

SMUD's Shade Tree and Cool Roof Programs Energy and Climate Impacts

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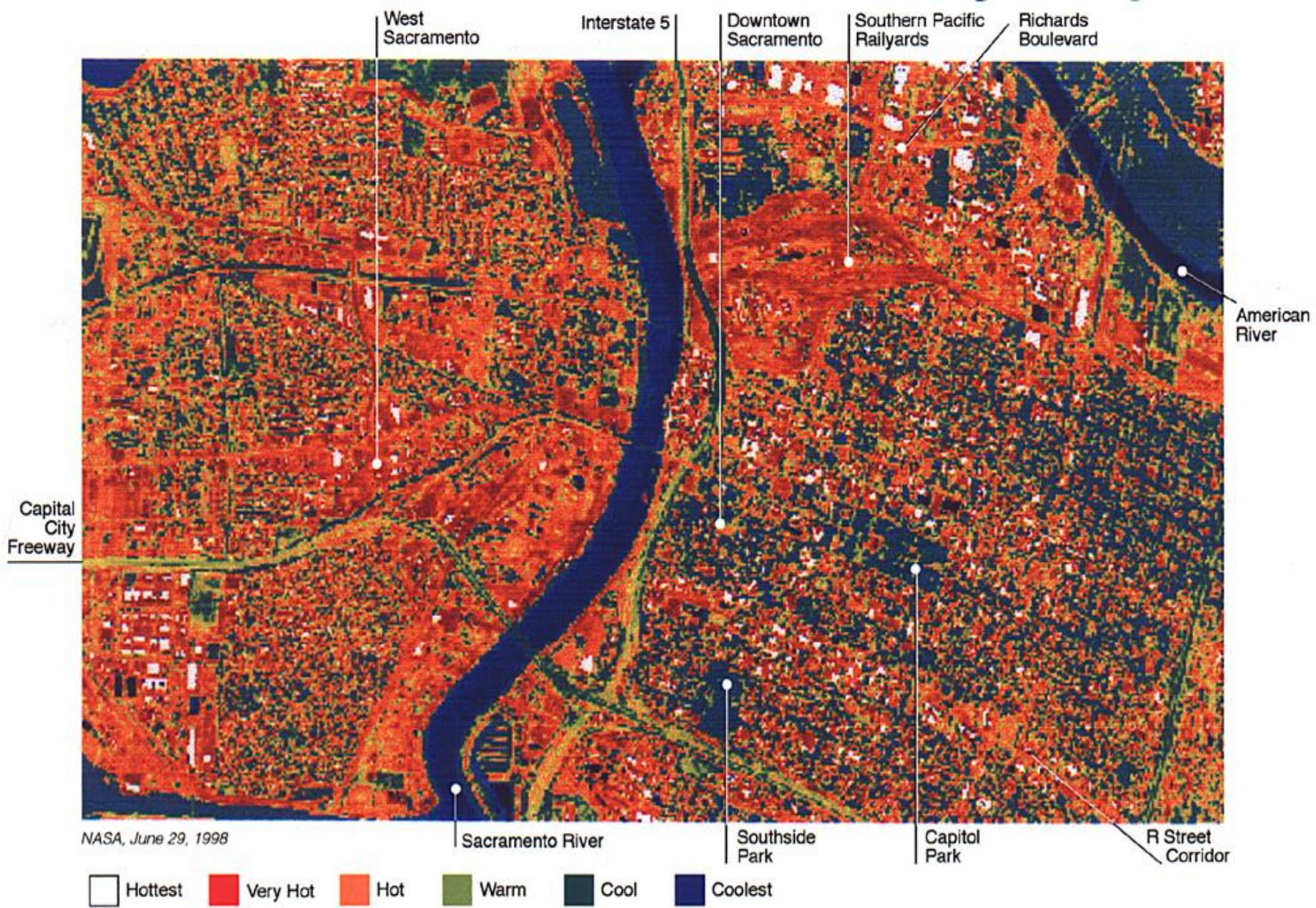
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California Adaptation Forum

Powering forward. Together.



What is SMUD?

- SMUD generates, transmits and distributes electric power to 900 square mile territory (i.e. Sacramento County)**
- Municipal Utility– governed by 7 member board of directors elected by the voters**
- \$1.3 billion operating revenues in 2011**
- 2,007 full time employees**
- 595,076 customers in 2011**
- 1.4 million people in SMUD service area**
- J.D. Powers – 2007 – 2011 recognition**



What's Hot and What's Not!

SMUD's Urban Heat Island mitigation efforts

- ✓ **Program #1: Increased Vegetation– SMUD's Shade Tree program (since 1990)**

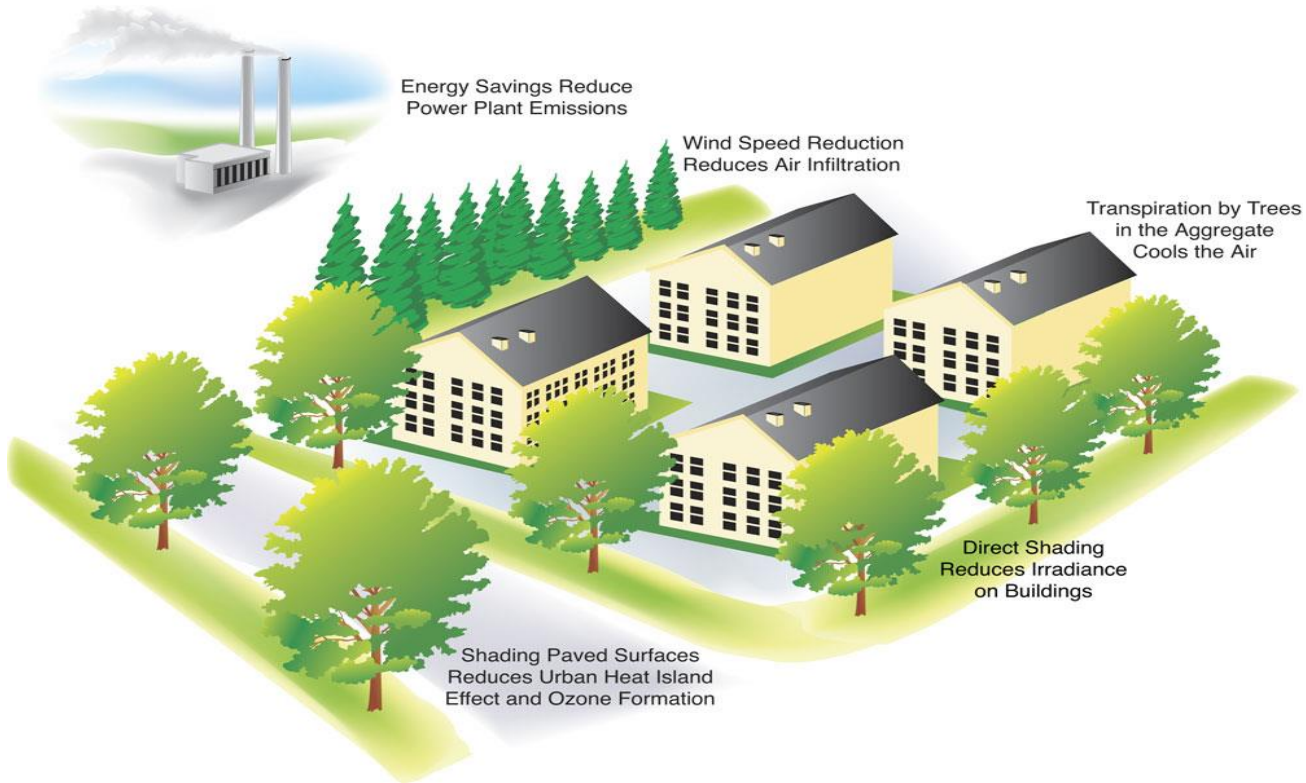
Web site: SMUD.org

- ✓ **Program #2: Increased Roof's Albedo— SMUD's Cool Roof program (since 2001)**

Web site: SMUD.org

- ☐ **Light colored pavements (i.e. Cool Parking Lots)– Sacramento Cool Community Project (1999)**

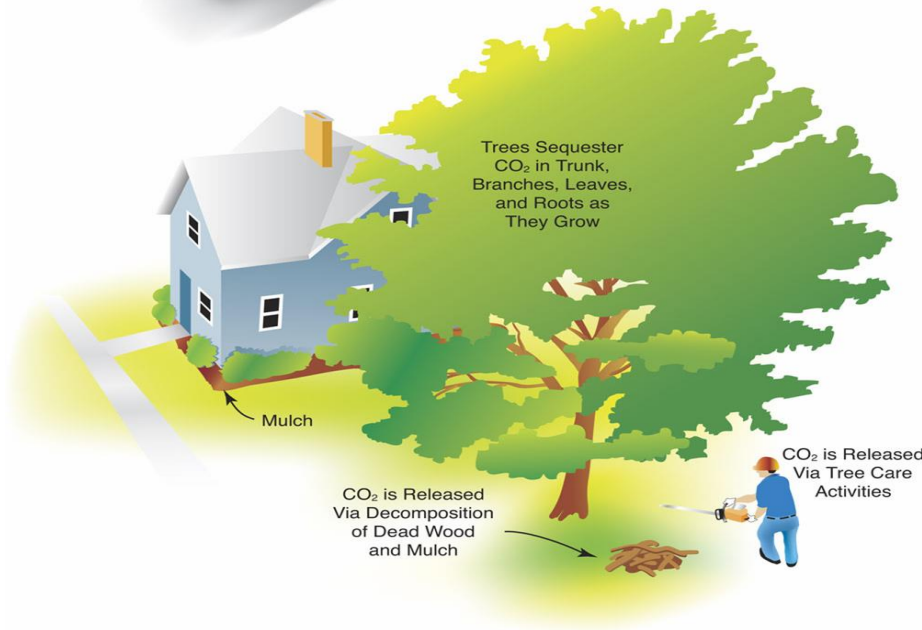
Energy Savings



Reducing Carbon Dioxide



Trees Save Energy for Cooling,
Thereby Reducing CO₂ Emissions
from Power Plants

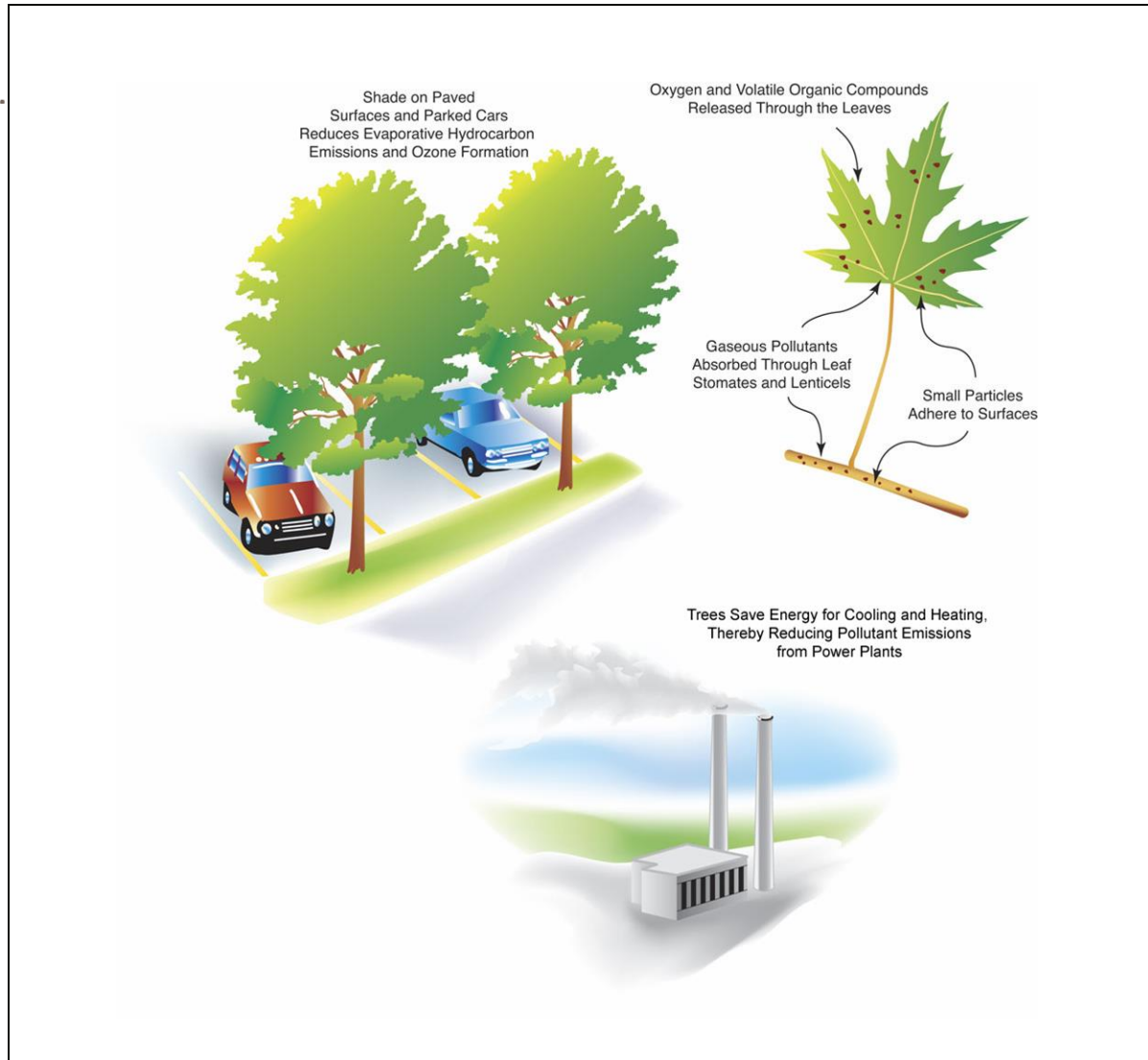


Trees Sequester
CO₂ in Trunk,
Branches, Leaves,
and Roots as
They Grow

CO₂ is Released
Via Decomposition
of Dead Wood
and Mulch

CO₂ is Released
Via Tree Care
Activities

Air Quality Improvements



Program Objectives

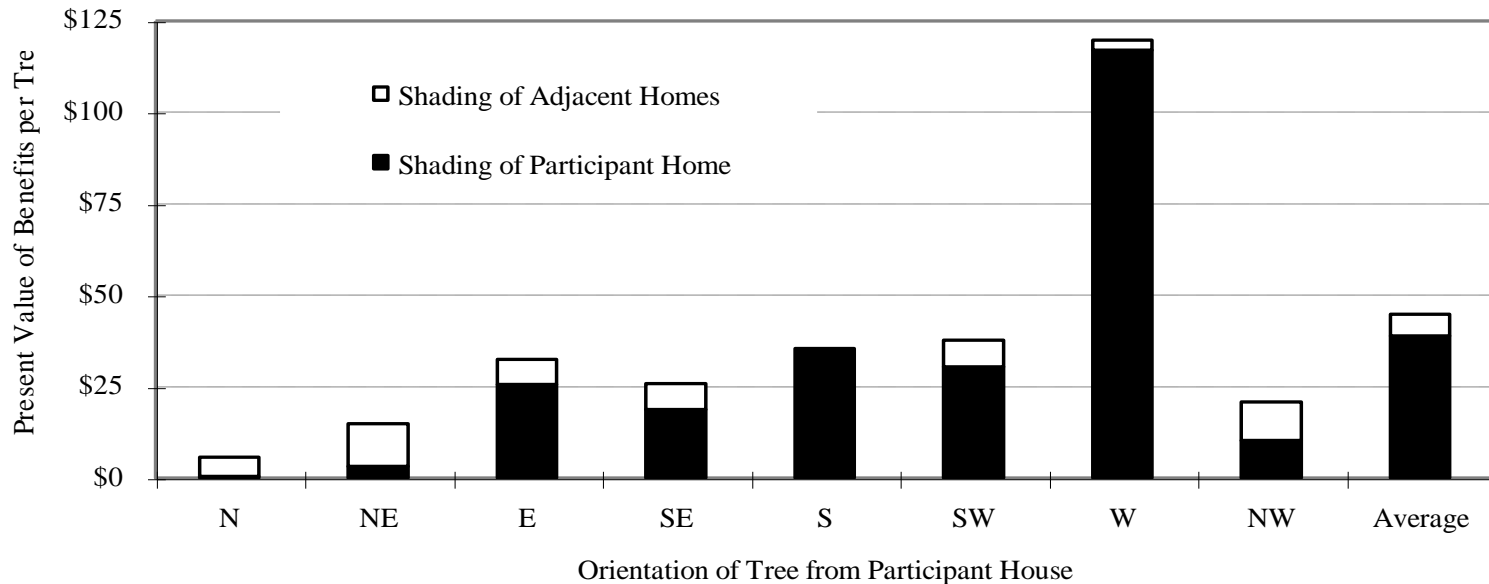
- **Primary and short-term objective : Load Reduction-- reduce electricity peak demand and air conditioning energy load during the summer months**
- **Secondary and long-term objective: Urban heat island effect mitigation-- reduce the ambient temperature 1 to 2°F and thus reduce air conditioning needs**
- **Tertiary and long-term objective: Market Transformation**
- **Positive externalities: Improving the region's air quality, carbon sequestration, enhancing the aesthetics in the region, and promoting a sense of community spirit and cooperation.**

SMUD Sacramento Shade

- ~~started in 1990~~.....
- implemented in collaboration with the local, non-profit, community based organization (Sacramento Tree Foundation)
- the program is 100% funded by SMUD
- Program provides free trees (5 gallon), stakes, ties, and expert advice (STF)
- over 175,000 program participants
- over 500,000 trees planted
- annual budget approximately \$1.1 million
- Approximately 11,000 shade trees planted every year
- over \$30 million invested since 1990
- received several national and state awards

SMUD Shade Tree Program

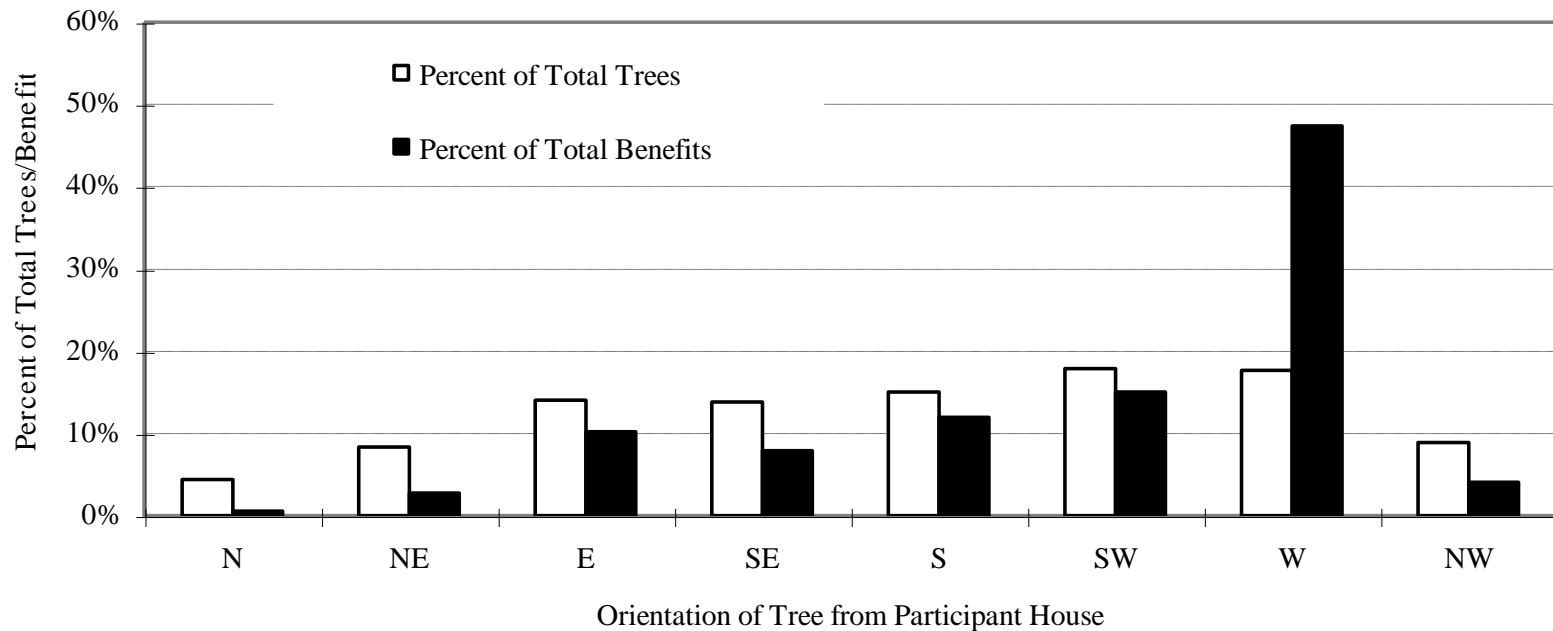
Figure 1
Total Average Present Value of Benefits (PVB) per Tree by Tree Orientation [1]



[1] Based on estimated long-term tree mortality of 42.5 percent over 30-year period for trees planted under program in 1991-1993.

SMUD Shade Tree Program

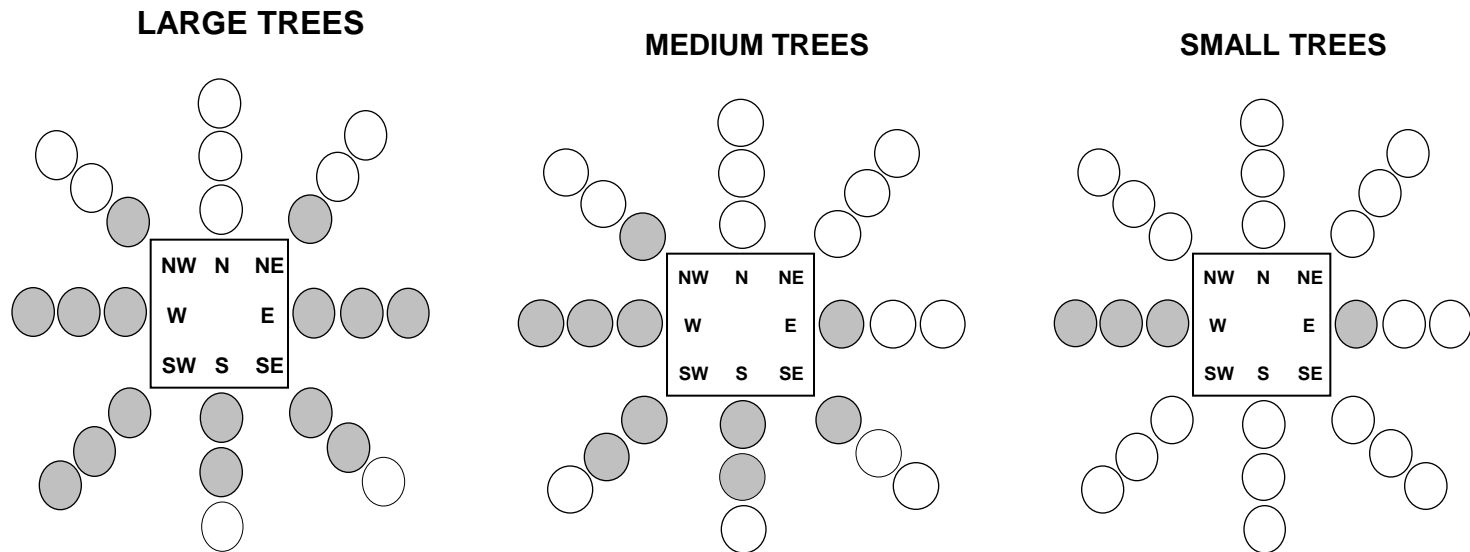
Figure 2
Percent of Total Trees Planted and Total Program Benefits by Tree Orientation



SMUD Shade Tree Program

Figure 3

What is Allowed Under the SMUD's Tree-Siting Guidelines



Shaded sites have higher than the minimum \$20 per tree PVB.

SMUD Community Shade

- ~~implemented in 1997 (trees for public places)~~
- implemented in collaboration with the Sacramento Tree Foundation (STF)
- The 100% funded by SMUD
- Program provides free trees (15 & 5 gallon), stakes, ties, fertilizers and expert advice (STF)
- program participants: Schools, Park Districts, cities
- approximately 30,000 trees planted since 1997
- annual budget over \$300,000
- Approximately 5,000 trees planted every year
- over \$3.5 million invested since 1997

Estimates of Energy Savings

Shade Tree Program

- Average energy cooling load savings are 125 kWh/year/ per mature tree
- Average demand savings are 0.048 kW per mature tree
- It takes into account California Title 24 standards for residential buildings
- It takes into account higher than expected tree mortality rate for urban trees

Estimates of Carbon Benefits

Average Total Carbon sequestered and stored in Kg per mature tree is the following:

- Large size tree: 2,735 Kg
- Medium size tree: 1,393 Kg
- Small size tree: 88 Kg

Average Total CO2 sequestered in Kg per mature tree is the following:

- Large size tree: 10,039 Kg
- Medium size tree: 5,112 Kg
- Small size tree: 325 Kg

- This does NOT take into account the environmental benefits of the avoided power generation.
- The Shade Tree Program annual KWh savings are added into the SMUD's total Energy Efficiency portfolio and thus reported there.
- The standard SMUD assumption is that for every MWh savings, SMUD avoids 810 Lbs of CO2 from power generation
- This SMUD CO2 Benefits factor (810 Lbs/MWh) depends on the SMUD's unique power generating mix (Hydro, solar, wind, geo-thermal, bio-mass, and natural gas). SMUD does not have or purchase coal power.

Tree Benefits Estimator

- **This free Web-based application can help utilities quantify and track the benefits of planting shade trees (www.SMUD.org)**
- **It estimates the amount of total energy savings (KWh saved), capacity savings (KW saved) and carbon and CO2 sequestration (lbs) resulting from mature trees planted in urban and suburban settings (takes into account evapotranspiration effect and winter heating penalty).**
- **The tool takes into account any climate zone in the USA.**
- **The Tree Benefits Estimator can be used by those who have no formal background in urban forestry or energy efficiency utility practices.**

Tree Benefits Estimator results

Tree Benefits

Page 1 of 1

Shade Trees: Estimated Benefits

Climate Area: San Fran.-Oak.-San Jose, Calif.
 Heating Degree Days (HDD): 3042
 Cooling Degree Days (CDD): 108
 Latent Enthalpy Hours (LEH): 0
 Tree - Common Name: California Sycamore
 Tree - Botanical Name: Plantanus Racemosa
 Tree Size: Large
 Tree Type: Deciduous
 Tree Age: 24
 Tree DBH: 20.0
 Number of Tree(s): 1
 Tree Orientation: W
 Distance from the house: Adjacent
 Summer Rate: \$ 0.176
 Winter Rate: \$ 0.235

KW Saved*	Direct Shading Annual KWh Saved*	Heating Penalty KWh Lost	Indirect Evapotranspiration Benefits	Total Summer Cooling Benefits	Total Winter Heating Penalty	Total Volume (m3) t*	Total Carbon Kg**	Stored CO2 Kg**	CO2 Seq/yr Kg**	Total Carbon Lbs**	Stored CO2 Lbs**	CO2 Seq/yr Lbs**
Benefits From MATURE Tree:												
)	45	30	0	\$ 8	\$ 7	8	2735	10039	98	6030	22128	216
Benefits From Existing Tree of 20.0 DBH (incorporates tree age and tree growth rate):												
)	23	16	0	\$ 4	\$ 4	1	285	1045	76	628	2304	168
Benefits From Program Tree (trees planted by utilities) - utility perspective (incorporates tree growth rate and assumed tree mortality rate):												
)	13	9	0	\$ 2	\$ 2	2	535	1963	19	1179	4327	42

* Source: SMUD & USDA Forest Service, Center for Urban Forest Research & Education. SMUD Shade Tree Program Impact Evaluation(1986)

** Source: USDA Forest Service, Center for Urban Forest Research & Education.

Close

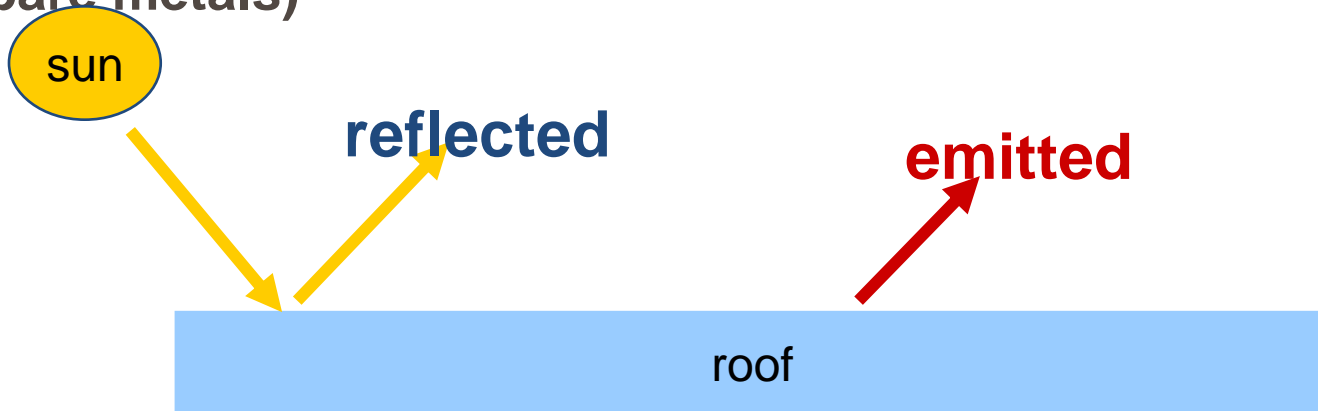
SMUD Cool Roof Program

- **Solar Reflectivity standards**

- High Reflectivity--Amount of incoming solar energy a material reflects, also called “albedo” (higher than 75 % for low slope roofs and 40% for steep slope roofs)

- **Emissivity standards**

- High Emissivity--Amount of energy a material emits due to its own heat and temperature (higher than 75 %- no bare metals)



Roofing Material Temp Survey

Sacramento, CA Outside Air 89°F



“White” Cap Sheet 158°F

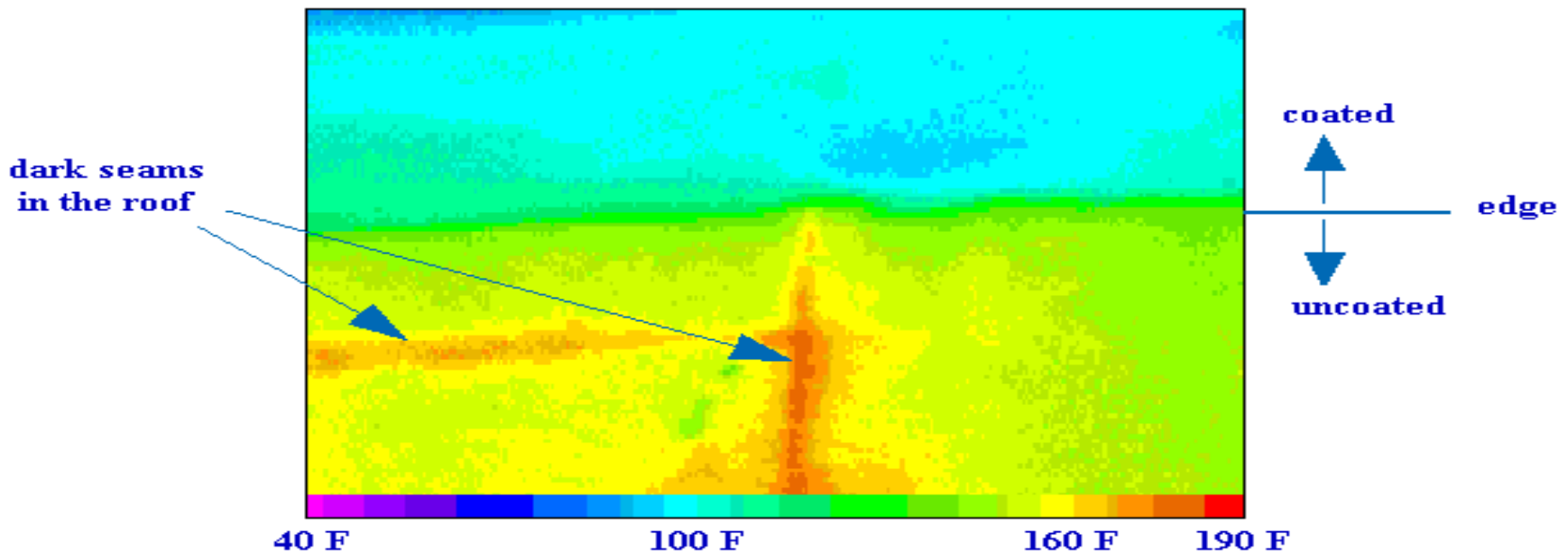


White PVC 121°F



Roof Temperatures

Infrared Photo of the Roof at the Edge of a White Coating



- Roof Cooled from 160°F to 100°F

Cool Roof Surfaces for flat roofs

1. **Single-ply Membranes (single pre-fabricated sheets applied in a single layer, 35 to 60 mils thick, attached to roof and bonded with the heat gun, in use since 1960s (EPDM), 1970s (PVC & CPA), 1980s (TPO))**
 - PVC (polyvinyl chloride)
 - TPO (thermoplastic polyolefin)
 - CPA (copolymer alloy)
 - Hypalon (synthetic rubber)
 - EPDM (ethylene propylene diene monomer)
 - Cost \$4 to \$5 per sq.ft.

Cool Single Ply Roofs



Cool Roof Surfaces for flat roofs

Coatings (2 types)

thick coat with additives which is sprayed or rolled onto the roof, since 1970s

1. Elastomeric (polymers)

acrylic, urethane, silicone

- Contain titanium dioxide
- waterproof membrane
- Metal based coatings NOT allowed
- Cost \$0.75 to \$1.50 per sq.ft.

2. Cementitious (white cement particles)

- Pervious coatings
- Cost \$0.35 to \$0.50 per sq.ft.



Cool Roof Surfaces for flat roofs

2. Sprayed Polyurethane Foam (SPF)

- ❑ SPF is created when two components (isocyanate and polyol) are carefully proportioned, mixed together and sprayed with the spray gun.
- ❑ When the two chemicals are mixed, reaction occurs generating heat and the mixture expands 20 to 30 times its volume.
- ❑ Coatings (and/or gravel) must be applied to protect SPF surface from UV light
- ❑ In use since 1960s, good insulation, light weight

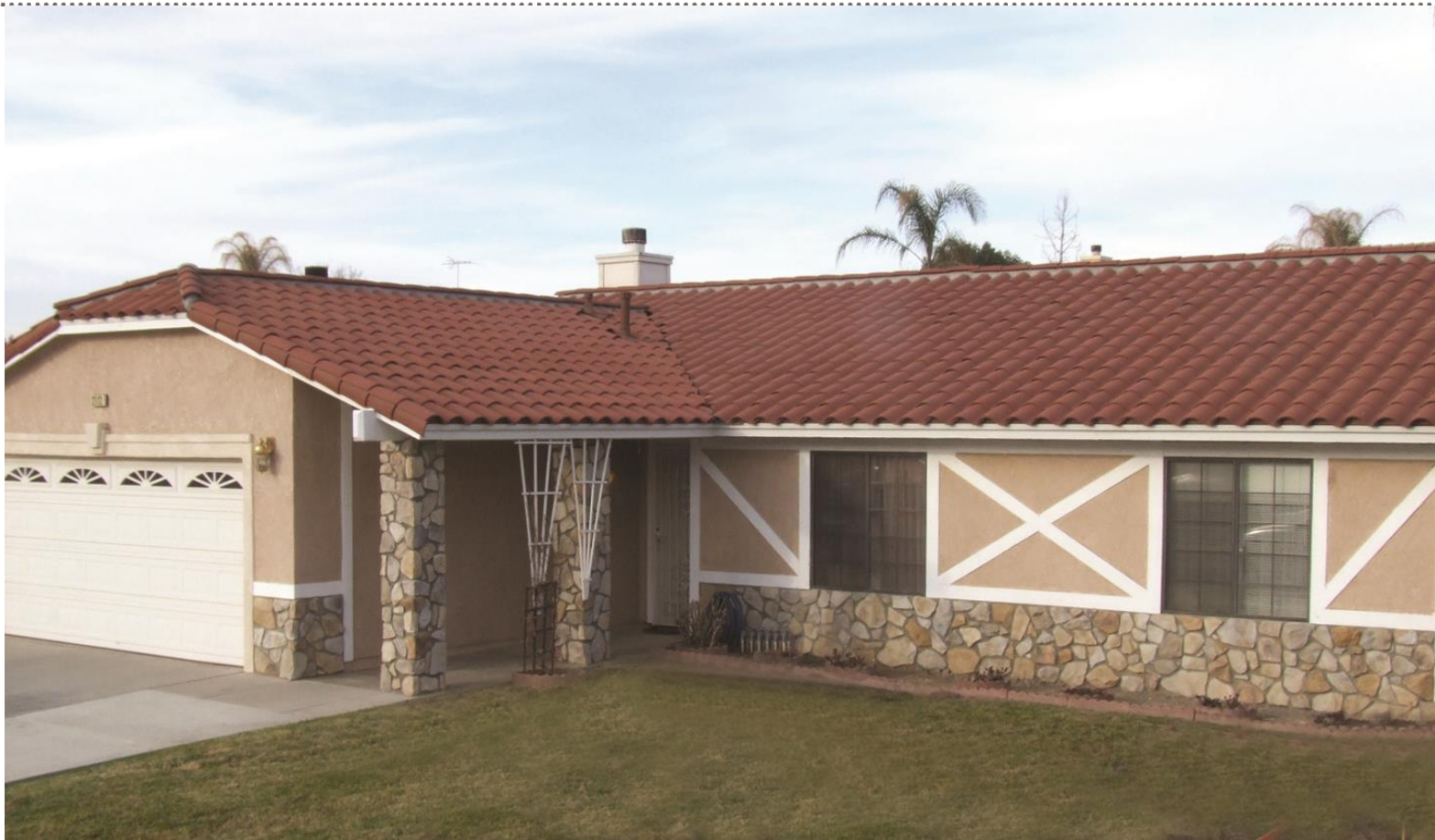
Cool Roof Surfaces for steep slope roofs

- Tile roofs (light weight light color concrete or clay tiles)**
- Coated metal roofs (elastomeric coatings)**
- Can be done in many different colors**
- More expensive than conventional asphalt shingle**

Before -Steep Slope Roof



After -Steep Slope Roof



SMUD Cool Roof Program

- **Contractor driven program: contractors market the program, screen the potential candidates, process the paperwork**
- **Contractors agree to install only the Cool Roof products that meet or exceed the Energy Star® standards**
- **Residential, mobile homes and multi family buildings that have "flat" or steep slope roofs that cover central compressed air conditioned space are eligible.**

SMUD Cool Roof -results since 2001

- **Participating Contractors: 30+**
- **Number of projects: 500+**
- **2008 Residential Cool Roofs: 189,000 sq.ft., 119 homes**
- **Total Square Footage: 8,800,000 (mostly commercial)**
- **Average Square Footage: 22,900 com./1,600 res.**
- **Largest Roof Area: 216,000 sq. ft.**
- **Smallest Roof Area: 1,200 sq. ft.**
- **Total Incentive Payments: \$904,000**
- **Average incentive Payment: \$4,500 com. / 260 res.**
- **Largest Incentive payment: \$64,000**
- **Smallest Incentive payment: \$120**

Estimates of Savings

Cool Roof Program

- Average energy cooling load savings of 20% (commercial buildings)
- Average energy savings are 0.15 kWh/year/Sq.Ft. and average demand savings are 0.25 W/Sq.Ft. (for commercial properties)
- For residential properties— on average 406 kWh/year for single family homes and 719 kWh/year for mobile homes

Incentive

Residential Cool Roof Program

- SMUD provides an incentive of \$0.10 per square foot of steep slope roof surface and of \$0.20 per square foot of low slope roof surface

Shade Tree Program

- SMUD provides free 5-gallon deciduous trees (max. 10 per household), ties, stakes and expert advice on tree planting and care and free 15-gallon evergreen and deciduous trees for schools, parks and street trees.

Funding

The future ain't what it used to be. (Yogi Berra)

- **Pre 1996: Demand Side Management was resource, competing with supply side options (power generation)**
- **Post 1996: Public Goods funding mandates**
- **All electric utilities (investor owned utilities and public power utilities) must spend at least certain percentage of their gross revenues on public goods: energy efficiency, low income, research & development and renewable energy programs**

Thank you for making this day necessary (Yogi Berra)

I never said most of the things I said (Yogi Berra)

Lessons Learned

- ✓ **There are other more cost effective energy efficiency strategies for SMUD, but ...**
- ✓ **Programs valued highly by utility customers (i.e. Shade Tree program)**
- ✓ **Continuous program refinements in design & operation**
- ✓ **SMUD Board & Management made enduring commitment to Urban Heat Island mitigation efforts**
- ✓ **Involve local trade allies (roofing contractors, urban forestry organizations)**

For More Information

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- Visit www.SMUD.org
- (search under “shade tree” or “cool roof” in the search box)

