California EnerTrees

December 2013

Growing Trees Make Great Neighborhoods

Acknowledgements

We wish to thank the California Department of Forestry and Fire Protection (CalFIRE) for the financial support that made this project possible. In particular, we would like to thank James Scheid and John Melvin for their guidance and help throughout the process.

Thanks go to Marin County Supervisor Charles McGlashan (deceased) and Marin Clean Energy for their early support for the project that helped get things moving.

We thank Jared Carlson, Amanda Barker and their team at the National Arbor Day Foundation for collaborating with us to develop such a complete and valuable tool.

We thank Doug Wildman and his staff at Friends of the Urban Forest for their help in organizing and planting our demonstration project at San Jose Middle School. Principal Justin Mori and Director of Maintenance, Operations & Transportation Mark Silva of San Jose Middle School are thanked for their support for the project and for their openness to the idea of a tree planting prjoect on school grounds.

Qingfu Xiao, Greg McPherson, Julia Bartens, Chelsea Wu, and the rest of the team at the Urban Ecosystems and Processes team are thanked for their help with the environmental benefits analysis. Ellen Hines, Bill Kruse, Eli Waggoner, and Gabe Cortez of San Francisco State University are thanked for their work in the land cover analysis.

Thanks to everyone at the existing shade tree programs for sharing their knowledge and experience with us.

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Chapter 1: Introduction

Trees are increasingly being recognized for their ability to help solve some of our most pressing environmental problems, including the need to conserve energy.

- A 2003 study by the Center for Urban Forest Research determined that strategically increasing the urban forest canopy in California by 30% could reduce energy consumption enough that it would eliminate the need to build seven 100 MW power plants.[1]
- A 2006 study of New York City by scientists at NASA and Columbia University found that planting street trees is the most efficient way to reduce the urban heat island effect and therefore urban energy use.[2]
- A large tree strategically planted on the west side of a house can save more than 400 kWh of energy use or more than $65 a year.[3] More trees equals more savings!
- When a tree helps save energy, it doesn't just save dollars and kilowatt-hours. Every bit of energy conserved means fewer greenhouse gases in the atmosphere and fewer air pollutants!

As a result of this growing knowledge, a number of organizations throughout the United States have begun organizing shade tree projects with the goal of planting shade trees strategically around buildings to reduce the amount of energy they use and to help reduce greenhouse gases. These campaigns range from small ones with budgets in the low thousands of dollars to programs like the Sacramento Municipal Utility District's Sacramento Shade Program, conducted in collaboration with the Sacramento Tree Foundation, which has planted more than 500,000 trees over 20 years. It has been repeatedly identified as the favorite SMUD program by their customers.

The goal of the California EnerTrees project was to help remove start-up hurdles that might hinder those interested in carrying out their own shade tree program. Our objective was to provide program users with all the materials and the organizational structure needed to get started, including outreach material, legal templates, a tracking system, guidelines for species choice and planting locations, and more, so that rather than reinventing the wheel and spending time and money getting started, program users could put energy and funding into getting trees out there where they will do the most good. Ultimately, we worked with the National Arbor Day Foundation to create a tool that can be used by anyone to organize, publicize, conduct, and track a shade tree program. You'll find everything you need to get started at www.caufc.org/enertrees.

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[1] McPherson EG, Simpson JR (2003) Potential energy savings in buildings by an urban tree planting programme in California. Urban Forestry & Urban Greening. 2: 73-86

[2] Rosenzweig C, Solecki WD, Slosberg RB (2006) Mitigating New York City's heat island with urban forestry, living roots, and light surfaces. NYSERDA, Albany

[3] i-Tree (2013) i-Tree Design. www.itreetools.org/design.php. Specifications: Live oak, 30 inch dbh, west side of house, 20-40 ft away, Southwest Desert climate zone.

The objective of this report is threefold: (1) to share what we learned along the way so you can put it to use in your programs, (2) to describe the CA EnerTrees program and explain how to participate, and (3) to provide you with information on other types of shade tree programs so that, should you chose to, you can organize a project under a different format. You'll find the following chapters inside:

- **Chapter 2: How trees conserve energy**. Here we describe how trees help reduce energy use and how to plant them strategically for the best results. There are links to resources for more information.
- **Chapter 3: Shade tree programs of North America**. Here we share everything we learned about the programs already in place in the U.S. and Canada: who sponsors shade tree programs, how they are organized, and what kind of guidance is provided to participants in terms of species choice and locating planting sites. A table of existing programs is included. The chapter closes with our "lessons learned" on what factors help make a program successful.
- **Chapter 4: Shade tree program types**. This chapter provides an in-depth look at the three main models almost all programs are organized around: tree give-aways, tree rebates, and reduced cost programs. We highlight some of the most successful aspects of different programs.
- **Chapter 5: The California EnerTrees program**. This chapter represents the real heart of this report. Here we present an overview of our collaborative project with the National Arbor Day Foundation, the steps you'll take to get your project going, and approximately what you can expect it to cost.
- **Appendix 1: Land cover and canopy cover analyses and deciding how to prioritize tree plantings; case study.** Here we describe three kinds of analyses that can add value to your shade tree program: basic canopy cover, land cover, or environmental benefits land cover analysis. The advantages and disadvantages of each are covered. We present the methods and results of an environmental benefits land cover study we undertook.
- **Appendix 2: Demonstration project case study: San Jose Middle School**. A demonstration project can also add value to a shade tree program. Here we walk through the steps of organizing a demonstration (finding a site, developing a planting plan, choosing species and planting sites, getting the trees planted) and share the lessons we learned as we planted trees at a local middle school in Novato, CA.
- **Appendix 3: Good examples from existing projects.** We've highlighted some of the best examples we found during our research of guidelines for planting, species choice, etc.

We hope this guide will help you as you organize a local shade tree program. Whether you choose to proceed with the California EnerTrees program or create something different, in the following pages you will find helpful knowledge from those who have gone before you.

Chapter 2: How trees conserve energy

The idea of planting trees strategically around buildings to conserve energy might be new to you, but of course it's just an offshoot of knowledge you already have—we all know to stand in the shade of a tree when it's hot! In fact, trees can offer huge energy conservation benefits, all while providing a range of other "ecosystem services" such as cleaning the air, filtering stormwater, reducing greenhouse gases, and providing habitat for birds, insects and animals.

How do they do it?

Trees conserve energy in three main ways (Fig. 1):

- By directly shading buildings and other manmade materials (like roads and parking lots), trees reduce the amount of heat absorbed from the sun. This lowers temperatures so that less air conditioning is required.
- As trees undergo evapotranspiration—that is when they transform liquid water in their leaves into water vapor—they use up energy that would otherwise result in heating of the air.
- By blocking cold winter winds, trees help reduce the amount of cold air that seeps into buildings, so less heating is needed.

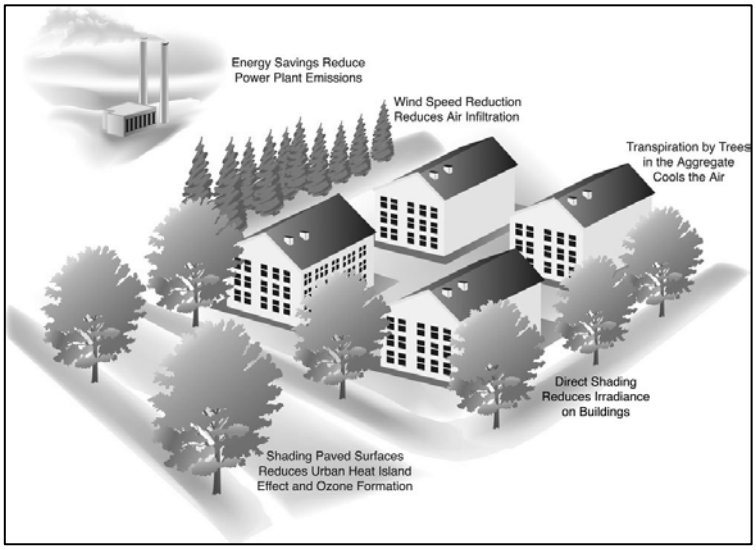


Fig. 1. Trees help reduce energy use in many way, both direct and indirect. (drawing by Mike Thomas, courtesy of the US Forest Service)

How should we plant trees to get the greatest energy benefits?

Where you plant the tree can have huge repercussions on the energy conservation benefits you get. So follow these suggestions on how to plant trees strategically to get the most out of them.

- In general (space permitting) large trees are best. They will grow up to provide shade to the roof, whereas a small tree will at most shade the side of a building. Large trees also do the most work of providing other kinds of environmental benefits, such as sequestering greenhouse gases and capturing air pollutants.

- The west side of a building tends to be the warmest as that is where the sun shines in the heat of the summer afternoon. So priority should be given to planting trees on the west whenever possible. The east is the second best choice.
- In the winter, the sun is low in the sky and stays mostly along the southern horizon (Fig. 2). Avoid planting evergreen trees to the south of buildings as these trees will have leaves in the winter that will block that warming sun and increase the amount of heating needed.
- Don't plant trees too close to buildings as they can cause significant damage with their roots and branches. At least 10 feet away from buildings is a good rule. Don't plant trees too far away either. Trees planted more than 60 feet away will not provide much in the way of shade.
- Choose the right kind of tree for the right space. Trees of different species grow in different shapes (Fig. 3): some arch up and over in a vase shape, some have branches that grow very close to the ground, others have a round top like a lollipop. Consider the amount of space you have for the tree and what shape will fit best.

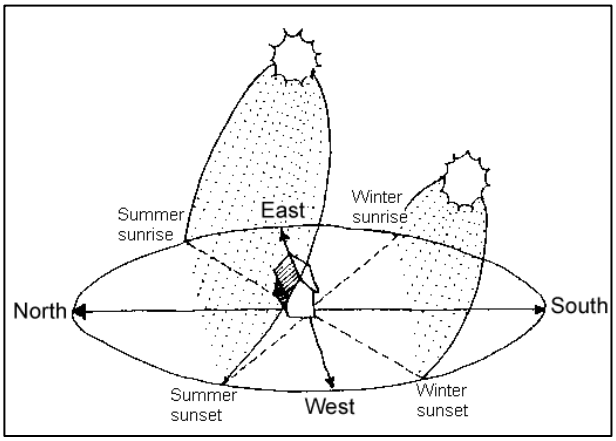


Fig. 2 Paths of the sun in the summer and winter. Plant trees to shade buildings from hot summer sun but not warming winter sun. (Sand 1991. Planting for Energy Conservation in the North.)

Fig. 3 Trees of different shapes (photos from SelecTree).

For more information

The US Forest Service's series of *Community Tree Planting Guides: Benefits, Costs, and Strategic Planting*. Available at: http://www.fs.fed.us/psw/programs/uesd/uep/tree_guides.php

Save Dollars with Shade. Available at:
http://www.fs.fed.us/psw/programs/uesd/uep/products/3/cufr_149.pdf

Alliance for Community Trees Energy Factsheet. Available at:
http://actrees.org/files/Resources/factsheet_energy.pdf

Alliance for Community Trees: Benefits of Trees and Urban Forests: A Research List. Available at:
http://www.actrees.org/files/Research/benefits_of_trees.pdf

Green Plants or Power Plants? Available at:
http://www.fs.fed.us/psw/programs/uesd/uep/products/3/cufr_148.pdf

How to Plant Trees to Conserve Energy, from the Arbor Day Foundation:

For summer shade: http://www2.arborday.org/globalwarming/summerShade.cfm
For winter warmth: http://www2.arborday.org/globalwarming/winterWarmth.cfm
For winter windbreaks: http://www2.arborday.org/globalwarming/windbreak.cfm

Chapter 3: Shade Tree Programs in North America

As a first step to developing a model for a shade tree program that could be used throughout California, we conducted a search for existing programs. Our goal was to understand the strengths and weaknesses of the different approaches to enable us to identify the components that are necessary for a successful project. We asked the following questions:

- Who sponsors shade tree programs and who are common partners?
- What are the energy and emissions characteristics of power companies with shade tree programs?
- What is the incentive that is used to encourage tree planting, e.g., discounts, rebates?
- Are guidelines given for choosing planting sites?
- Are guidelines given for selecting species?
- Are there follow-up inspections to ensure compliance?

Our research uncovered 22 shade tree programs throughout the United States and 1 in Canada (Table 1). The majority are still underway, but to provide as much information as possible, we have included several programs that have been discontinued.

Program sponsors

The majority of the programs (14) are sponsored by the local utility company. Eight programs are sponsored by local nonprofit tree advocacy groups, almost always in partnership with the local utility, who generally provides the funding.

The participating utility companies range widely in size. The smallest is the municipal utility of Kaukana, WI, which serves 13,500 customers. The largest utility engaged in an ongoing project in terms of customers is the Public Service Company of Colorado with 3.4 million customers. The largest utility in terms of the amount of energy produced is Arizona Public Service with a rated capacity of 11,500 MW.

Program types

The shade tree programs can be divided into several general types (these are described in more detail in Chapter 4):

- **Rebates:** Participants apply for a rebate after purchasing a tree.
- **Free trees**: Trees are given away to participants for free.
- **Discount trees**: Trees are sold directly to participants for a reduced cost.

Table 1. Shade tree programs across the United States and Canada.

Program	Sponsor	Market	Program type
APS Shade Tree Program	Arizona Public Service utility company	Metro Phoenix region, AZ	Free trees
Operation ReLeaf	Alliant Energy	Vast majority of Iowa's counties	Discount trees
Plant-a-Tree	Cedar Falls Trees	Cedar Falls, IO	Rebate
Plant some shade	MidAmerican Energy	Iowa	Discount trees
Green Shade	CPS Energy	San Antonio, TX	Rebate
Casey Trees - Tree Rebates	City of Washington, DC District Department of	Washington, DC	Rebate
TreePower	Kaukana Utilities	Kaukana, WI	Rebate
Tree Power!	Menasha Utilities	Menasha, WI	Rebate
Cool Communities	L.E.A.F., a local nonprofit	Ontario, Canada	Rebate
Trees for Tucson	Tucson Clean and Beautiful	Greater Tucson area, AZ	Discount trees
Tree Power	City of Glendale Water and Power	Glendale, AZ	Free trees
SRP Shade Tree Program	SRP (power company)	Salt River, AZ	Free trees
TreePower	Anaheim Public Utilities and City of Anaheim's	Anaheim, CA	Free trees/rebate
Sac Shade	Sacramento Tree Foundation	Greater Sacramento area, CA	Free trees
Trees for a Green LA	LADWP	Los Angeles, CA	Free trees
Roseville Shade Tree Program	Roseville Electric	Roseville, CA	Rebate
Tree Power	Riverside Public Utilities	Riverside, CA	Free trees/rebate
Cool Trees	Pasadena Water and Power	Pasadena, CA	Rebate
Shade Tree Program (ended)	CCSE	San Diego and Orange Counties, CA	Free trees
Shade Tree Rebate Program	TID Water and Power	Turlock Irrigation District, CA	Rebate
ShadeNSave	Our City Forest	San Jose, CA	Free trees
Trees for Energy Savings	Mile High Million	City and County of Denver	Free trees
Energy-saving Trees	Arbor Day Foundation	Targeted at utility companies	Free trees

Rebate programs

In rebate shade tree programs, the participant purchases a tree and later submits a rebate form. The rebate covers a portion or all of the price of the tree. Nine programs used this method with the value of the rebate ranging from $20–100 per tree. In one city, higher rebates were paid out for trees purchased from local merchants; in some other cases larger trees received larger rebates. In most cases, the rebate comes in the form of a check, but in Riverside, CA, participants receive the rebate as a deduction from their power bill.

In all cases, only trees that met certain specifications (species, size, etc.) and were planted in appropriate locations (to create shade) received a rebate.

Free trees

Eleven programs offer free trees to participants. The ways in which these programs are organized differ greatly. In three programs, participants must attend a workshop, where the principles of maximizing shade and the best species choices are laid out. In five programs, a representative consults personally with the homeowner, usually in person on site, but in one case on the phone. The two parties collaborate on the best locations and species, and the trees are delivered. In Riverside, CA, utility customers bring their power bills to one of three participating nurseries and receive their free tree there.

In all but one case, the homeowner is responsible for planting the tree; in Denver's Trees for Energy Savings program, the trees are planted by a contractor.

Discount trees

In five programs, participants purchase trees at a discount, either directly from the project sponsor or in collaboration with a nursery. In the programs of Alliant Energy and MidAmerican Energy, both in Iowa, the participant fills out an application and includes a check for $25–30 per tree. Trees are then picked up by the homeowner in a particular location at a certain time. In Tucson, AZ, participants fill out an application and include a check for $8 per tree. The trees are delivered to their homes.

In Cedar Falls, IO, homeowners purchase trees from a participating nursery and are given a discount there. The nursery is then reimbursed by the utility company. In Ontario, Canada, homeowners visit a booth at a participating nursery where they receive information on planting guidelines and fill out a survey. If they choose an approved species, they receive a discount at the register.

Planting guidelines

For trees to contribute to energy conservation, they must be planted strategically as described in Chapter 2.

Despite the critical nature of the planting site, five programs do not offer any guidelines for planting strategically. In five programs, guidelines are provided in person, either at a mandatory workshop, such as the APS Shade Tree Program in Phoenix, AZ, where sponsors help homeowners choose the location, which must be adhered to, or on site. In the Sacramento Tree Foundation's Sacramento Shade program and Denver's Trees for Energy Savings, program representatives visit participants' homes and help choose the best site. With the Tree Power program in Glendale, AZ, advice on siting the tree is given by an arborist over the phone.

The remainder of the programs offer printed and online materials to help participants choose planting sites. An example from San Antonio's Green Shade program is shown in Fig. 4. Non-qualifying areas to the north of the building are clearly shown and the appropriate distances from the building are indicated.

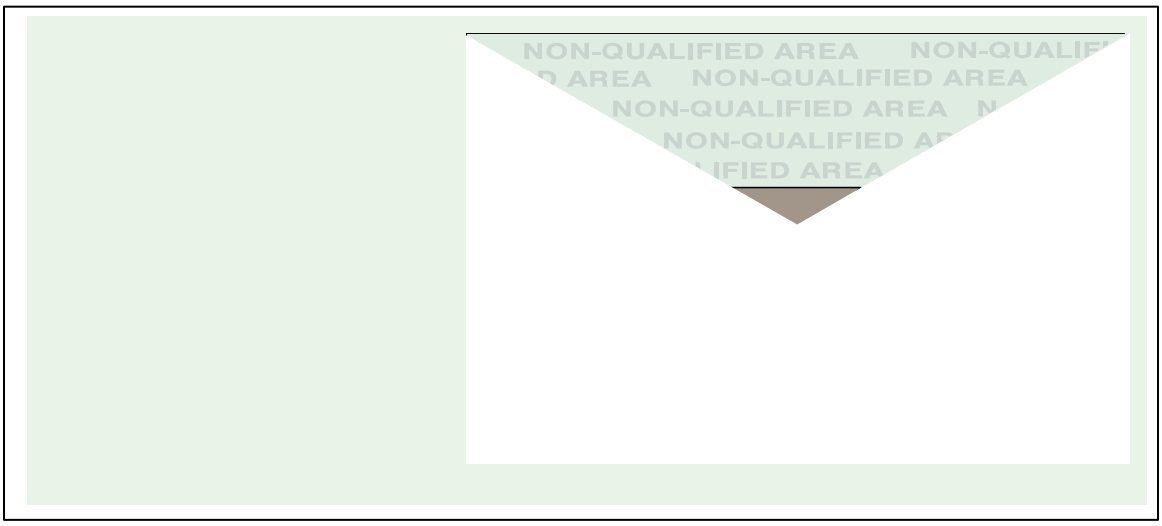


Fig. 4. Tree planting requirements for the Green Shade program in San Antonio.

Most materials give guidelines for avoiding powerlines. Minimum and maximum distances from buildings to be shaded are also often given. These vary widely. Minimum distances range from 8 ft to 15 ft (where fire safety is a concern). Maximum distances are generally around 35' but Turlock Irrigation District has a maximum of 50 ft, and two programs in Arizona, Trees for Tucson and the SRP Shade Tree Program in Salt River, have a maximum of 15 ft. Most printed and online materials emphasize the need to contact local utility authorities before digging.

An innovative new program by the Arbor Day Foundation includes an online map that allows users to identify their homes using Google Maps and find the most efficient location to plant their new trees. (See Chapter 5 for more details and for information on how to participate.)

Species guidelines

Species choice has a significant effect on energy savings. Trees that shade the roof of a building are much more valuable from an energy conservation perspective than those that only shade the walls. For this reason, large trees provide the greatest energy benefit. In addition, as noted

in Chapter 2, it is important to avoid planting evergreen trees—either broadleaf or coniferous—on the south sides of buildings where they will block the warming rays of the winter sun.

Species guidelines and species availability differed widely among programs. For choosing species, most programs offered a set list of approved trees. In some cases, participants could choose from a limited pallet of only five or six trees. Most programs, however, had lists of 20–30 approved species. In contrast, other programs such as Turlock Irrigation District and two cities in Wisconsin set only a minimum mature tree size (10 ft and 25 ft, respectively) and allowed the participant to choose the tree. In Ontario, only native trees qualify for rebates.

Species sizes ranged widely. Most programs offered a mix of small, medium, and large trees in their approved lists with the understanding that not every site is suitable for large trees. In some cities, only large trees were offered. In Anaheim, CA, in contrast, trees may not *exceed* 25 ft and in two Arizona programs all trees on the approved list were small.

Project checks

Returning to planting sites to check that trees have been planted and have survived adds value to projects—allowing sponsors to adjust the program based on results. At the same time, this kind of monitoring is expensive and time-consuming.

In five programs, no explicit mention was made of inspections in the application. Eleven programs included wording in the application or in their materials stating that the trees must be made available for inspection by program monitors. It was not possible to determine through our research, however, which programs *actually carry out inspections* rather than simply relying on the threat of inspection to improve compliance. For the remaining seven programs, we were unable to determine if participants were required to agree to inspection.

Program highlights

There were a number of programs with components that were particularly successful.

Planting guidelines

The City of Pasadena has an extensive planting guide available on their website[4] that helps participants consider the many necessary factors for successful planting and successful energy conservation, including the following:

- Avoiding underground and aboveground utilities
- Leaving room for growth of existing trees
- Planning for growth of shade-tree program trees
- Optimizing distance and direction from the building to the tree
- Considerations of tree shapes

[4] http://ww2.cityofpasadena.net/waterandpower/cooltrees/Cool Trees Guidebook.pdf

Species selection

Turlock Irrigation District allows participants to choose any species over a certain height. Their application materials[5] include valuable and accessible information on a variety of species including the distances the trees should be planted apart, the distances they should be planted from existing infrastructure, and a few useful characteristics, such as whether they offer fall color, prefer wet or dry soil, and their growth rate.

Use of technology

The Arbor Day Foundation's tool for assessing the best location for planting trees will likely be of great assistance to participants. The tool is based on the iTree Tools Design software, which can be used here[6]. The user enters the address where the tree will be planted, draws an outline of the building to be shaded, and based on this information, areas for planting to maximize energy conservation are indicated.

Lessons learned: Components of a successful program

Based on our research, including conversations with program administrators, we can highlight a few components of a successful program.

- Wide species availability to encourage diversity and to suit a variety of planting spaces.
- Clear guidelines on where to plant including:
    - How far trees should be planted from buildings
    - Which sides of the building trees should be planted on
    - Planning for clearance for underground and aboveground utilities and existing infrastructure.
- Random future inspections to measure success.
- Adequate online resources to provide participants with information.
- Good customer service, particularly a phone number where a representative is available to answer questions and provide assistance.
- Collaboration with nurseries to ensure that good quality stock is provided.

[5] http://www.tid.org/sites/default/files/documents/tidweb_content/Shade Tree Brochure_web.pdf
[6] http://itreetools.org/design.php

Chapter 4: Shade Tree Program Types

In this chapter, the different kinds of shade tree programs (rebates, discounts, free trees and others) are discussed in depth, considering the advantages and disadvantages of each. Examples from the most successful programs are provided.

Free tree programs

Eleven shade tree programs give trees away for free. As we heard repeatedly from utility companies, "Customers like free trees." Although all fall under the heading of "free trees," these programs are organized in very different ways.

A long-standing concern in tree advocacy work has been whether customers value trees they get for free. Some feel that when customers do not contribute at least a nominal amount, they feel less "buy-in" to the program, and the trees they receive are less likely to be planted, survive, and thrive as a result. As a way of addressing this concern—and, of course, as a way of imparting useful information—most of the free tree programs required a different, non-financial kind of buy-in from participants.

Three programs required that recipients attend workshops (either online or in person) where the principles of siting trees to conserve energy were addressed and tips on planting and tree care were offered. The Arizona Public Service Shade Tree[7] workshop, for example, covers the requirements for participating in the program, an explanation for how trees conserve energy, information on choosing the right tree, and guidelines for planting, watering, and pruning. Their curriculum is available online[8].

In five cases, tree recipients work either in person or on the phone with an arborist or other tree specialist to choose the best species and the best locations. The Sacramento Tree Foundation's Sacramento Shade program[9] has a staff of "community foresters" that visit customers' homes and, in consultation with the homeowner, select the species and identify the planting sites. The customer receives a hand-drawn map to refer to when planting the trees (which are usually delivered within ten days).

In the most elaborate scenario (and certainly most likely to be successful in terms of tree survival), Denver's Trees for Energy Savings[10] sends arborists to customers' homes to help choose planting locations and select species, and later to actually plant the trees.

The National Arbor Day Foundation's Energy Saving Trees[11] program makes the best use of technology of all the programs studied. Here, participants use a web application to (a) view an

[7] http://www.aps.com/en/residential/savemoneyandenergy/coolingheating/Pages/shade-tree-program.aspx
[8] http://www.aps.com/library/marketing1/ShadeTreeWorkshopCurriculum.pdf
[9] http://www.sactree.com/pages/24
[10] http://milehighmillion.org/pages/section/programs/trees-for-energy-savings
[11] http://energysavingtrees.arborday.org/#Home

aerial image of their home and draw an outline of their house, (b) choose among different tree species, (c) "plant" the trees in different virtual locations and watch the energy benefits change as their distance and direction from the building changes, (d) place an order for the trees. (See Chapter 5 for how you can create an Energy Saving Trees program yourself.)

In most cases, trees are delivered directly to the residence or can be picked up at the workshops. In Riverside, CA, however, utility customers bring their power bills to one of three participating nurseries and receive their free tree there. In the Energy Saving Trees program, seedlings are sent through the mail.

Advantages of the free tree model include the following:

- Customer satisfaction with free trees and, in many cases, with the personal service they receive from the sponsor.
- More opportunities for outreach between the sponsoring organization and the public. Because outreach and customer relations are often the objectives of these programs, this aspect can be particularly valuable.

Disadvantages of the free tree model include:

- These kinds of programs are generally the most expensive because the trees are completely paid for and because many provide personal assistance to help customers make the best choices.
- The program logistics can be challenging as the trees must be procured and delivered to each individual address by the project sponsor.
- It remains an open question whether free trees have worse outcomes than trees partly paid for by participants.
- Because participants are almost always responsible for planting the trees themselves, there is little opportunity for organizers to measure program success, especially over time. In a very few cases, spot inspections may be performed, but there is no simple method to track trees in the long term (with the exception of the Arbor Day Foundation's program; see Chapter 5).

Rebate programs

In the rebate model, eligible customers purchase a tree and later submit a rebate form to receive a partial reimbursement.

Most programs follow a similar process. Customers purchase a qualifying tree, plant it in a qualifying location, and mail in the rebate form along with the receipt for the tree. Rebates are then mailed back as checks.

Ontario's Cool Communities[12] program is significantly different. Here, LEAF, a local nonprofit tree organization, sponsors booths at participating nurseries where people who are interested in planting a tree for shade can get more information and help choosing a species and the best planting site. Visitors to the booth are given a coupon to be used immediately at the nursery. Cedar Falls Utilities' Plant-A-Tree[13] program works similarly. Here customers purchase an approved tree from a participating nursery and receive a 40% discount (up to $100) immediately. The nursery is reimbursed by the utility company.

Most programs require participants to choose from a list of approved species or to choose a species that meets specific requirements, such as a minimum mature size. Ontario's Cool Communities program only funds rebates for native species. In some cases, such as Casey Tree's[14] program, larger trees are eligible for a larger rebate. In Pasadena's Cool Trees[15] program, participants who buy their trees from a local vendor receive a larger rebate.

The most common value for rebates is $50, but one program, Casey Tree's, pays up to $100 for large stature species.

In almost all cases there is a maximum number of rebates per customer, ranging from three to ten. Casey Tree does not have a maximum. In addition, in most cases, the program description states that total funding is limited and rebates are only available until funds run out.

The rebate form typically includes a legal contract; the contents of these agreements vary widely, however and may include some, all or none of the following:

- An approved tree was planted in an approved location. (CPS Energy[16], Pasadena[15], Kaukana[17], Menasha[18])
- The project sponsors are not liable for any damage or loss associated with the project. (Roseville[19], CPS Energy[16], Turlock ID[20], Pasadena[15], Kaukana[17], Menasha[18])
- The participant has the legal right to plant the tree on the property. (Pasadena[15])
- The participant has called the appropriate underground service alert organization to determine that the planting location does not conflict with underground utilities. (Pasadena[15])
- The sponsor has the right to a future inspection to prove that the tree was planted in the proper location. (CPS Energy[16], Turlock ID[20], Casey Tree's[14], Kaukana[17], Menasha[18])
- The participant agrees to care for the tree during the establishment period. (Casey Tree, Turlock ID[20], CPS Energy[16], Pasadena[15])

[12] http://yourleaf.org/cool-communities
[13] http://www.cfu.net/save-energy/shade-tree-discount/plant-a-tree-program.aspx
[14] http://caseytrees.org/programs/planting/rebate/
[15] http://cityofpasadena.net/waterandpower/CoolTrees/
[16] http://www.cpsenergy.com/files/Greenshade_application.pdf
[17] http://www.kaukaunautilities.com/media/Tree_Power_Incentive_Applicaiton_2-17-12.pdf
[18] http://www.menashautilities.com//energy_efficiency/default.asp?CategoryNumber=2&SubcategoryNumber=13
[19] http://www.roseville.ca.us/civicax/filebank/blobdload.aspx?blobid=17827
[20] http://www.tid.org/sites/default/files/documents/tidweb_content/Shade Tree Brochure_web.pdf

- The sponsor does not guarantee an energy-saving effect. (Kaukana[17], Menasha[18])

Rebate programs are significantly less expensive and less labor intensive than tree giveaways programs from an administrative perspective. A representative from the CPS Energy Green Shade Program told the audience at the 2011 Partners in Community Forestry conference that overseeing their program required only a half-time intern, whose tasks included ensuring that the tree species was from the approved list and that the tree had been planted in an appropriate location.

The advantages of the rebate model include the following:

- Lower costs. The project sponsor is responsible only for a portion of the tree price, no delivery, and lower labor costs for supporting logistics.
- Very simple logistics. Project sponsor must only process rebate forms.
- It is possible that the trees in this model may be more successful if theories about participant "buy-in" and successful establishment are correct.
- The rebate model *can* support purchase of larger trees than the free tree model for the same cost. Customers may prefer the option to use their rebate to buy a larger tree.

Disadvantages of the rebate model include the following:

- In general, programs following this model have little to no customer interaction and fewer opportunities for outreach.
- As above, in this method no attempts have been made to track tree survival and growth over time.
- When customers choose their own trees, they might lack the knowledge to choose the healthiest and best specimens.

Reduced cost programs

Other shade tree programs offer trees to participants at reduced costs. In these programs, the typical procedure is for the participant to fill out an application for trees and mail it in with payment. Trees are then picked up on a specific date from a central location. During pickup, participants are usually offered planting tips and advice on siting trees to conserve energy.

The Iowa Department of Natural Resources partners with several[21] utilities[22] throughout Iowa to provide low cost trees to utility customers. Trees are sold for $25–30 (actual cost $65–125) and five or six species are available. The trees are in 5–7 gallon containers.

The Trees for Tucson[23] program, in contrast, functions much more like the free tree programs. Here, participants fill out an application, indicate their desired species and where they plan to

[21] http://www.alliantenergy.com/CommunityInvolvement/CommunityOutreach/OperationReLeaf/index.htm
[22] http://www.midamericanenergy.com/ee/ia_res_shade.aspx
[23] http://www.tucsoncleanandbeautiful.org/assets/docs/trees-for-tucson-residential-form-tep.pdf

plant the tree for energy conservation. They send the application in with a very minimal payment ($8) and the trees are delivered to their home. The advantages and disadvantages of this program are similar to those described above for the free tree model.

The advantages of reduced cost programs like those sponsored by Iowa DNR include the following:

- Simpler logistics than free tree programs. Trees are ordered in bulk from a nursery, and delivery only needs to be scheduled to one central location for distribution.
- There are opportunities for community outreach at the pickup locations.

The disadvantages of reduced cost programs include the following:

- The choice of species is usually very limited.
- Costs are higher than with the rebate model.
- As above, in this method no attempts have been made to track tree survival and growth over time.

Chapter 5: The California EnerTrees program

If you're an organization in California (or anywhere really) and interested in launching a shade tree program but are worried about the logistics of getting and keeping everything going, this is the chapter for you! Having researched shade tree programs across North America, we applied the lessons learned and developed a model that could be implemented by communities throughout the state; we call it California EnerTrees. CA EnerTrees does all the logistical work for you—you provide some basic information about your organization and a budget to cover the trees and we help with everything else. In this chapter, we'll describe CA EnerTrees, walk you through the steps, and point you to all the materials you need to get started.

What is the CA EnerTrees program?

To create a robust model that met our objectives (good customer service, ability to track trees over time, help for customers choosing the best planting sites, minimal set-up and ongoing maintenance for organizers), we partnered with the Arbor Day Foundation (ADF) to expand their Energy Saving Trees program, opening it up for use by smaller entities with limited budgets.

When you use the CA EnerTrees version of the Energy Saving Trees program to start a shade tree program, you get:

- A website specifically for your customers. The website includes:
    - Google Maps for customers to find their homes on aerial images.
    - The ability for customers to "draw" their home on the map and "move" trees around to find the most effective spot for energy conservation.
    - Information about the species you're offering.
    - The ability for customers to order their trees right from the website.
    - Branding with your program name and logo.
- A choice of regionally appropriate species you can offer to customers.
- A back-end database you can access that tracks customers, tree species, and planting locations.
- Help with outreach materials including brochures, bill inserts, emails, social media communications, and more.
- Legal language to protect your organization.
- The option to have trees delivered directly from a regional nursery to the customer in the mail (you never have to worry about a thing) OR the option to source the trees yourself and deliver them directly to customers or make them available at a central location for pickup.
- Customer service provided by the Arbor Day Foundation, if you'd like, or of course, by you.

Ready to start your own shade tree program?

To get started, stop by the California Urban Forest Council's EnerTrees webpage: www.caufc.org/enertrees. We'll tell you about any other shade tree programs that might be going on in your area to help you fine tune your target audience, provide you with some useful materials for printing and point you in the right direction.

There you'll find a link to the Energy Saving Trees website, where you'll walk through a number of steps, providing information on your organization and your vision for your shade tree program. At the end, you'll submit your application and a representative of the Arbor Day Foundation will contact you to finalize the details. You'll be ready to go!

The online process looks like this:

Step 1: You'll provide contact information for your organization and the program liaison.

Step 2: You'll answer questions about your shade tree program's budget and target audience. The Arbor Day Foundation will also provide templates for marketing materials, including bill inserts, email blasts, brochures, and social media posts. In this step, you indicate which you are interested in receiving.

Step 3: As one way of protecting the integrity of your program as well as determining the appropriate species selection, you'll need to provide a list of the zip codes your program will serve (in Word, Excel or plain text form).

Step 4: In this step, you'll make some decisions about how and which kinds of trees to offer:

- The maximum number of trees you will allow each customer to order.
- Whether you want to have the trees delivered through the mail to your customers (small saplings only) or provide them for pickup at a central location (allowing for larger specimens).
- Whether you want to provide the trees yourself (which allows for greater species choice and for you to exercise quality control) or if you prefer the Arbor Day Foundation to manage this part of the operation (the much simpler option).
- The species you want to offer your customers.

Step 5: To be sure you're only providing free trees to your intended recipients, you can choose between two methods for validating the customers (validation is optional):

- Account numbers or employee numbers: In this case, you provide a list (in Word, Excel, or plain text) of customer account numbers or employee numbers. The recipient must enter a number on this list to receive free trees.
- Custom promotion codes: Here, you provide recipients with a promotion code via email, flyer, bill insert, newsletter, etc. In this step, you upload a list of those codes (in Word, Excel, or plain text) and they are cross-referenced.

Step 6: You'll provide some final details here and incorporate some customizations:

- You can choose to provide customer support to participants yourself (via email or phone) or allow the Arbor Day Foundation to do so.
- You'll specify how the initial map should appear when recipients land on your site.
- If you have GIS data on locations of overhead or underground utilities, it can be uploaded here to help customers avoid obstructions.
- Default terms and conditions have been included, but you can customize the legal language.
- You can upload your logo for the header (maximum size 150 x 18 pixels).
- You can write custom introductory text for your program's home page.
- You can upload a larger logo for the home page (maximum size 180 x 180 pixels).

Step 7: You'll review your application here and submit! The Arbor Day Foundation will contact you to discuss the final arrangements.

Once you're up and running, you can send participants to your program's website. There, they'll:

- Enter their address.
- Zoom in and view an aerial image of their property.
- Trace the outline of their home on the aerial image.
- Choose among several species of trees.
- Move the tree around their property to see how the energy benefits change with location.
- Indicate the final planting site.
- Enter their name and address and submit their request.
- Receive their tree(s) in the mail or pick them up from a designated location!

Once tree orders start rolling in, you'll have access to the data, including program progress (how many trees have been given away), recipient information, and the locations and species of trees that have been planted.

Estimated budget

There are two main costs associated with this program: (1) a per-tree cost paid to the Arbor Day Foundation that covers the tree itself, shipping, and program overhead and (2) advertising and public outreach.

Because there are several ways to organize your program, the per-tree costs can range from $20 to $30 if you choose to have your trees shipped directly from the ADF or $10 to $100 if you choose to provide the trees yourself and make them available at a central pickup point. Your Arbor Day Foundation representative can help you understand how the different options affect the price.

To ensure success, in most cases it will be necessary to advertise your program. Be sure to set aside funds for printing bill inserts or flyers, posters, etc. In some cases, emails to your members or employees may be enough.

Why did we partner with the Arbor Day Foundation?

The ADF's program met many of our objectives:

- The Energy Saving Trees program uses technology to help customers understand the best locations and species choices for conserving energy. No other program was as intuitively helpful in siting trees.
- The program tracks trees over time. Customers mark the locations of their trees on an online map and that data is stored and made available to program organizers.
- ADF is a well-respected tree organization offering excellent customer service.
- Because the basic logistics are in place, you can get started right away. No need to set up (and pay for) your own system; all funding goes to paying for trees and for publicizing the program.
- Ongoing administration of the program is in the hands of the ADF, so no elaborate infrastructure is needed on the part of the organizer.

Who are good candidates for organizing tree give-away shade tree programs?

The original thereEnergy Saving Trees program was initially targeted at large utility companies, but our collaboration with ADF has resulted in the simple and inexpensive "self-starter" program that will suit many kinds of organizations:

- Utility companies, small and large
- Corporations interested in giving free trees to their employees as a part of a public service campaign
- Nonprofit tree advocacy groups interested in giving trees to their members
- Companies and organizations interested in using trees to reduce their carbon footprint
- Cities; counties; air, water, or regional conservation districts

Appendix I: Land cover and canopy cover analysis and prioritizing tree plantings; case study

If resources permit, an analysis of your community's existing tree canopy and land cover can be a valuable tool for shaping the goals of your shade tree program. These kinds of analyses can be conducted at several different levels, with increasing amounts of information available for increasing costs (and time required).

Types of land cover and canopy cover analysis

Very simple canopy cover and/or land cover analysis

The simplest analysis has only one result: the percentage of canopy cover over a specified region. The easiest method for doing this kind of assessment is i-Tree Canopy[24]. Canopy is very simple to use and can be done by anyone.

1. You draw the outlines of your study area on a Google Map or upload a GIS file with the boundaries of your area.
2. You accept the default land cover types: tree and non-tree.
3. I-Tree Canopy selects several hundred random points throughout your designated area and zooms into them one at a time in a Google Maps aerial image, allowing you to see the land cover type under the point.
4. You identify the land cover type in that spot as "tree" or "non-tree" and move on to the next one.
5. The percent canopy cover is presented with the standard deviation.

You can also use i-Tree Canopy to go one step beyond a simple canopy cover assessment and use it to determine the percentages of the different land covers in your area. To do so, in Step 2 above, you specify additional land cover types. Typical choices are tree, non-tree vegetation (shrub, grass, flowers), impervious surface (building, road, sidewalk, parking lot), bare ground, and water.

This very simple method costs almost nothing and should take only a few hours of your time. The disadvantage is that the end result is a series of numbers (or even just one number: percent canopy cover) and nothing more. You will have a better knowledge of your percent canopy cover and perhaps other land covers, but no information, for instance, on how the trees are distributed geographically.

Standard land cover analysis

A more advanced solution that requires significantly greater resources (in terms of time and money) is a standard commercial land cover analysis using GIS software. In this case, you work

[24] http://www.itreetools.org/canopy/

with a firm or university department that is skilled in geographic analysis. You provide the boundaries of your study region and the land cover classes you are interested in. These might be similar to those above, but one possible valuable refinement would be to distinguish between irrigated and unirrigated areas as this information could inform your decisions about where to plant trees in the future. The specialists use aerial imagery and existing geographic files (such as those showing water bodies, building footprints, or streets) to distinguish among the land cover types across your study area.

There are a number of advantages to this method over the previous one. You have actual geographic information about where trees are located. You may also (depending on how you defined your land cover types) have information about potential planting areas [areas that are currently low-growing vegetation and either irrigated (may be more suitable for ornamental and nonnative species) or unirrigated (possibly more suited for native species)]. Finally, you can set viable goals for future canopy based on the available planting space, a consideration that is often overlooked. For example, if your site is very urban and you discover that it has a canopy cover of 10% and an impervious cover of 80%, it would not be reasonable to set a goal of 25% canopy cover—there simply isn't enough room to plant trees to achieve that goal.

The disadvantage of a standard land cover analysis is the time and cost involved. Expect to pay $10,000 or more and for it to take several months.

Environmental benefits land cover analysis

The most advanced solution builds on the standard land cover analysis described above. Once that analysis is complete, it can be used for several purposes:

- To determine the ecosystem services that the existing canopy is providing.
- To better understand how trees are distributed around buildings and, using that information, better determine the energy conservation benefits of the existing canopy.
- To estimate the number of available planting spaces in your area.
- To test different planting scenarios to determine which provides the greatest benefit.
- To predict future ecosystem services to be provided by a chosen scenario.

To carry out an environmental benefits land cover analysis, you would begin by conducting the standard analysis described above. You then work with urban forestry specialists to carry out the second phase. They will first determine a typical tree species and size mix for each land cover type in your area. To refine the energy conservation benefits provided by the trees, they will select a random sample of buildings throughout the study area and assess the typical distance and direction of trees from buildings; they will also use census information to determine the mix of housing types, vintages and sizes for the region. Based on the above information, regionally specific values for the trees' environmental benefits are set on a per-acre basis for each land use. From this, the total environmental benefits provided by each land cover type can be determined.

In the next phase, available planting spaces are determined through a computer algorithm. You set the parameters for where trees can be planted, for example, in (a) areas currently identified as non-tree vegetation, (b) at least 15 feet from buildings and other impervious surface, (c) where there is at least 125 ft^2 of open space. The algorithm "looks for" as many sites that meet your specifications as it can find and tallies up the numbers. Although this number should be taken with a grain of salt as not all potential planting spaces will be correctly identified (for example, a football field would meet the above parameters but that doesn't mean you really want to plant trees there), this is a much better basis for calculating your potential canopy cover when working to set goals for the future.

Now that you have a sense of how much potential planting space you have, in the fourth phase, you can set some reasonable goals for the future and play with different planting scenarios to see how they affect future benefits. For example, you might prioritize planting trees around buildings that are currently unshaded as you would expect this to have the greatest effect on energy conservation. You might wish to focus efforts on neighborhoods that currently have the least amount of tree cover. Once you've proposed a planting scenario, the algorithm will be run again according to your specifications, and the number of trees and potential benefits will be calculated.

The main advantage to the environmental benefits land cover analysis is that it helps you to make informed decisions for the future. You'll have a better understanding of what exists, what is possible, and how to achieve your goals. The main disadvantage is that the time and money involved are significant. Expect to spend $35,000–$50,000 and 6+ months to get results.

Advantages and disadvantages to canopy and land cover analyses

Because canopy cover and land cover analyses can be expensive and time consuming, it is important to consider just what you do and don't get when you conduct one.

Depending on the extent of the analysis, some advantages include the following:

- A scientifically valid number to describe the percentage of tree cover for your community. This can be helpful for generating political will in favor of trees and for setting feasible goals for the future. (All methods above)
- A better understanding of where trees are located in your community and which areas need more support. Here we aren't considering individual trees per se, but rather which areas have greater canopy cover and which have less. (Standard and environment benefits land cover analyses)
- Information on the distribution of trees among different land uses or even around buildings. (Standard land cover analysis for the former and environmental benefits analysis for the latter)
- Information that can be used to prioritize tree plantings so that funds are used to achieve the greatest energy savings. (Environmental benefits analysis)

It's important to keep in mind the limitations of a canopy and land cover analysis, such as:

- The locations of individual trees aren't determined. Instead groups of trees are presented as masses.
- No information on species or tree health can be determined from canopy cover analyses. (Although in some cases, aerial imagery has been useful in distinguishing among a few limited species in wildland forests, to date there has been no such success in urban areas where species numbers can be in the hundreds.)
- No information is available on individual tree DBH (diameter at breast height). This is critical as it is often DBH that drives management decisions, such as pruning schedules and costs. DBH is also used to determine the environmental benefits of *individual* trees. [Note that in a very few cases it may be possible to derive DBH from the available information. This requires the following: trees that are widely spaced with canopies that do not touch, valid equations to derive DBH from crown diameter, and pruning and growth patterns that conform to the conditions under which the equations were developed.]

Our environmental benefits land cover analysis of the urban areas of Marin County

We undertook an environmental benefits land cover analysis of the urban areas of Marin County in order to determine the existing canopy cover and the amount of potential planting space and to assess different planting scenarios. We worked in collaboration with graduate students at San Francisco State University, who conducted the initial land cover analysis, and with scientists at the Urban Ecosystems and Social Dynamics Program (a collaboration between the US Forest Service and UC Davis), who performed the urban forest analysis.

In this section, we'll describe the basic methodology and our results. The complete study, together with the raw data, can be found on our website at: www.caufc.org/enertrees_resources.

Methods

Project process

The first phase of the process used aerial imagery and GIS data to map and quantify land *cover* (e.g., impervious surface, building, tree, irrigated grass, etc.) and used zoning maps from Marin County to determine land *use* (e.g., single family residential, commercial, institutional, etc.). The second step consisted of an analysis of urban forest structure to determine the current extent and potential extent of the urban forest. This included quantifying the current tree cover as well as vacant planting sites. The third step involved quantifying, monetizing, and mapping annual

ecosystem services and property value increases provided by the existing and potential future urban forest.

Data

The following data layers were used for the analysis:

- 2010 multispectral National Agricultural Imagery Program (NAIP) images (3 ft resolution)
- 2011 natural color aerial images (1 ft resolution) provided by Marin County
- 2010 Census block, block group, and tract data
- Population data were acquired from the 2010 census
- Buildings GIS layer, corrected if necessary to assure building polygons aligned with the aerial image.
- City and community boundaries
- Zoning classes (e.g., commercial, industrial, single-family residential)
- 2010 Golden Gate LiDAR Project data set

Land cover and land use analysis

Land cover classification was conducted using 2010 NAIP images and the following seven classes were included: buildings, other impervious surfaces, trees, shrubs, irrigated grass, non-irrigated grass and dry soil, and water. This information was used to determine the existing tree cover and to determine where it will be possible to plant trees.

Zoning GIS data from Marin County was used to perform the land use classification. The 23 jurisdictions of the county included 450 different land use classifications, which were grouped into nine categories for the purpose of this study: agriculture, commercial, industrial, mixed use, multi-family residential, open space, public–quasi-public space, single family residential, and small commercial. Land use information was used to adjust environmental benefits data, in particular for energy conservation.

Ecosystem services calculations

Ecosystem services were determined on a per-acre-of-canopy-cover basis. The principle is known as “transfer function,” which is a term used to describe the transfer of data for a particular “study site” to a “policy site” for which little or no data exists. In this study, transfer functions are defined as measures of an ecosystem service (e.g., gallons of rainfall intercepted) per acre of tree canopy that are aggregated and applied to a region by land use class.

The following benefits were addressed in this report:

- **Annual energy conserved**: By shading buildings and other manmade materials (like roads and parking lots), trees reduce the amount of heat absorbed from the sun, lowering temperatures so that less air conditioning is required. Also, as trees undergo

evapotranspiration, they use up energy that would otherwise result in heating of the air. Finally, by blocking cold winter winds, trees help reduce the amount of cold air that seeps into buildings, so less heating is needed.

- **Annual stormwater management**: Trees capture rainwater and remove impurities, reduce the volume of water entering into sewer systems, and reduce peak stream flows. Canopy cover helps reduce erosion by reducing the impact of raindrops on bare ground.
- **Annual air pollutant reduction for volatile organic compounds (VOCs), ozone, nitrogen oxides, sulfur dioxide, and small particulate matter (PM_{10}):** Trees remove harmful pollutants from the air by absorbing them into their leaves or by intercepting them and allowing them to be washed away with the rain. Also, when energy is conserved, fewer air pollutants are created at the power plant.
- **Annual greenhouse gas sequestration**: Trees capture carbon dioxide from the atmosphere in the process of respiration and transform it into living matter—leaves, branches, trunks, and roots. Again, when energy is conserved, fewer greenhouse gases are produced at the power plant. Results are presented in pounds of carbon dioxide equivalents sequestered.
- **Property value increases:** Research indicates that homebuyers are willing to pay more for properties with trees. To some extent, this increase in value reflects some of the less tangible contributions of trees, such as beautification, privacy, and a sense of place.

Some species of trees also have a potentially negative impact on air pollutant emissions: they produce biogenic volatile organic compounds (BVOCs), which—in areas with poor air quality—may combine with nitrogen oxides to produce smog. To provide the most conservative estimate of the trees' environmental contributions, **annual BVOC emissions** are also calculated and combined with the positive VOC reduction benefit to produce a net number.

Benefits of carbon storage, carbon sequestration, air quality, and property values were based on transfer functions taken from the San Francisco Bay Area State of the Urban Forest study (Table 2).[25] Energy effects were determined specifically for this study based on local conditions (see below).

Table 2. Transfer function values for ecosystem services and property value increases (resource units/acre) for Marin County (taken from Simpson and McPherson 2007[25])

Land use	CO_2 (lbs)	NO_2 (lbs)	O_3 (lbs)	PM_{10} (lbs)	SO_2 (lbs)	Net VOCs* (lbs)	Storm water (1,000 gal)	Property value ($/acre)
Low-density residential	14,909.6	19.8	25.7	22.0	4.4	-19.0	79.7	14,935.5
High-density residential	10,283.5	17.2	26.5	21.4	3.5	-11.9	91.1	8,401.9
Commercial/industrial	13,679.7	18.8	22.8	19.4	2.2	-53.2	64.4	4,493.8

[25] Simpson JR, McPherson EG (2007) San Francisco Bay area state of the urban forest final report. USDA Forest Service, Pacific Southwest Research Station, Albany, CA

Land use	CO_2 (lbs)	NO_2 (lbs)	O_3 (lbs)	PM_{10} (lbs)	SO_2 (lbs)	Net VOCs* (lbs)	Storm water (1,000 gal)	Property value ($/acre)
Institutional	9,834.7	15.2	28.3	21.6	2.7	-53.2	82.9	4,322.5
Open space	10,837.0	16.0	29.6	22.6	2.8	-56.6	89.5	N/A
Transportation	5,185.1	13.2	24.7	18.6	2.4	-26.0	67.9	5,425.0
Mixed use	13,263.6	18.4	26.3	21.7	3.7	-29.7	81.2	10,302.5

*Trees both reduce the production of VOCs at the power plant when they help conserve energy and, in some species, emit VOCs of their own, which—in areas of poor air quality—may combine with nitrogen oxides to produce smog. To provide the most conservative estimate of benefits, the trees' effects on VOCs are shown here as a net number; a negative value indicates that they give off more VOCs than they reduce.

Determining energy benefits

Several factors influence the energy conservation benefits of trees:

- The size and type of tree (deciduous, coniferous, broadleaf evergreen)
- The distance and direction from the shaded building to the tree
- The vintage of the house (as this reflects, to some extent, the size, shape, window coverage, and insulation of the house, all of which affect energy consumption)
- The scale of the building being shaded, e.g., residential, industrial, commercial. Larger buildings associated with industrial land uses, for example, cannot be fully shaded by trees in the same way single-family homes can be. In this study, we focused on assessing trees in residential areas as this is where they can have the greatest impact in terms of saving energy.

The first step in determining the energy benefits of trees in residential areas is to get an understanding of how the trees are distributed in relation to the buildings. In the future, with the use of aerial imagery and LiDAR data, it may be possible to assess each tree and building individually. For now, however, we assess a random sample of plots and then apply that information across the study region.

One hundred and twenty five points were distributed randomly across the region. A circle with a diameter of 100 m was drawn around each point; this was the initial plot. In addition, any building that fell at least part way within the initial plot was included in the analysis and a further circle with a radius of 18.3 m was drawn around that building. This additional area was incorporated in the final plot.

For all trees within the final plot, the crown boundary was delineated and the size class was determined (DBH was first derived from the crown diameter). The centroid of any buildings within the plot was determined using GIS. For each tree, it's distance and direction from any nearby buildings (within 60 ft) was determined. Look-up tables created for the city of Santa Rosa, CA,[1] were then used to determine the energy benefits of the trees based on four variables:

- Distance to building (three distance classes)
- Direction from building to tree (eight cardinal directions)
- Building vintage (three vintage classes)
- Tree size (nine DBH classes)

In addition to these benefits from direct shade, all trees, including those more than 60 ft from a building, were associated with a general climate benefit that also has a small effect on energy conservation as a substantial tree canopy can reduce the urban heat island effect over a region.

Once the energy conservation benefits for the sample plots were determined, they were transformed into transfer functions (i.e., kWh of cooling energy conserved and therms of heating energy conserved per acre of tree canopy). The transfer functions can then be applied to residential areas across the study region.

In addition to the transfer functions, which are an average value that is applied wholesale across a particular land use type, energy conservation templates were developed for use in assessing tree planting scenarios. These templates show the energy conservation benefits of three medium size trees (a broadleaf evergreen, a conifer, and a deciduous tree) planted in eight cardinal directions, at three distances, around homes of three different vintages. These templates (available at: www.caufc.org/enertrees_resources) can be used to prioritize locations for planting.

Finding potential tree planting spaces

The same sample plots used to assess the distribution of trees around buildings were used to determine where potential tree planting spaces were. Again, in the future, it may be possible to use aerial imagery and LiDAR data to pinpoint actual planting spaces throughout the entire study site; current technology does not support this. Therefore results from 125 sample plots were applied across the study region.

In each sample plot, a computer algorithm searched for available planting spots using the following criteria:

- All pervious areas (irrigated grass, dry grass and bare soil according to the land cover study) were considered available for planting.
- Spots for large trees (15.3 m crown diameter) were sought first, then medium trees (9.1 m diameter), then small trees (4.6 m).
- A minimum of 9.3 m^2 of soil was needed for large trees, 3 m^2 for medium trees, and 1.5 m^2 for small trees.
- The tree center had to be at least 0.6 m from any impervious areas.
- Tree centers had to be at least 5 m from buildings for large trees and 3 m for medium trees. There was no minimum distance for small trees.
- No large or medium trees were placed within 5 m of an intersection to avoid obstructing visibility for vehicles.

- No medium or large trees were placed under power lines or other infrastructure that would interfere with growth.
- No small trees were placed where they would be surrounded closely by existing medium or large trees that would limit their growth or survival.

A limitation of this method is that computer algorithms are literal and will find *all* spots that meet these criteria and count them as potential planting spaces. Many of these will in fact not be truly suitable for planting as they may be currently occupied by other uses, such as vegetable gardens or sports fields, or there may be overhead powerlines or underground water lines present. To determine the rate of truly suitable planting spaces, 211 random spots identified as potential planting spaces were assessed in the field. The total number of planting spaces throughout the study region was adjusted according to the ratio found in the field assessment.

Planting scenario

Once the theoretical maximum number of planting spaces has been determined, this information is used to outline a practical planting scenario, based on short or long term goals. Some ideas for possible planting scenarios include:

- Filling 25% of all available planting spaces.
- Growing the forest from 10% canopy cover to 15%.
- Planting 10,000 trees on the west sides of buildings within 20-40 ft.

In our case, we decided to assess the benefits of an ambitious planting project that would fill 50% of all irrigated available planting spaces with a medium size tree and 50% of all unirrigated available spaces with a large native oak. The transfer functions and energy templates were used to calculate the benefits that will be returned if this scenario is achieved.

Results and discussion

Land use and land cover

There are estimated to be 1.9 million trees within the urban areas of Marin County, with a density ranging from 21 trees per acre to 72 trees per acre. The urban tree cover of the study area was a generous 36.3%. Other land covers included impervious surfaces (18.4%), irrigated grass (13.7%), bare soil and unirrigated vegetation (11.5%), buildings (10%), shrubs (6.4%), and water (3.7%). More than half the land use is single-family residential (59.4%). Other land uses included public–quasi-public (9.8%), open space (9.5%), multi-family residential (8.4%), agriculture (5.9%), with commercial, industrial, and mixed use making up the remaining 7%.

Stocking level is an often overlooked, but critical, measure of tree canopy that gives a more accurate picture of potential for increasing tree cover. It is defined as the percentage of total pervious surface (irrigated grass, unirrigated vegetation, trees) that is filled with trees, thus it accounts for the fact that trees cannot be planted in all areas. A very urban area, such as downtown San Francisco, might have only 10% canopy cover but 90% stocking if trees are

planted everywhere they can grow. In the urban areas of Marin County, the stocking level was an admirable 82%, with several jurisdictions over 90%.

Potential tree planting sites

A total of 425,488 potential planting sites were identified in the region. Approximately half are located in residential land use areas and 16% in open space land. More than 80% of the potential sites (345,013) are in irrigated areas, with the remaining (80,475) in unirrigated areas.

Planting scenario

The planting scenario we designed would involve filling 50% of irrigated spaces with medium size trees (172,506 trees with 30-ft crown diameter) and 50% of unirrigated spaces with large native oaks (40,238 trees with 50-ft crown diameter).

Planting trees at this level would increase the canopy cover to 45.7% from 36.6% and increase the stocking level to 91% from 82%. All jurisdictions would exceed 80% stocking in this scenario.

Ecosystem services of existing trees

The annual value of the ecosystem services and property value increases provided by the existing trees is $273 million (Table 3). It should be noted that this is a very conservative estimate of the benefits provided by the trees as it does not include the value associated with provision of wildlife habitat, improvements to human health, biodiversity, job creation and many other intangible offerings.

Table 3. Annual ecosystem services and property value increases provided by the existing tree canopy of the urban areas of Marin County.

Benefit	Resource units	Dollar value
Natural gas conservation for heating	481,000 MBtu	$4.6 million
Electricity conservation for cooling	319,000 MWh	$59 million
Greenhouse gas reduction	121,000 tons	$1.2 million
Nitrogen oxides reduction	167 tons	$1,670
Ozone reduction	238 tons	$816,000
Small particulate matter reduction	197 tons	$676,000
Sulfur dioxide reduction	35 tons	$45,000
Net VOCs*	-0.123 tons	$-552,800
Stormwater mitigation	1.5 billion gallons	$8.5 million
Property value increase	--	$198 million
Total dollar value		**$273 million**

* See footnote to Table 2.

Ecosystem services of the trees planted in the planting scenario

If 50% of all irrigated and 50% of all unirrigated planting spots are filled with trees, the total benefits will increase by $56.2 million (Table 4). These values assume that the existing canopy will be maintained and that any dead trees will be replaced. It is assumed that these benefits will be achieved 30 years after planting.

Table 4. Annual ecosystem services and property value increases provided by the additional tree canopy of the urban areas of Marin County at maturity.

Benefit	Resource units	Dollar value
Natural gas conservation for heating	98,900 MBtu	$943,000
Electricity conservation for cooling	63,480 MWh	$11.8 million
Greenhouse gas reduction	29,500 tons	$295,000
Nitrogen oxides reduction	42 tons	$420
Ozone reduction	62 tons	$213,000
Small particulate matter reduction	51 tons	$174,000
Sulfur dioxide reduction	8 tons	$10,700
Net VOCs*	-0.04 tons	$-176,700
Stormwater mitigation	381 million gallons	$2.2 million
Property value increase	--	$41 million
Total dollar value		**$56.2 million**

* See footnote to Table 2.

Appendix II:
Demonstration project case study:
San Jose Middle School

Demonstration projects can be a valuable part of a shade tree planting campaign:

- They help spread the word publicly about the campaign.
- They help participants understand the benefits of trees in a practical, hands-on way.
- They allow you to engage with different audiences who will then spread the word in different directions. For example, a demonstration at a school engages parents, students, teachers and staff, who might then become interested in planting trees for shade around their own homes.
- They let you get your hands dirty!

Finding a site

What to look for

When looking for a site for a demonstration project, remember that your goals are to (1) conserve energy, (2) reduce levels of greenhouse gases, and (3) inform the public and spread the word about your EnerTrees campaign. Things to consider:

- Public access to the site is important. It need not necessarily be public property, but it shouldn't be out of sight on private land. The more people that can see the project, the better a demonstration it will be.
- Look for a site with few or no existing trees on the west, east, and south sides of the buildings. You want your trees to make a difference.
- For the demo, it's good to have enough space to plant ***large*** trees according to arboriculture best management practices. Remember that this project will represent the larger campaign and should help other people make good decisions about planting. Large trees provide the most benefits, but also need sufficient room to grow.
- Work with an organization tht has sufficient resources to care for the trees in their early years, particularly watering. Existing irrigation is helpful or at least a system that can be inexpensively extended to include the new trees. Otherwise, community support is critical; be sure there are participants who are conscientious enough to water the trees weekly. Dead or dying trees won't be a good advertisement for your project!

Where to look

Demonstration projects can work on a variety of public or private sites. The biggest virtue of a private site is that it tends to be easier to get permission for planting. You might start your search of private options with:

- Stand-alone buildings housing businesses associated with green industries, gardening, landscape architecture, architecture, or energy
- Service organizations such as the Lions Club, Rotary International, or the VFW
- Houses of worship
- Daycare centers
- Private schools

Public options to consider include:

- Schools
- Libraries
- Public administration buildings like city hall
- Rec centers in and out of parks
- Existing planting strips in commercial areas

How to look

Perhaps the easiest way to begin your search for an ideal site is using Google Maps in satellite view. You might begin by searching your area for “schools” or “churches” and then zoom in on each to determine whether or not it has significant existing canopy cover. Google Street View can help refine your search. Of course you’ll need to visit any possibilities in person to be sure that trees haven’t been planted in the time since the imagery was produced or that there aren’t infrastructure concerns such as overhead powerlines that would interfere with planting.

Your social media networks and of course your old-fashioned networks of family and friends can be queried for possible demonstration sites as well.

Our project

We wished to have a more explicitly educational component to our project, so we began our search with schools. Within our project region, the city of Novato has the fewest trees, thus we used Google to search for schools in Novato and zoomed in to explore each one in more detail. Examples of unsuitable sites are shown below (Figs. 5 and 6).

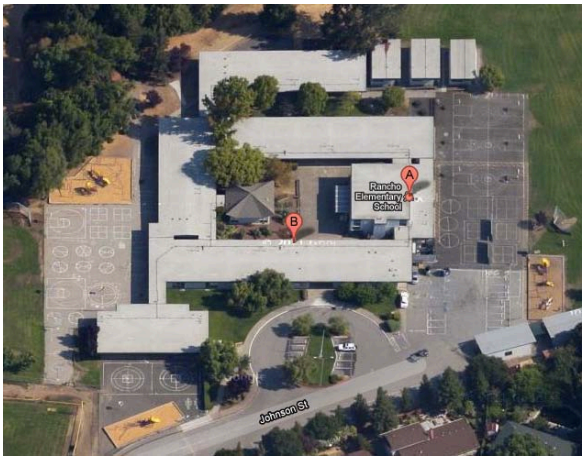


Fig. 5 Rancho Elementary School. Asphalt on the east and west sides of the building (the most valuable sites for energy conservation) would be difficult and expensive to remove.

Fig. 6. The Montessori School of Novato is already well-planted with trees on the east, west and south sides of the building.

Our search ended with the San Jose Middle School (Fig. 7). The site had few trees in energy-conservation sites, sufficient land for planting, and the presence of grass suggested that irrigation was in place. A visit in person showed that the southern buildings were uncomfortably warm and bright even in winter.

Fig. 7. San Jose Middle School, Novato, CA. The southern buildings in particular offer plenty of room for strategic planting of trees for energy conservation.

Planting plan

Figuring out where to plant your trees doesn't require a formal drawing by a landscape architect, but it's good to walk through the site and put your ideas down on paper. Figure 8 shows our planting plan for San Jose MS. Here's how to get started:

1. Review the section of this manual that presents guidelines for strategic planting of trees for energy conservation. Remember that the most important rules are:
    a. Plant trees first on the west and east of buildings.
    b. Plant only deciduous trees to the south.
    c. Keep trees at least 10 feet from buildings and within 40–60 feet for the greatest benefit.
2. Print out several copies of the aerial image of your site from Google Maps. On one copy of the aerial image, sketch your initial thoughts about where trees might go for the greatest benefit.
3. Visit the site in person and note on your aerial image any factors that would affect tree planting that weren't obvious, such as overhead powerlines and other infrastructure elements, steep slopes, or new trees not visible yet in imagery.
4. Considering both your initial drawing ideas and new information from the site visit, finalize planting locations for trees. Remember not to crowd the trees! If you're planting large species (as you should for the greatest benefits), when they're mature they'll require 30–40 ft of space each.

Choosing species and trees

Generally speaking, with energy conservation in mind, it is best to plant the largest tree that is practical for the given space. Get started thinking about species choice by reviewing the section of this manual that presents guidelines for choosing species for energy conservation. Remember that the most important rules are:

1. Fit the mature size of the tree to the available planting space.
2. Trees planted on the southern sides of buildings should be deciduous so the warming winter sun isn't blocked.
3. Choose a tree with the appropriate mature shape. Consider whether a pyramidal, oval, arching or other shaped tree is best for the given space.
4. Match the water needs of the species to the available water sources. Native, drought-tolerant trees are great where water availability is low, but might not be the best choice for irrigated lawns.

Once you've decided on a few appropriate species, visit your local nurseries to see if good quality specimens are available.

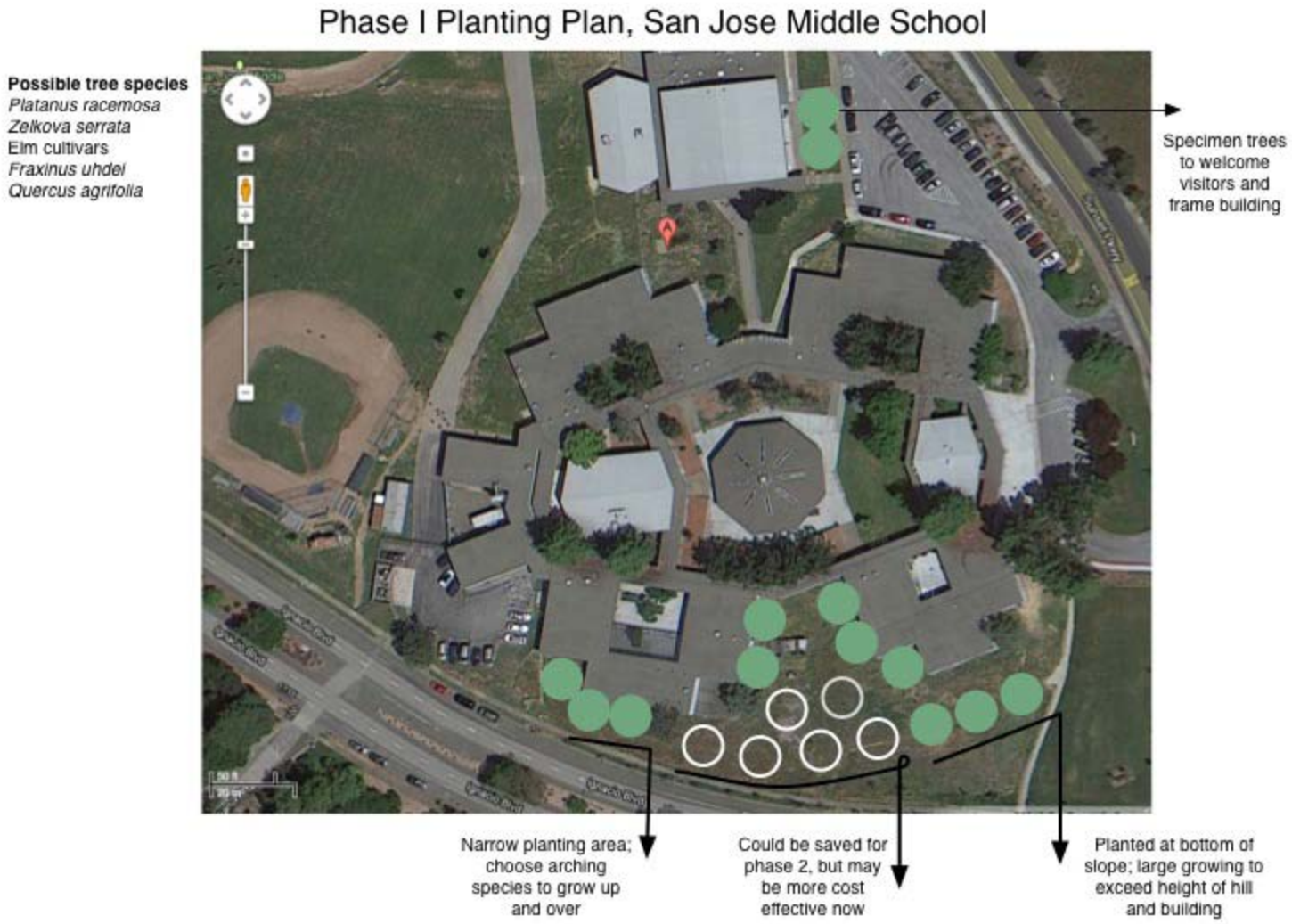


Fig. 8. San Jose Middle School draft planting plan. Trees are planted to the west, east, and south sides of the southern buildings and to the east of the northern building. The species planted on the southern sides will be chosen to allow filtered winter light to enter the rooms. The final plan differed slightly from what is shown here. (This plan was created in Microsoft Word, but a hand-drawn plan is sufficient.)

Our species choices

Our objectives when choosing species included the following:

- Choose large species as we had sufficient room to plant them.
- For the trees closest to the buildings, find species that would arch up and over the roofs as they grew. Although there was plenty of soil and space available, in some cases the trees would need to be planted fairly close to the buildings owing to steep slopes. Conical or pyramidal trees would not have fit.
- Choose drought-tolerant species to accommodate potential problems with irrigation that might occur when school was out of session and there was less oversight of the trees.
- Consider native species if possible.

Our final species list:

- Coast live oak (*Quercus agrifolia*), 15 gallon
- California sycamore (*Platanus racemosa*), 15 gallon
- Hungarian oak (*Quercus frainetto* 'Forest Green'), 24" box

Getting the trees planted

Your best method for getting the trees in the ground will depend on the resources you have available. Some options include:

- Professional services: Landscape professionals dig the holes with heavy equipment, plant the trees, stake and tie them if desired, mulch the planting site, lay irrigation if necessary, and provide the young tree care.
- Volunteers: Volunteers dig the holes by hand, plant the trees, and undertake all the other steps. In this case, it's critical that the process be overseen by someone with tree knowledge.
- Some combination of the two.

Each of these options has its advantages. If you can afford professional help (or know professionals who are willing to donate their labor or equipment), the work will, of course, move more quickly, the planting holes will be bigger, the trees will be straighter and their short-term survival will probably be guaranteed. A volunteer-based project will have greater buy-in from the participants, who will feel like the project is *theirs*. Their greater involvement might support greater long-term survival.

It is likely that some combination of these two is best, such as finding professional help for the more labor-intensive aspects like hole-digging, while saving the more rewarding tasks like planting the trees for volunteers.

Our project

We worked with a team that included staff of Friends of the Urban Forest, a local nonprofit tree advocacy group, who oversaw the project; local landscape professionals who volunteered some of their time and equipment to dig the holes and lay the additional irrigation; students of San Jose Middle School.

Fig. 9. Planting trees at San Jose Middle School.

Estimating project benefits

One of the most powerful things you can do to spread the word about your project and about the value of strategically planting trees in general is to communicate the energy-saving (and other) benefits of the trees you're planting. Many people will be surprised to learn that trees can save hundreds of dollars in energy costs over time, while also reducing greenhouse gases in the atmosphere, cleaning our air and water, and increasing property values.

How to calculate the benefits of your trees

A great place to start is the regional Community Tree Guides written by scientists at the US Forest Service, which are full of great information on the benefits of trees (available here: www.fs.fed.us/psw/programs/uesd/uep/tree_guides.php). The appendixes include tables that show those benefits over time for four "typical" species of the region. You can use the five-year average values in these tables, as we did, to estimate the contributions of the trees over 40 years (see more below).

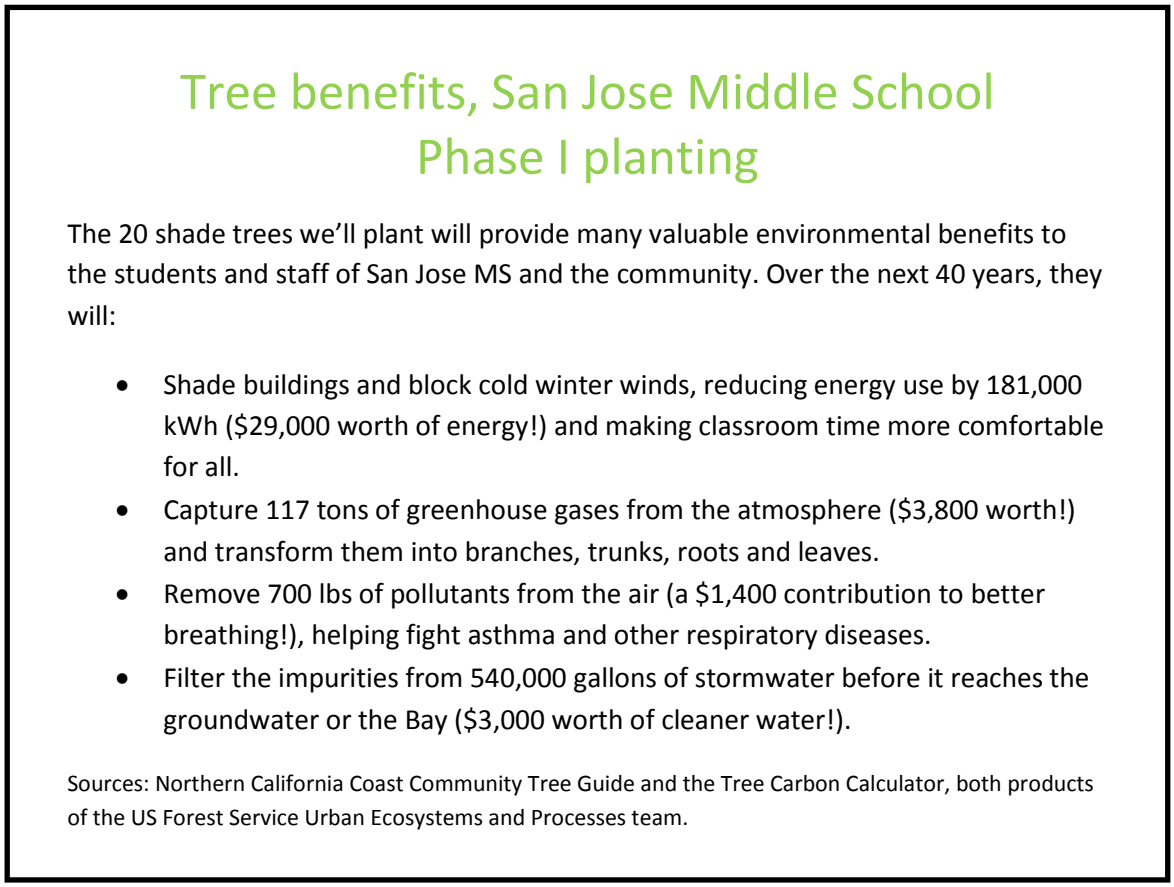
The National Tree Benefits calculator (www.treebenefits.com) is another great resource.

Benefits of our project

We used the Northern California Coast Community Tree Guide and the Forest Service's Tree Carbon Calculator to estimate the benefits of the trees we planted. Over the next 40 years, they will:

- Shade buildings and block cold winter winds, reducing energy use by 181,000 kWh ($29,000 worth of energy!) and making classroom time more comfortable for all.
- Capture 117 tons of greenhouse gases from the atmosphere ($3,800 worth!) and transform them into branches, trunks, roots and leaves.
- Remove 700 lbs of pollutants from the air (a $1,400 contribution to better breathing!), helping fight asthma and other respiratory diseases.
- Filter the impurities from 540,000 gallons of stormwater before it reaches the groundwater or the Bay ($3,000 worth of cleaner water!).

We presented these results in a flyer that was distributed at the school (Fig. 10).



Tree benefits, San Jose Middle School Phase I planting

The 20 shade trees we'll plant will provide many valuable environmental benefits to the students and staff of San Jose MS and the community. Over the next 40 years, they will:

- Shade buildings and block cold winter winds, reducing energy use by 181,000 kWh ($29,000 worth of energy!) and making classroom time more comfortable for all.
- Capture 117 tons of greenhouse gases from the atmosphere ($3,800 worth!) and transform them into branches, trunks, roots and leaves.
- Remove 700 lbs of pollutants from the air (a $1,400 contribution to better breathing!), helping fight asthma and other respiratory diseases.
- Filter the impurities from 540,000 gallons of stormwater before it reaches the groundwater or the Bay ($3,000 worth of cleaner water!).

Sources: Northern California Coast Community Tree Guide and the Tree Carbon Calculator, both products of the US Forest Service Urban Ecosystems and Processes team.

Fig. 10. Flyer describing benefits of tree planting project at San Jose Middle School.

Appendix III: Resources from existing projects

Good examples of strategic siting guidelines

LEAF (Ontario): Tree planting and care[26]

City of Pasadena: Cool Trees Guidebook[27]

Good examples of species guidelines

LEAF (Ontario): Tree selection guide[28]

CPS Energy (San Antonio): Trees for the San Antonio Region[29]

Good examples of planting and tree care guidelines

LEAF (Ontario): Tree siting checklist[30], Tree planting and care[31]

CPS Energy (San Antonio): Trees for the San Antonio Region[29]

City of Pasadena: Cool Trees Guidebook[27]

Good examples of other things

Arizona Public Service: Workshop curriculum[32]

CPS Energy (San Antonio): Green Shade Rebate Application[33]

Turlock Irrigation District: All-in-one brochure[34] with program description, siting guidelines, species selection information, and rebate form

[26] http://yourleaf.org/sites/yourleaf.org/files/LEAF_PlantingAndCare.pdf
[27] http://cityofpasadena.net/WorkArea/DownloadAsset.aspx?id=6442459765
[28] http://yourleaf.org/sites/yourleaf.org/files/LEAF_TreeSelectionGuide.pdf
[29] http://www.cpsenergy.com/files/full_tree_guide.pdf
[30] http://yourleaf.org/sites/yourleaf.org/files/Homeowner Siting Checklist.pdf
[31] http://yourleaf.org/sites/yourleaf.org/files/LEAF_PlantingAndCare.pdf
[32] http://www.aps.com/library/marketing1/ShadeTreeWorkshopCurriculum.pdf
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[34] http://www.tid.org/sites/default/files/documents/tidweb_content/Shade Tree Brochure_web.pdf