214 kWh per year per mature shade tree and had three mature shade trees on the east, west, or south side of the house, it would reduce its annual electricity consumption by about 4.6%. During the summer cooling season, the percentage savings would be larger.

Table 2 describes commonly planted desert-adapted trees. To maximize air conditioning energy savings, shade trees for southwestern areas should have a broad spreading form and a dense crown, should shade windows, and should shade west-facing walls.[8] Trees for Tucson recommends that trees be planted within 15 feet of the west, east, or south side of the house, the west side being considered the best location for energy savings.[9]

Some program managers emphasize use of native species for urban sites and for restoration of natural areas. They also advise that invasive species be avoided.[10] The definition of "native trees" can be narrow, pertaining to trees that naturally would have grown in a particular local area, or broad to include the Southwest and northern Mexico generally. Native trees, broadly defined, include velvet mesquite (Prosopis velutina), honey mesquite (Prosopis glandulosa), screwbean mesquite (Prosopis pubescens), desert ironwood (Olneya tesota), southwestern sweet acacia (Acacia minuta), whitethorn acacia (Acacia constricta), blue palo verde (Cercidium floridum), foothills palo verde (Cercidium microphyllum), desert willow (Chilopsis linearis), and Texas ebony (Pithecellobium flexicaule).[11] It is important to choose trees that can tolerate hot, dry summers and that do not require a lot of care. Native trees best meet these requirements.

Table 2. *Common Desert-Adapted Trees for Urban Sites*[12]

SPECIES	COMMON NAME	MATURE TREE SIZE	GROWTH RATE
Acacia minuta	Sweet acacia	Small	Fast
Acacia salicina	Willow acacia	Medium	Fast
Cercidium floridum	Blue palo verde	Medium	Fast
Cercidium praecox	Palo brea	Medium	Fast
Chilopsis linearis	Desert willow	Small	Moderate
Lysiloma microphylla	Feather tree	Small	Moderate
Olneya tesota	Ironwood	Small-medium	Slow
Pithecellobium flexicaule (Ebenopsis ebano)	Texas ebony	Small	Slow
Prosopis chilensis	Chilean mesquite	Medium	Fast
Prosopis velutina	Velvet mesquite	Medium	Fast

6 Kim Clark and David Berry, "House Characteristics and the Effectiveness of Energy Conservation Measures," *Journal of the American Planning Association* 61, no. 3 (Summer 1995): 386-395. E. Gregory McPherson and Eileen Dougherty, "Selecting Trees for Shade in the Southwest," *Journal of Arboriculture* 15, no. 2 (February 1989): 35-43.

7 Arizona Public Service Company Rate Case Filing, Schedule H-2, Docket No. E-01345A-08-0172.

8 E. Gregory McPherson and Eileen Dougherty, "Selecting Trees for Shade in the Southwest," *Journal of Arboriculture* 15, no.2 (February 1989): 35-43.

9 Trees for Tucson, "Home Shade Tree Application." http://www.ci.tucson.az.us/tcb/docs/tftapp.pdf, accessed October 12, 2009.

10 Two major invasive species in southern Arizona are not trees, but Fountain grass and Buffel grass. See Arizona Native Plant Society web site, http://www.aznps.com.

11 Arizona Native Plant Society, Trees for Tucson, Global ReLeaf, "Desert Trees," 1990. [

12 Sources: Arizona Native Plant Society, Trees for Tucson Global ReLeaf, "Desert Trees," 1990. [Sunset Editors, Sunset Western Garden Book, Menlo Park, CA: Lane Publishing Co., 1988.

ENERGY SAVINGS FROM LARGE-SCALE TREE PLANTING PROGRAMS

Trees are a long-term energy-efficiency measure and will not produce significant energy savings for several years after planting unless the trees, when planted, are large (and expensive). Thus, a shade tree program for energy savings differs from programs that produce relatively quick savings by replacing, for example, large numbers of inefficient light bulbs or air conditioners in a short time period.

When estimating the energy savings attributable to a shade tree planting program, it is necessary to account for the growth rates and survival rates of trees. The trees that are planted will generally be relatively small and will not be mature for 10 years or more, depending on the initial size of the trees and the growth rate of the trees. In general, in their early years, newly planted trees will not cast much shade. Additionally, a fraction of the trees planted in the shade tree program will die each year.

Figure 1 shows the annual energy savings from planting 10,000 shade trees at residential sites in the Phoenix area each year for 10 years, assuming the median annual kWh savings reported in Table 1 for a mature tree, taking into account growth rates, and assuming the annual survival rate published by the American Public Power Association.[13] For this level of program effort, energy savings would peak at about 14,000 MWh in the twenty-first year.

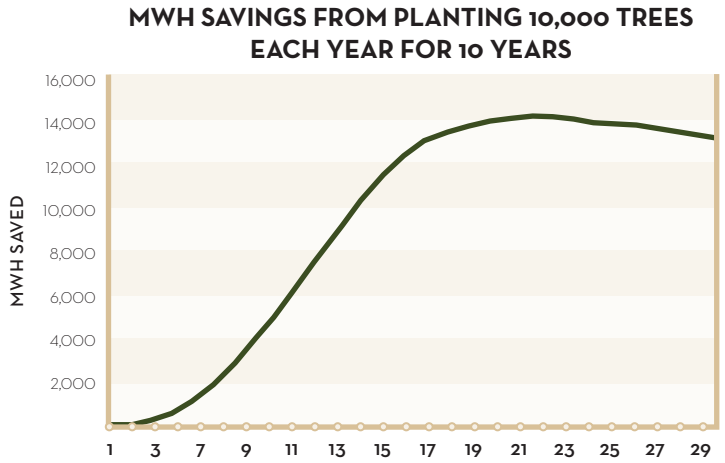


Figure 1. *Energy Savings from Planting 10,000 Trees Each Year for 10 Years*

WATER USE IMPACTS OF SHADE TREES

In the Phoenix desert, water use matters, and drought-tolerant trees are appropriate. However, low water use trees in an urban setting still require some watering, depending on the tree and the tree location as well as the amount of rainfall.

Figures 2 and *3* show water requirements[14] of smallish desert-adapted and moderate water use trees in Phoenix, assuming average precipitation over the period 1999 to 2008.[15] These trees are assumed to have a canopy diameter of 10 feet — smaller trees would require less water and larger trees would require more water. The desert-adapted tree would require about 800 gallons per year of water in addition to rainfall, and the moderate water use tree would require about 1,400 gallons of water in addition to rainfall, on average.

13 Survival rates are from "Tree Mortality & Growth Rate Factor," American Public Power Association web site, www.appanet.org/treeben/data/growthmortalitydata.asp. These rates are not constant over time. We also assumed that trees would attain 50% of their shading capability in the sixth year after planting and 100% in the thirteenth year.

14 Arizona Municipal Water Users Association, Arizona Landscape Irrigation Guidelines Committee, *Guidelines for Landscape Drip Irrigation Systems*, 2001, Appendix J.

15 Precipitation data from National Weather Service. http://www.wrh.noaa.gov/psr/climate/climatetable.php?wfo=psr&month=All&parm=MonthlyPcpn&site=PHX.

Average residential water use in Phoenix is 135 gallons per capita per day,[16] so a household with three persons would use, on average, 148,000 gallons per year. The addition of a small number of low or moderate water use trees would increase water use only very slightly.

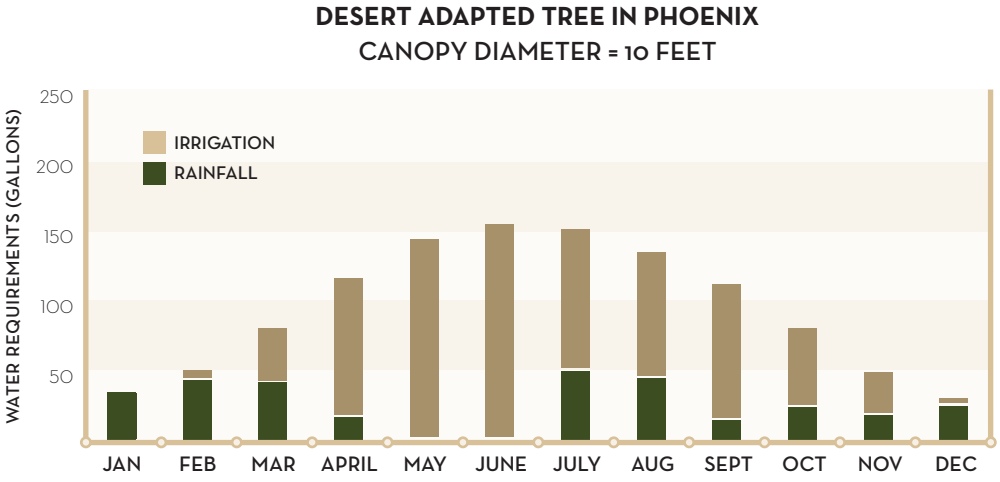


Figure 2. *Water Requirements of Desert-Adapted Tree in Phoenix*

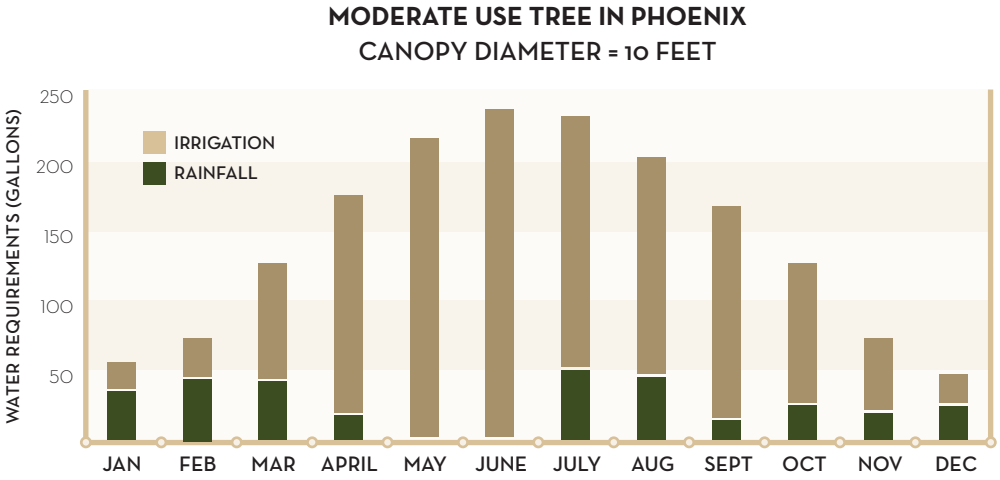


Figure 3. *Water Requirements of Moderate Water Use Tree in Phoenix*

OTHER BENEFITS OF URBAN TREES

This report is concerned with the energy savings attributable to the urban forest. However, urban forests provide other benefits, including storm water runoff reduction, reduced pollutants and suspended solids in surface water runoff, reductions of sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide, and particulate matter in the atmosphere, and sequestration of carbon dioxide. In addition, urban trees provide aesthetic and wildlife benefits and contribute to the walkability of neighborhoods, as they shade houses and sidewalks.

As shade trees reduce electricity consumption, carbon dioxide emissions from power generation are reduced. For each 10,000 shade trees planted in the Phoenix area, carbon dioxide emissions from power plants would decline by about 15,000 metric tons over a 30-year period.

A study of the benefits and costs of street and park trees in Glendale, Arizona, indicated that

16 City of Phoenix Water Services Department, *Water Resources Plan: 2005 Update*, p. 46.

the benefits far exceed the costs.[17] The benefits measured in the study were energy savings, net reduction of carbon dioxide in the atmosphere, improvements in air quality, storm water runoff reduction, and increases in property values.

17 Sources: Greg McPherson, James Simpson, Paula Peper, Scott Maco, and Qingfu Xiao, *City of Glendale, Arizona Municipal Forest Resource Analysis,* Report CUFR-7, USDA Forest Service, Pacific Southwest Research, Center for Urban Forest Research, 2005. Greg McPherson, James Simpson, Paula Peper, Scott Maco, and Qingfu Xiao, "Municipal Forest Benefits and Costs in Five US Cities," *Journal of Forestry* (December 2005): 411-416.

DESIGNING & SUSTAINING SHADE TREE PROGRAMS

An organization contemplating a large-scale tree planting program must consider program design. Program design encompasses two dimensions — a visionary dimension and an implementation dimension.

We reviewed activities and structures of many of the major nongovernmental tree planting organizations in North America to identify features common to successful programs. Table 3 lists the community tree planting organizations we reviewed. Our focus is on tree planting activities. Many of the organizations we looked at also do other things, from park design to job training. This report does not assess these other activities, but it should be kept in mind that some organizations have multiple areas of expertise.

In this section we examine:

- Visionary planning
- Program goals, focus, scale, and location
- Outreach
- Logistics of large-scale tree planting programs
- Funding levels
- Management

Additionally, nongovernmental organizations often work with local government and electric utilities to implement tree planting programs.[18] Some examples are provided in the following sections.

VISIONARY PLANNING

In a study of urban forestry programs, Ann McCoy Allen concluded that a necessary ingredient in a successful program is a passionate, persistent, visionary leader.[19] Typically, visionary planning develops long-term scenarios with desired characteristics and identifies corresponding changes in communities, markets, and policies needed to achieve the vision. The vision provides overall direction for achieving practical objectives.

Visionary planning may focus on a specific outcome or on a process. Million Trees LA provides an example of a visionary outcome.[20] The vision is to plant one million new trees in Los Angeles. Trees may be planted on public property, in parks, or on private land. To

18 The city of Phoenix has a Tree and Shade Task Force cooperative effort among several city departments. The task force is developing a Shade Master Plan, but because of budgetary limitations progress may be slow. One of the issues to be addressed is the promotion of volunteer-based community shade education and tree planting programs and continued development of corporate and community partners, the subject of this section of the report. Memo from Dale Larsen, Acting Director Parks and Recreation Department to Rick Naimark, Deputy City Manager, "Tree and Shade Task Force Overview," prepared for City Council Work Study Session, May 26, 2009.

19 Ann McCoy Allen, "Quiet Revolutions: Neighborhood Urban Forestry Programs," master's thesis, Louisiana State University and Agricultural and Mechanical College, School of Landscape Architecture, 2005. She conducted case studies in Houston, Atlanta, and Little Rock.

20 See Million Trees LA web site, http://www.milliontreesla.org.

accomplish the goal, city departments, individual volunteers, community groups, and businesses must all play a role.

An example of a visionary process is provided by Trees Forever's goal: to create a long-lasting organization that will have an enduring impact on people, communities, trees, and the land. To be a long-lasting organization, Trees Forever focuses on educating the next generation to be stewards.[21]

Table 3. *Community Tree Planting Organizations Reviewed for this Report*

TYPE	ORGANIZATION	LOCATION	WEBSITE
Urban/Metropolitan	Trees for Tucson/Tucson Clean & Beautiful	Tucson, AZ	www.ci.tucson.az.us/tcb/tft/
	Sacramento Tree Foundation	Sacramento, CA	www.sactree.com
	Tree People	Los Angeles, CA	www.treepeople.org
	North East Trees	Los Angeles, CA	www.northeasttrees.org
	Roseville Urban Forest Foundation	Roseville, CA	www.rosevilletrees.org
	Our City Forest	San Jose, CA	www.ourcityforest.org
	Trees for Houston	Houston, TX	www.treesforhouston.org
	Tree Folks	Austin, TX	www.treefolks.org
	Up With Trees	Tulsa, OK	www.upwithtrees.org
	Friends of Trees	Portland, OR and Vancouver, WA	www.friendsoftrees.org
	Tree Trust	St. Paul, MN	www.treetrust.org
	Trees Atlanta	Atlanta, GA	www.treesatlanta.org
	Savannah Tree Foundation	Savannah, GA	www.savannahtreefoundation.com
	Greensboro Beautiful	Greensboro, NC	www.greensborobeautiful.org
	Trees Greenville	Greenville, SC	www.treesgreenville.org
	Baton Rouge Green	Baton Rouge, LA	www.batonrougegreen.com
	Shreveport Green	Shreveport, LA	www.shreveportgreen.org
	Greenscape of Jacksonville	Jacksonville, FL	www.greenscapeofjacksonville.com
	UC Green	Philadelphia, PA	www.ucgreen.org
	LEAF	Toronto, ON	www.leaftoronto.org
Regional	Tree Utah	Utah	www.treeutah.org
	Tree New Mexico	New Mexico	www.treenm.com
	Trees Forever	Iowa and Illinois	www.treesforever.org
	Colorado Tree Coalition	Colorado	www.coloradotrees.org

GOALS, FOCUS, SCALE, AND LOCATION

Trees Atlanta advised that a tree planting organization should focus on a few projects or goals and do them well. This section summarizes some of the major planning elements of tree programs (see *Table 4*). These programs take place within different spatial contexts and reflect a variety of goals and focal points:[22]

» Program goals (e.g., energy savings, aesthetics, recreation, ecosystem protection, neighborhood quality of life, job training).

21 Trees Forever, *2007 Annual Report,* 2008, available at http://www.treesforever.org/Content/Learn/Resources/Annual-Reports.aspx.

22 See Tseira Maruani and Irit Amit-Cohen, "Open Space Planning Models: A Review of Approaches and Methods," *Landscape and Urban Planning* 81 (2007): 1-13.

» Program focus (e.g., shading individual buildings, restoring habitat, increasing public participation in neighborhood issues).

» Scale and location (e.g., a metropolitan region, a neighborhood, roadways, parks).

Table 4. *Goals, Focus, and Spatial Context of Community Tree Programs*

PROGRAM GOALS	FOCUS	SCALE/LOCATION	EXAMPLES
Energy savings	Shading individual buildings	Metro-wide	Trees for Tucson, Sacramento Tree Foundation, Roseville Urban Forest Foundation
Aesthetics	Providing and maintaining street and sidewalk trees or trees on public property: greenways or neighborhood green spaces	Linear: roadways, trails Nodal: neighborhood green spaces	Up with Trees (Tulsa), Baton Rouge Green, Trees Atlanta, UC Green (Philadelphia), Trees for Houston
Recreation	Providing and maintaining park trees	City or rural parks	Greensboro Beautiful
Watershed or other landscape and ecological protection	Restoring and protecting (native) habitat and reducing soil erosion	Riparian areas or other large-scale landscapes, in rural or metropolitan areas	Tree New Mexico, Trees Forever (Illinois and Iowa), Friends of Trees (Portland, OR)
Environmental protection	Improving air quality and reducing storm water runoff	Metro-wide	Trees Greenville
Neighborhood quality of life	Increasing active participation in neighborhood improvement through tree planting and maintenance	Neighborhoods	NeighborWoods programs:[23] Shreveport Green, Up with Trees (Tulsa), Greensboro Beautiful, Baton Rouge Green Neighborhood arboreta: Trees Atlanta and Friends of Trees (Portland, OR)
Job training	Providing learning opportunities for youth or others by planting or maintaining trees on public property	Neighborhood or metro-wide	Tree Trust (Minnesota)

One aspect of focus and spatial context is the neighborhood arboretum. Friends of Trees in Portland, Oregon, helped develop a linear arboretum along a two-mile stretch of one street where residents can see 60 different species of trees by walking or bicycling. Trees Atlanta helps sponsor arboreta in several neighborhoods to educate the public, improve the care and biodiversity of the urban forest, and create citizen advocates for trees. Neighborhood groups work with Trees Atlanta to increase the number of tree species. Granite markers are sold that identify the neighborhood and trees, and descriptive brochures are provided for visitors.[24]

For the Phoenix area, energy savings should be a major goal for a community tree planting organization, as indicated above. Many of the other program elements presented in *Table 4* may also be applicable, depending on the vision of the organization and the community. For instance, neighborhood quality of life, aesthetics, recreation, or ecological protection may be major factors in designing and implementing a Phoenix area tree planting program.

OUTREACH NETWORKS

To be successful, community tree planting programs must respond to community needs and draw from the community essential inputs, such as volunteer labor. In addition, outreach efforts can gain visibility for the organization.

Generally speaking, outreach occurs through social and business networks:[25]

» Use of networks increases the information available to the organization, such as re-

23 NeighborWoods is a program sponsored by the Alliance for Community Trees with grant money provided by the Home Depot Foundation. See Alliance for Community Trees web site, http://actrees.org/site/whatwedo/index.php.

24 See Friends of Trees web site, www.friendsoftrees.org/tree-resources/linear-arboretum.php; and Trees Atlanta web site, www.treesatlanta.org/NeighborhoodArboreta.aspx.

25 Frank Dobbin, "The Sociological View of the Economy," in Frank Dobbin, ed., *The New Economic Sociology,* Princeton, NJ: Princeton University Press, 2004, pp. 1-48.

vealing opportunities for future donations or volunteers.

- Widening network interactions increases the amount of information available to all parties. For example, educational programs, participation in other organizations' activities, and deliberately seeking out particular types of organizations for tree planting programs all may widen the organization's network, increase information, and generate more funding and volunteer effort.

- Network relationships foster reciprocal transactions that benefit the organization and counterparties. Awards, for example, may increase future participation or reward past participation in helping the organization meet its goals.

- Networks provide the opportunity to create trust among parties and to disseminate information about the reputations of the parties.

Several studies have shown the importance of buy-in from the community in determining the success of urban greening programs. In a study of an Oakland program, Richard Ames found that discussion of program details — species selection and tree placement — helped solidify public support, and that enhancing tree planting events with music and food improved participation.[26] As neighborhood residents took ownership of the tree planting project, tree survival rates improved.

Similar lessons have been drawn about tree planting projects in business districts. Kathleen Wolf concluded that, in addition to obtaining technical knowledge about trees, it is necessary to develop an inclusive civic process for actively involving stakeholders and addressing their concerns.[27]

In her history of community gardens, Laura Lawson concluded that public outreach is critical for funding and obtaining active community participation.[28] She found that local gardens must be perceived as community resources and serve the public interest through visible positive outcomes, such as increased property values, reduced vandalism, and ecological restoration. Maintaining public support requires broad public participation through fairs, children's gardens, and educational programs, and is enhanced by involvement with other community organizations, such as neighborhood associations.

A community tree planting organization may also be a resource for other organizations. For example, several Iowa utilities carried out tree planting programs to save energy.[29] Trees Forever contracted with these utilities to deliver funding to the communities for tree planting activities. Under their agreements with Trees Forever, the communities undertook several types of activities to obtain and continue receiving funding, including:

- Establishing volunteer tree planting groups
- Establishing tree boards or commissions
- Raising funds for tree planting
- Conducting tree inventories
- Developing tree management plans
- Carrying out tree planting events
- Developing ordinances pertaining to shade trees or street trees

A major factor contributing to the success of the Iowa programs was the designation of community coordinators to provide information and training of volunteers.

Events and activities that bring visibility to the organization are essential. These events

26 Richard Ames, "The Sociology of Urban Tree Planting," *Journal of Arboriculture* 6, no. 5 (May 1980): 120-123.

27 Kathleen Wolf, "Human Dimensions of the Urban Forest in Small City Business Settings," in *Forestry at the Great Divide: Proceedings of the 2001 National Conference*, Washington, DC: Society of American Foresters, 2001.

28 Laura Lawson, *City Bountiful*, Berkeley: University of California Press, 2005, pp. 300-301.

29 This discussion is based on Mark Vitosh and Janette Thompson, "Iowa Communities Benefit from an Externally Funded Tree-Planting Program," *Journal of Arboriculture* 26, no. 2 (March 2000): 114-119.

could be regularly scheduled planting projects (e.g., weekly planting projects throughout the community) or the occasional planting of some large trees in a heavily used area, for instance.

Visibility and reputation may generate new opportunities — other organizations may reach out to community tree planting organizations as a way to advance their own environmental agendas. For example, the Section of Environment, Energy and Resources of the American Bar Association (ABA) established a One Million Trees Project.[30] The ABA encourages its members to plant trees themselves and to work through partner tree organizations, such as the Alliance for Community Trees, The Arbor Day Foundation, Tree Link/Tree Bank, American Forests, and the Institute for Environmental Solutions.

Table 5 summarizes outreach strategies of several community tree programs. These programs employ a variety of strategies to gain and maintain community support and increase their visibility within their communities through:

- Volunteers
- Educational programs
- Targeting of specific market segments
- Awards and events to draw attention to the organization and its activities
- Demonstration projects to gain visibility and educate the public

Table 5. *Examples of Outreach for Community Tree Programs*

OUTREACH STRATEGY	EXAMPLES
Recruit and use volunteers	• Most community tree organizations rely heavily on volunteers to plant trees, restore natural areas, distribute information, and recruit other volunteers
Educate children through school programs	• Trees Greenville's tree gardens at schools • Baton Rouge Green: work with high school students and teachers on ecological restoration, tree planting projects at individual schools, Arbor Day program at elementary schools
Provide expertise to other organizations	• Trees Forever (Iowa and Illinois) collaborates with other community groups and provides expertise on planting projects on roads and trails
Educate the public	• Savannah Tree Foundation: workshops on tree maintenance, lectures on the role of trees in storm water abatement and road design, informational brochures, presentations to community groups, sponsorship of satellite studies to identify the rate and location of land cover changes • Tree Folks (Austin, TX): training course on tree care and installation, speaker's bureau, tree growing brochures • North East Trees (Los Angeles): workshops on tree planting and care plus classes in native plant identification and exotics removal • Trees Forever (Iowa and Illinois): educational classes on native plants • Trees Greenville and Trees for Tucson: tree walks or guided tours • Trees Atlanta and Friends of Trees (Portland, OR): neighborhood arboreta with a variety of species and tree markers on public and private property along a street or in a neighborhood
Target specific market segments	• Up with Trees (Tulsa): free trees for nonprofit and faith-based organizations to plant on their property
Create visibility through awards	• Trees for Houston: Arbor Day Awards•Sacramento Tree Foundation: Tree Hero Awards
Create visibility through events	• NeighborWoods tree planting events in selected neighborhoods (e.g., Greensboro Beautiful)
Develop and sustain public interest through demonstration garden	• Tree Utah Ecological Demonstration Garden: classes on urban sustainability covering ecological design concepts, water harvesting, permaculture principles

30 "One Million Trees Project," American Bar Association web site, http://www.abanet.org/environ/projects/million_trees/home.shtml.

LOGISTICS OF LARGE-SCALE TREE PLANTING EFFORTS

In order to shade the Phoenix area expeditiously, it will be necessary to operate on a large scale, with at least 10,000 trees planted per year, on average (see *Figure 1*). Fortunately there is experience with large-scale tree planting programs *(Table 6)*, which suggests that a large-scale effort in the Phoenix area is potentially within the capability of a community tree planting organization.

Table 6. *Large-Scale Tree Planting Efforts*

PROGRAM	TREES PLANTED	TIME PERIOD (YEARS)	AVERAGE NUMBER OF TREES/YEAR	COMMENTS
Trees Forever	1,200,000	20	60,000	Community forestry programs only
Tree New Mexico	950,000	19	50,000	Seedling distribution (reforestation and conservation), plus urban and riparian plantings
Sacramento Tree Foundation/ Sacramento Municipal Utility District (SMUD) shade tree program	450,000	19	23,700	SMUD-supported component of projects only, not entire Sacramento Tree Foundation effort
Trees for Houston	360,000	26	14,000	Trees and seedlings throughout the city
Trees for Tucson			3,800	Trees distributed July 2008 to July 2009 through utility-sponsored component of program
Greenscape of Jacksonville	150,000	34	4,400	Trees planted along streets and other public property
Trees Atlanta	75,000	24	3,000	Most trees planted in the central part of the city

For a tree planting program to work, it is necessary to distribute large numbers of trees efficiently and ensure that trees are properly planted so that they are likely to survive. *Table 7* summarizes the logistics of some utility-sponsored tree planting programs. All the approaches involve an education component, as described below, and many provide a subsidy to participants. In some cases, trees are delivered to a central location for pick-up; in others, homeowners purchase the trees directly; and in some cases, the trees are delivered to the planting site. In general, homeowners are responsible for planting their trees, although some programs provide information on having the trees professionally planted.

Some of the trees may be planted as a group community project in which citizens and neighbors plant trees together.[31] This hands-on group project promotes community-building and volunteer involvement and enhances tree survival. Group projects may increase the costs, in part because larger trees might be planted and in part because of the greater effort in coordinating the project.

With regard to education, participants are typically provided with information on how to plant and care for their new trees. Trees Atlanta pointed out that hands-on training before planting would increase the survival rates of trees. Some programs use videos on their web sites, some have classes or workshops, and some provide written instructions. It is also helpful to contact participants prior to tree delivery to distribute planting and maintenance information and to explain where the trees should be planted to provide shade and improve the chances of survival. Sample planting and care instructions appropriate for a desert envi-

31 Group efforts are probably not practical for planting all of the 10,000 trees each year proposed for the Phoenix area.

ronment are provided in *Appendix C*.[32]

Follow-up inspections are highly useful in determining tree survival rates and whether trees are actually shading buildings. This follow-up may be conducted on a random sample of participants. If problems are encountered, such as poor planting techniques, poor tree health, poor location for providing shade, or failure to plant the trees, they can be quickly addressed.[33]

The tree species eligible for the program should be restricted to varieties that will thrive in the local environment without requiring large water consumption. *Table 2* lists good candidates for the Phoenix area. In addition, program managers should select tree varieties with features that people want and that will provide shade. As indicated above, shade trees for southwestern areas should have a broad spreading form and a dense crown. Trees for Tucson found that preferred varieties should be resistant to insects and disease, plus have limited pollen output, limited maintenance requirements, and, if possible, no thorns. For programs in which program staff choose the trees, it is important to inspect trees from the nursery or grower and to select plants that are healthy and have desired shading characteristics.

FUNDING LEVELS

Funding is obviously necessary for community tree organizations. *Table 8* lists the annual expenses or budgets of several community organizations and general sources of funding.

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For large-scale tree planting programs, a commensurably large financial commitment is needed. Many community tree programs rely on large donors — often local businesses and individuals — and on grants from state or federal programs or from private foundations, such as the Home Depot Foundation. Programs that focus on planting and maintaining municipal trees and on maintaining the urban forest on public land — street trees, park trees, and trees in other public places — may receive a significant portion of their funding from city government. If a tree planting program has as a focus energy savings from shade trees, the local electric utility can be a critical partner. *Table 9* summarizes some utility partnerships for energy savings. Utility programs in Arizona must be cost-effective in order to receive approval for cost recovery by the Arizona Corporation Commission. *Appendix A* addresses the economics of shade trees in Arizona.

32 For additional information, see Trees for Tucson's instructions at "Trees Planting and Care Information," Tucson Clean & Beautiful web site, http://www.ci.tucson.az.us/tcb/tft/treedescriptions.htm#plant; and University of Arizona, College of Agriculture, Cooperative Extension, "Planting Guidelines: Container Trees and Shrubs," Report AZ 1022, May 1998, available at http://www.dbg.org/index.php/gardening/growingguides.

33 For an example of an assessment of urban tree health, see Jean Stutz, "Urban Tree Health in the Phoenix Metropolitan Area," Central Arizona-Phoenix Long-Term Ecological Research Poster, no date listed, *http://caplter.asu.edu/docs/symposia/symp2008/Stutz_2008.pdf* (accessed October 9, 2009).

Table 7. *Logistics of Some Utility-Sponsored Tree Planting Programs*

PROGRAM	TARGET	LOGISTICS
Trees for Tucson and Tucson Electric Power	Individual residences	• Homeowners receive trees up to six-feet tall for $8 each if they agree to plant them on the east, west, or south side of the house. • Older houses may receive up to four trees, newer houses up to two trees. • Homeowner or group must submit an application. • Trees are delivered to homes or to central location for group projects. • Species available are all drought-adapted. • Written planting and care instructions are provided.
Sacramento Tree Foundation and SMUD	Individual residences	• Homeowners may receive up to 10 free shade trees. • Participants are directed to watch a video on how to plant a shade tree. • Participants schedule appointment with community forester to discuss siting the trees. • Trees are delivered to the homeowner. • Choice is given from about 30 deciduous tree species.
Roseville Urban Forest Foundation and Roseville Electric	Individual residences	• Homeowner selects location of tree and selects species from a list of 19. • Homeowner purchases and plants trees according to siting and planting instructions. • Homeowner submits a rebate form and receives a utility bill credit up to $30 per tree (maximum of six trees per household). • Arborist may request to inspect the tree prior to homeowner receiving rebate.
MidAmerican Energy, Plant Some Shade	Individual residences	• Residents purchase and plant trees. • Trees are obtained in bulk from local nurseries and distributed at a central location. • Maximum of two trees per customer. • Participants receive planting and tree care instructions.
Our City Forest and PG&E	Individual residences	• One free shade tree for San Jose customers of PG&E with air conditioning. • Participant sends application to Our City Forest. • Our City Forest representative makes a site visit to determine suitable species and site for tree. • Participants receive tree care instructions and guidelines. • Trees may be inspected within three months of planting.
Alliant Energy, Branching Out	Community	• Grants of $1,000 to $10,000 available for community tree planting projects. • Application must be submitted – trees need not be shade trees but could provide other environmental benefits.

Table 8. *Annual Expenses of Some Community Tree Planting Organizations* [34]

ORGANIZATION	EXPENSES OR BUDGET (YEAR)	MAJOR SOURCES OF FUNDING
Sacramento Tree Foundation	$2,162,000 (YE 6/30/07)	SMUD (utility), government agencies, native tree mitigation service contracts
Trees Atlanta	$2,144,730 (YE 6/2008)	
Trees Forever	$1,703,000 (YE 12/2007)	Utilities, business
Trees for Houston	$1,589,774 (YE 5/2008)	Contributions, special event revenue
Friends of Trees (Portland, OR; Vancouver, WA)	$743,000 (YE 8/31/08)	Government, tree fees, individual donors, businesses, foundations
LEAF (Toronto)	$418,000 (2008)	Grants, project revenue

Table 9. *Examples of Utility Partnerships with Tree Planting Organizations*[35]

UTILITY	PROGRAM	UTILITY FUNDING AND RESULTS
Alliant Energy	Branching Out in partnership with Trees Forever	• 1,141,529 trees planted • Project matching funds = $2,346,314
Alliant Energy	Operation ReLeaf in partnership with the Iowa Department of Natural Resources and Iowa County Conservation Boards	• 45,300 trees planted • Customer pays $25 and Alliant Energy subsidizes the remaining cost
Roseville Electric	Roseville Shade Tree Program in partnership with Roseville Urban Forest Foundation	• 14,000 trees planted • Up to $30 bill credit per qualifying tree
Tucson Electric Power	Partnership with Trees for Tucson	• 57,500 trees planted • Utility subsidy reduces the tree price to $8
Sacramento Municipal Utility District	Partnership with Sacramento Tree Foundation	• 450,000 shade trees planted • Free shade trees for residential customers

MANAGEMENT

The nongovernmental community organizations reviewed for this report are typically nonprofit organizations. They have an executive director, who is often the founder of the organization, and a board of directors. The director provides visionary leadership, raises funds, and directs the staff. The board normally enlarges outreach networks, facilitates fund-raising, provides general programmatic direction, provides expertise on trees and tree planting, and participates in organization events.

34 Sources for table: John Waddell & Co., "Audit of Sacramento Tree Foundation," 2007, p. 3. Sacramento Tree Foundation, "Native Tree Mitigation Services," http://www.sactree.com/doc.aspx?47. "Charity Rating - Trees Atlanta," Charity Navigator web site, http://www.charitynavigator.org/index.cfm?bay=search.summary&orgid=7205 (accessed September 3, 2009). Trees Forever, *2007 Annual Report*, 2008, p. 12, available at http://www.treesforever.org/Content/Learn/Resources/Annual-Reports.aspx. "Charity Rating - Trees Forever," Charity Navigator web site, http://www.charitynavigator.org/index.cfm?bay=search.summary&orgid=5346 (accessed June 24, 2009). Trees for Houston, *Annual Report 2007-2008*, p. 4, available at http://www.treesforhouston.org/publications.html. Friends of Trees, *2008 Annual Report*, p. 10, available at http://www.friendsoftrees.org/about-us.php. LEAF, *2008 Annual Report*, p. 14, available at http://www.leaftoronto.org/annual-report.

35 Data sources: Zack Hill, Alliant Energy, "Energy Efficiency Through Trees," Green Infrastructure and Urban Trees Forum, May 2009. "Roseville Shade Tree Program," Roseville Electric web site, www.roseville.ca.us/electric/shade_tree/default.asp. "Trees for Tucson," Tucson Electric Power web site, www.tep.com/Community/PartnershipReport/Environment.php?p=1#TFT. "Free Shade Trees," Sacramento Municipal Utility District web site, http://www.smud.org/en/residential/trees/Pages/index.aspx.

Staff sizes vary from a few individuals to several dozen, depending on the scope of the organization's activities and level of funding. Most rely heavily on volunteers to carry out many activities, such as tree planting and educational efforts.[36]

Caption to go here...

Trees Atlanta pointed out that the volunteer coordinator is a critical staff member. This person is responsible for recruiting volunteers for specific projects and making sure the volunteers show up and are properly trained. The volunteer coordinator must have an efficient means of contacting volunteers, such as an email notification system, to fill specific project needs. Additionally, effective volunteer coordinators must create and sustain enthusiasm among the volunteers.

Other staff positions can include an education program coordinator, various other program coordinators, and a director of development. Larger organizations often employ one or more professional arborists, urban foresters, and landscape architects. Some also utilize a geographic information system (GIS) to map the existing tree canopy or the locations of trees planted under the auspices of the program. In addition, larger organizations tend to have finance directors, as accounting and other financial matters can involve over $1 million per year.

Lastly, it is necessary to develop a good recordkeeping system for cost components, marketing efforts, and planting activities, especially if funding is obtained from utilities desiring to implement energy-efficiency programs. The paper trail would typically include such items as:[37]

- Application forms for participants to fill out
- A marketing program
- Educational materials (videos, brochures, classes, on-site visits, etc.)
- A tracking system for tree planting activities indicating where trees were planted, how many trees were planted, species planted, follow-up inspections, etc.
- Expenses, by type of cost (program administration, trees, delivery of trees, marketing, etc.)

The tree planting organization can expect to work with the utility to develop the necessary tracking details.

36 For an overview of managing a nonprofit organization, see William Werther and Evan Berman, *Third Sector Management,* Washington, DC: Georgetown University Press, 2001.

37 See, for example, Tucson Electric Power Company, "Shade Tree Program," filed in Arizona Corporation Commission Docket E-01933A-07-0401, July 2, 2007.

CONCLUSIONS

The Phoenix metropolitan area would benefit from the addition of at least 100,000 new shade trees planted over the next ten years.

These trees would cost effectively reduce the heat gain in buildings and consequently reduce the air conditioning load that must be served by Arizona Public Service Company, Salt River Project, and the City of Mesa electric utility.

A nonprofit community tree planting organization could be the principal vehicle for implementing a large-scale tree planting effort. These types of organizations have successfully operated in other communities.

FOCUS

A tree planting organization should focus on a few projects or goals and do them well. A central goal for the Phoenix area is shading to save energy. Desert-adapted trees are most appropriate for the Phoenix area, including such species as mesquites, desert willow, various acacias, palo verde, ironwood, feather trees, and Texas ebony. To maximize air conditioning energy savings, shade trees for southwestern areas should have a broad spreading form and a dense crown and should shade windows, if possible. Trees should be planted within 10 to 15 feet of the west, east, or south side of the house, the west side being considered the best location for energy savings. On average, one mature shade tree planted near a house would save roughly 214 kWh of electricity per year.

Other goals and focal points may be appropriate, too, such as restoring habitat, increasing public participation in neighborhood issues, and creating a more attractive urban design.

COMMUNITY RELATIONS

To be successful, community tree planting programs must respond to community needs and draw from the community for essential inputs, such as volunteer labor. In addition, outreach efforts can gain visibility for the organization. Partnering with other organizations can also help raise the visibility of the organization and the program, plus provide an additional pool of volunteers.

Programs employ a variety of strategies to gain and maintain community support and increase their visibility within their communities. These strategies include recruitment of volunteers and homeowners to participate in planting programs, educational programs, targeting of specific market segments for tree planting, use of awards and events to draw attention to the organization and its activities, and use of demonstration projects.

LOGISTICS AND SCALE

In order to shade the Phoenix area expeditiously, it will be necessary to operate on a large scale, with at least 10,000 trees planted per year, on average. There is experience with large-scale tree planting programs in other communities, which suggests that a large-scale effort

in the Phoenix area is potentially within the capability of a community tree planting organization.

For a tree planting program to work, it is necessary to distribute large numbers of trees efficiently and ensure that trees are properly planted so that they are likely to survive. Many tree planting programs subsidize trees for residential sites. In residential shade tree planting programs, trees can be delivered to a central location for pick-up, homeowners may purchase the trees directly, or the trees can be delivered to the planting site. In many programs, volunteers plant trees on public property.

Education is a critical component of a shade tree planting program. Participants and volunteers must be provided with information on how to plant and care for trees. Programs use videos on their web sites, have classes or workshops, and provide written instructions. It is also helpful to contact participants prior to tree delivery to provide planting and maintenance information and to explain where the trees should be planted to provide shade. Follow-up inspections are useful in determining tree survival rates and whether trees are actually shading buildings.

For large-scale tree planting programs, a significant financial commitment is needed. Many community tree programs rely on donors — often local businesses and individuals — and on grants from state or federal programs or from private foundations. If a tree planting program focuses on energy savings from shade trees, the local electric utility can be an important partner. Programs that focus on planting and maintaining municipal trees or maintaining the urban forest on public land may receive a significant portion of their funding from city government.

MANAGEMENT

A necessary ingredient in a successful tree planting program is a visionary director who provides leadership, raises funds, and oversees the staff. The board should facilitate fundraising, provide general programmatic direction, provide expertise on trees and tree planting, and participate in organization events. Most community tree planting organizations rely heavily on volunteers to carry out activities, such as tree planting and educational efforts; thus, an effective volunteer coordinator is a key staff member. Staff sizes vary from a few individuals to a dozen or more, depending on the scope of the organization's activities and level of funding. Larger organizations often employ a professional arborist, urban forester, or landscape architect, and have a finance director.

SUMMARY OF BENEFITS

A large-scale shade tree program in the Phoenix area would endow the region with significant benefits. First, it would cost effectively shade structures and reduce the demand for electricity for air conditioning. This would, in turn, reduce utility fuel and operating costs. Planting 10,000 shade trees at residential sites in the Phoenix area each year for 10 years would result in annual energy savings of about 14,000 MWh after the trees mature.

Second, a higher-density urban forest would reduce storm water runoff, reduce pollutants and suspended solids in surface water runoff, reduce sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide, and particulate matter in the atmosphere, and sequester carbon dioxide.

Third, urban trees provide aesthetic and wildlife benefits, plus contribute to the walkability of neighborhoods as they shade houses and sidewalks.

And fourth, as shade trees reduce electricity consumption, carbon dioxide emissions from power generation are reduced. For each 10,000 shade trees planted in the Phoenix area, carbon dioxide emissions from power plants would decline by about 15,000 metric tons over a 30-year period.

APPENDIX A

ECONOMICS OF SHADE TREES

In Arizona, regulated utilities' energy-efficiency programs must be cost-effective, that is, the benefits must exceed the costs. Tucson Electric Power Company's shade tree program has been in place since 1992 and has demonstrated its cost-effectiveness.[38]

The stream of energy saved by shade trees over time depends on several factors: location of the trees in relation to the building (shading the east, south, or west sides of the building), size of the trees, growth rate of the trees, and survival rates of the trees.[39]

The benefits of a shade tree program with regard to saving energy include:

- Avoided utility fuel costs and operating and maintenance costs.
- Avoided or deferred costs of increasing generating capacity.
- Avoided costs of complying with existing or impending environmental regulations, such as the costs of complying with carbon dioxide emission regulations from power generation.

The costs of a shade tree program are:

- Full costs of trees, including any planting costs. Costs of irrigation water.
- Incremental maintenance costs (these costs may be negligible if the program participant perceives the trees as part of gardening activity undertaken for non-pecuniary reasons).
- Tree program administrative costs.

To illustrate the relative costs and benefits of a shade tree program, we prepared an analysis of the case where 10,000 trees are planted in Phoenix at the outset, using the following parameters: a mature tree saves 214 kWh per year; trees grow and die over a 30-year time horizon; and the annual survival rate corresponds to the schedule reported by the American Public Power Association.[40]

The following cost parameters are also used for this case: all costs are in constant 2009 dollars; each tree costs $45 at the time of planting, including program administrative costs; watering costs are at current city of Phoenix water rates; and there are no tree maintenance costs, reflecting the assumption that tree maintenance is part of a gardening hobby.

The electric utility will be able to avoid fuel and variable operating and maintenance costs at the power plants that would reduce generation as a result of the energy savings attributable

38 See Arizona Corporation Commission Decision No. 70455, dated August 6, 2008.

39 Our City Forest reports a survival rate of 90% of trees planted since 1994: see http://d8crt.org/linkedfiles/tree_flyer.pdf . An Iowa tree planting program found a survival rate of 91% three to four years after planting: see J.R. Thompson, D.J. Nowak, D.E. Crane, and J.A. Hunkins, "Iowa, U.S. Communities Benefit from a Tree-Planting Program: Characteristics of Recently Planted Trees," *Journal of Arboriculture* 30, no. 1 (January 2004): 1-9, see p. 4 and Tables 3 and 4. A more conservative survival schedule is provided by the American Public Power Association: see "Tree Mortality & Growth Rate Factor," American Public Power Association web site, www.appanet.org/treeben/data/growthmortalitydata.asp.

40 "Tree Mortality & Growth Rate Factor," American Public Power Association web site, www.appanet.org/treeben/data/growthmortalitydata.asp. We also assumed that trees would attain 50% of their shading capability in the sixth year after planting and 100% in the thirteenth year.

to the shade trees.[41] It is assumed that, on average, the marginal generation units have a heat rate of 9,400 Btu per kWh; fuel (natural gas) costs are $5.00 per million Btu, escalating at a real rate of 2.7% per year; and operating and maintenance costs are $3 per MWh.

Transmission and distribution system losses are assumed to be 8%. Avoided carbon dioxide emissions are assumed to be 900 pounds per MWh saved, and carbon dioxide emission regulation compliance costs are assumed to be $20 per metric ton.

Looking over a 30-year time horizon and applying a 3% real discount rate, the present value of the net benefits (benefits minus costs) is $681,000. Under these assumptions, the tree program is cost-effective. But there is considerable uncertainty about many of the factors going into the calculation — for example, future fossil fuel costs and future costs of complying with carbon dioxide emission regulations are very uncertain.[42]

Lastly, another way to evaluate the net benefits of shade trees is to examine their effect on property values. The idea is that the costs and benefits of trees on a piece of property, including the aesthetic value of the trees and the value of trees in attracting wildlife, would be capitalized into the sale price of the property. In a study of sales prices of single-family houses in Baton Rouge, Louisiana, the presence of mature trees on the site was found to have increased the sales price by about 2%.[43] Kathleen Wolf reviewed several studies of the impact of trees on residential property values and found that trees add between 2% and 15% to the sale price of a property.[44] The variation in results reflects different study methods and differences in areas studied.

41 There may also be benefits attributable to avoided or deferred costs of new generating capacity, but these benefits appear to be small, based on the kW savings reported in Table 1.

42 In reviewing the Tucson Electric Power Company shade tree program, we found that the factors that make the biggest difference in costs and benefits are the assumed survival rates of trees, the kWh savings assumed per mature tree, and whether maintenance costs are treated as part of a gardening hobby and thus assumed to be $0. Therefore, it is important to gather good information about shade tree programs over time concerning these factors. Western Resource Advocates, "Initial Comments on Tucson Electric Power Company's Demand-Side Management Program Portfolio Plan," Arizona Corporation Commission Docket No. E-01933A-07-0401, filed October 10, 2007.

43 Jonathan Dombrow, Mauricio Rodriguez, and C. Sirmans, "The Market Value of Mature Trees in Single-Family Housing Markets," *The Appraisal Journal* 68 (January 2000): 39-43.

44 Kathleen Wolf, "City Trees and Property Values," *Arborist News,* August 2007, http://www.naturewithin.info/Policy/Hedonics_Citations.pdf.

APPENDIX B

ADDITIONAL RESOURCES FOR TREE PLANTING PROGRAMS

- Alliance for Community Trees web site, http://actrees.org/site/index.php. The alliance's mission is to support grassroots, citizen-based nonprofit organizations dedicated to urban and community tree planting, care, conservation, and education.
- Home Depot Foundation, *Stronger, Healthier Cities through Trees: A Resource Guide,* Atlanta, GA, 2007. The foundation is primarily focused on municipal tree planting programs; see its web site, www.homedepotfoundation.org.
- American Public Power Association's *Tree Power Report,* a newsletter available at www.appanet.org. The APPA's focus is on tree programs of public power entities.
- Arbor Day Foundation web site, www.arborday.org.
- Tree Link web site, www.treelink.org, which provides networking and communications tools for urban forestry professionals, nonprofits, government, and others.
- U.S. Environmental Protection Agency, *Reducing Urban Heat Islands: Compendium of Strategies, Trees and Vegetation,* http://www.epa.gov/heatisland/resources/pdf/TreesandVegCompendium.pdf, no date listed.

APPENDIX C

TREES FOR TUCSON PLANTING AND CARE INSTRUCTIONS[45]

LOCATION OF THE TREE

1. It is essential that trees be planted where they will shade your house as you noted on your application (no more than 15 feet from the house).

2. Plant trees at least 10 feet from sewer lines, 5 feet from waterlines, and 3 feet from all other underground lines (contact Blue Stake to locate lines); never plant under overhead lines nor in the public right of way without a permit.

PLANTING INSTRUCTIONS

1. Dig hole 1-foot deep and 2- to 3-feet wide. If you hit caliche (hard, almost cement-like material) dig deeper. Fill hole with water and make sure it drains in several hours. If it doesn't drain, then dig deeper or plant the tree elsewhere to ensure adequate drainage.

2. Carefully cut off the bottom of the container and then cut down the side, but leave a little of the plastic attached to the middle of the side to hold the root ball together until you get it in the hole right where you want it. Do not pull the tree out or roll the container on its sides to loosen. Hold the bottom and place the container in the hole. Put some soil back around the container, and then carefully finish cutting the side of the plastic container and remove. This will ensure minimal disturbance to the roots.

3. It is not necessary to amend the soil with mulch, but replace any rocks and chunks of caliche with good topsoil from elsewhere in your yard. If you do use mulch, don't use more than 1 part mulch to 3 parts original soil. Put 5-6 inches of mulch or compost on the surface to prevent the soil from drying out. Do not compact the soil. Let the water settle it.

4. Make a 3-foot wide tree well to hold enough water to ensure that the entire root ball gets soaked. If you have the space, it's even better to plant the tree in a 6- to 8-foot wide basin that captures rain runoff from your yard or roof. Water daily for the first week and then every other day, and so on. If the root ball was disturbed during planting, the tree may lose its leaves. Keep watering daily and the tree will grow new leaves, in most cases.

STAKING

1. Multi-trunked trees or ones that branch within a few feet of the ground will prove to be the most stable and resistant to being blown over by wind. A tree that is not staked or not tied tightly to a stake will develop better trunk size and strength. Trees that come from the nursery with stakes should have their stakes removed after planting. However, if the tree still needs support, the stake should then be driven into the

45 From Trees for Tucson, "Tree Planting Information," undated, by permission.

ground just beyond the root ball. Loosely tie the tree to the stake with plastic tree tape, soft cotton cloth strips, or wire and hose to allow the tree to gently move and develop a strong trunk without cutting the bark.

2. Remove stakes as soon as the tree can stand on its own. If the tree becomes top heavy, thin out the top (but not more than 33% of the foliage) to allow more wind to move through the tree and to reduce its weight and mass.

CARE

1. If the tree is planted in warm weather (90 plus degrees) in a sunny location, be sure to water it every day for the first few days, then reduce the frequency if the weather cools and/or the plant becomes established. Always water long enough to ensure that the entire root ball is watered. The trunk of the tree should not be allowed to stand in water for more than a couple of hours. During winter months, water only about every 2 weeks or so, in the absence of good rainfall.

    a. Form a basin about 6 inches deep that extends just beyond the outmost branches to water the tree. If drip irrigation is used, emitters should be added out to the outer edges of the branches as the tree grows. A 4- to 5-inch layer of mulch on the surface can significantly reduce the amount of water needed, especially in the hottest months. Add more mulch over time as it breaks down.

    b. Avoid planting in lawn areas, as the frequency of watering required by grass can be detrimental to proper root development of the trees.

2. In warm/hot weather, all types of trees may need watering 3-5 times a week until the root system gets large enough to store more water. Lack of water will leave trees stunted or, worse yet, dead.

3. Fertilize monthly during the summer to boost growth.

4. Protect the trunk from rabbit damage with chicken wire or other barrier.

5. Avoid pruning the tree up to a single trunk if it has upright growing lower branches.

6. Leaf cutter ants can damage desert willows. Treat ants with AMDRO or other ant-killing products. New leaves on mesquite can be damaged by tiny insects that cause distorted or partially unopened new leaves. Spray off daily with a water hose or soapy water as soon as they appear.

7. Generally, trees can be fertilized in February and through the growing season, but start with a small amount and water in thoroughly to avoid burning the roots. Check at nurseries or hardware stores for tree and shrub fertilizer.

8. Keep leaf litter and other dried plant and grass material from accumulating, especially within 20 feet of your home. Keep trees and shrubs adequately watered so they don't become a fire hazard during the dry summer months. Trees or large shrubs that are growing up under the eaves should be trimmed back away from the structure to reduce fire hazard.

PRUNING

1. Do not over-prune. Young desert-type trees often have many branches developing along their trunks. This is their natural growth form that should be nurtured rather than attempting to force them into single trunk trees. So regardless of how tempting it is to trim up to form a single trunk, let these branches grow for at least a few months during the warm, rapid-growth season, eventually allowing several trunks to develop.

This will result in a faster-growing tree that will be more stable and will greatly reduce long-term maintenance needs. Many trees in Tucson are trimmed up to single trunks, which then become top heavy with poor weight distribution, requiring staking and continuous maintenance.

2. Leaves stimulate more root development, which can then support more top growth as well as provide a stronger anchor to support the tree. Combined with unstaked trunks, this growth will also result in larger and stronger trunks. Retaining lower branches also provides protection for the tender bark from the intense sun.

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