



# **Sacramento Municipal Utility District's (SMUD) Urban Heat Island mitigation efforts**

**2<sup>nd</sup> International Conference on  
Countermeasures to Urban Heat Islands  
September 21-23, 2009**

**“If you ask me a question I don't know, I'm not going to  
answer” Yogi Berra**

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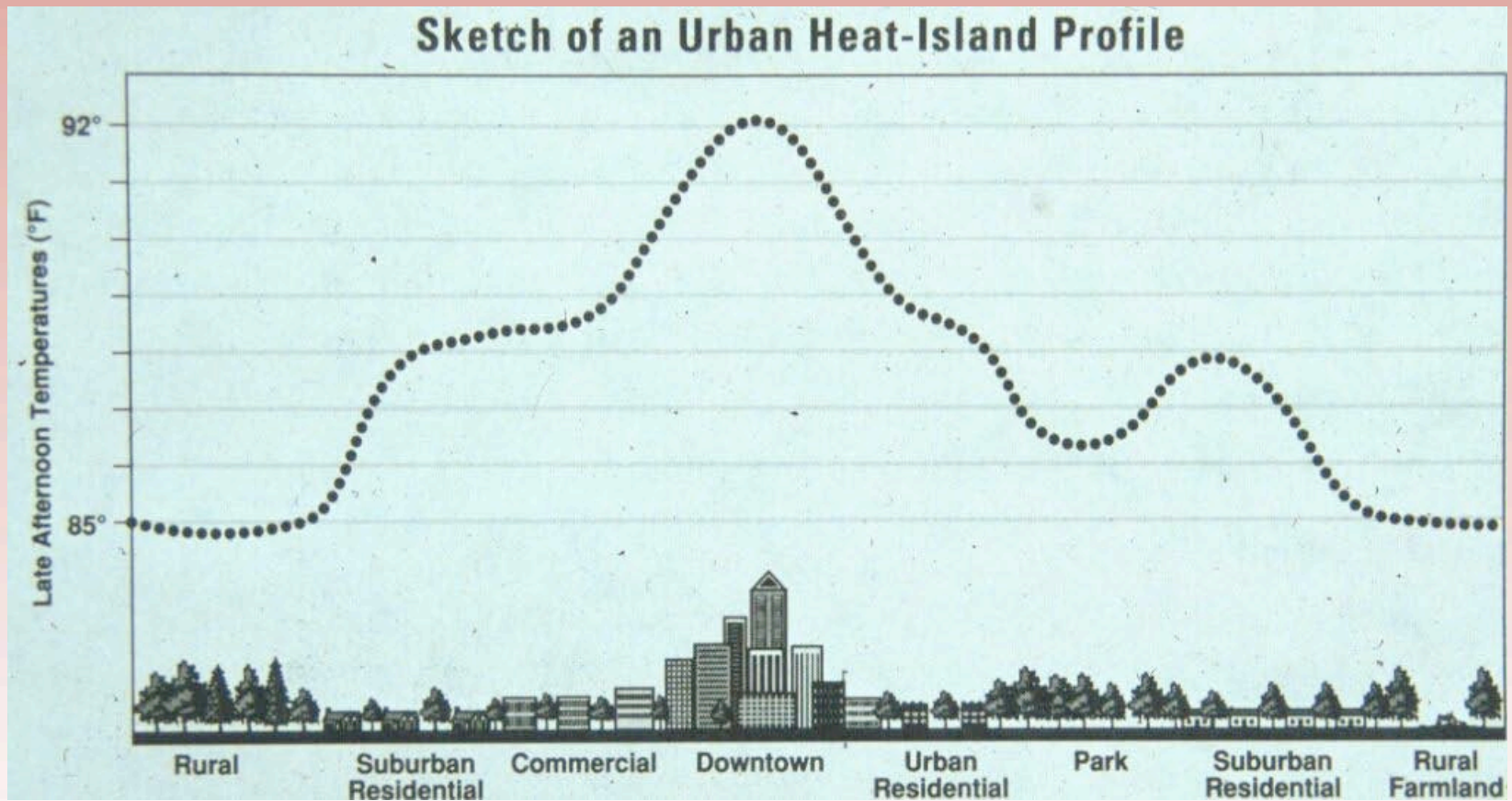


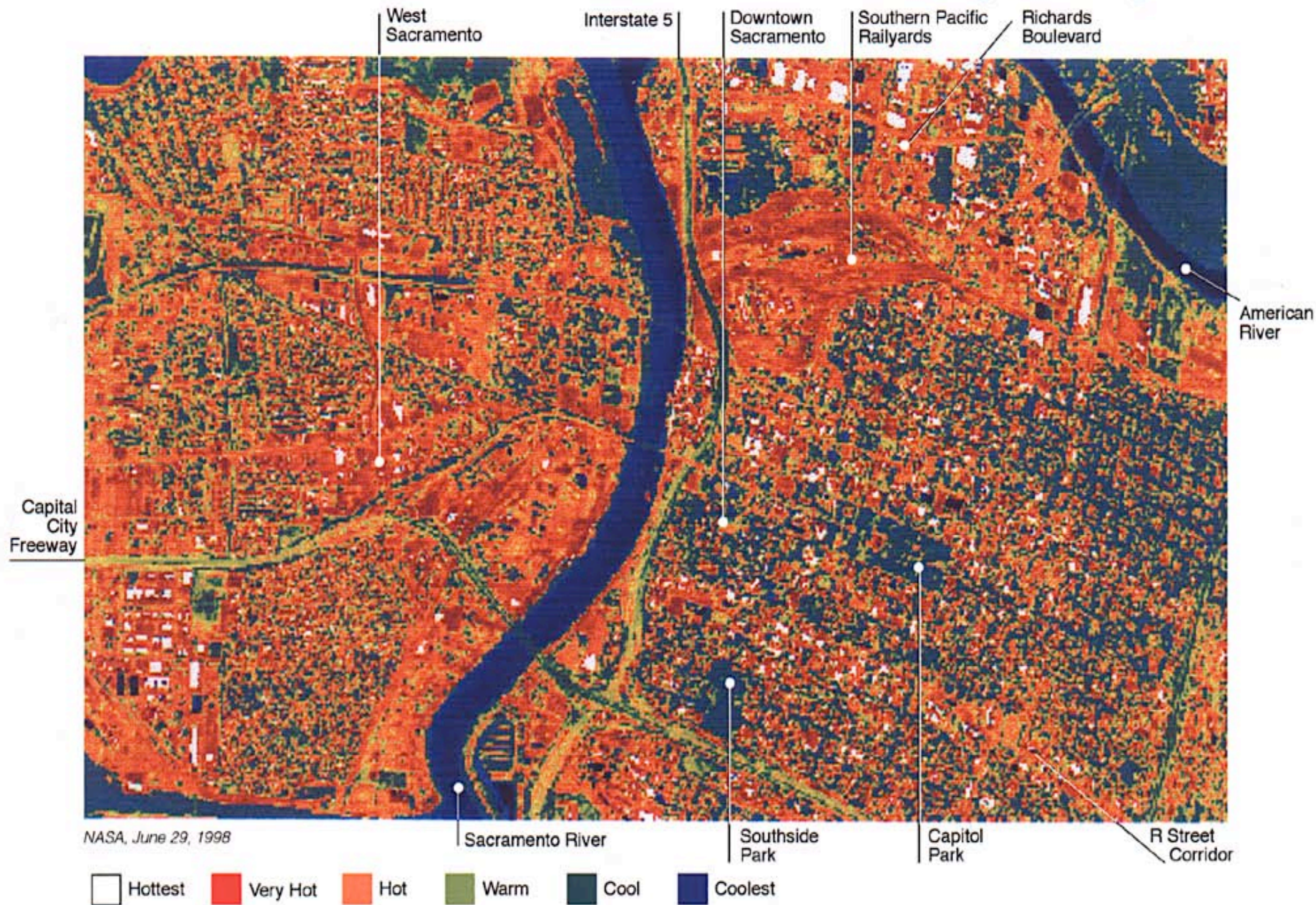


# What is SMUD?

- ❑ **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 2008**
- ❑ **2,226 full time employees**
- ❑ **589,599 customers in 2008**
- ❑ **1.4 million people in SMUD service area**
- ❑ **J.D. Powers – 2007 & 2008 best utility in the USA**

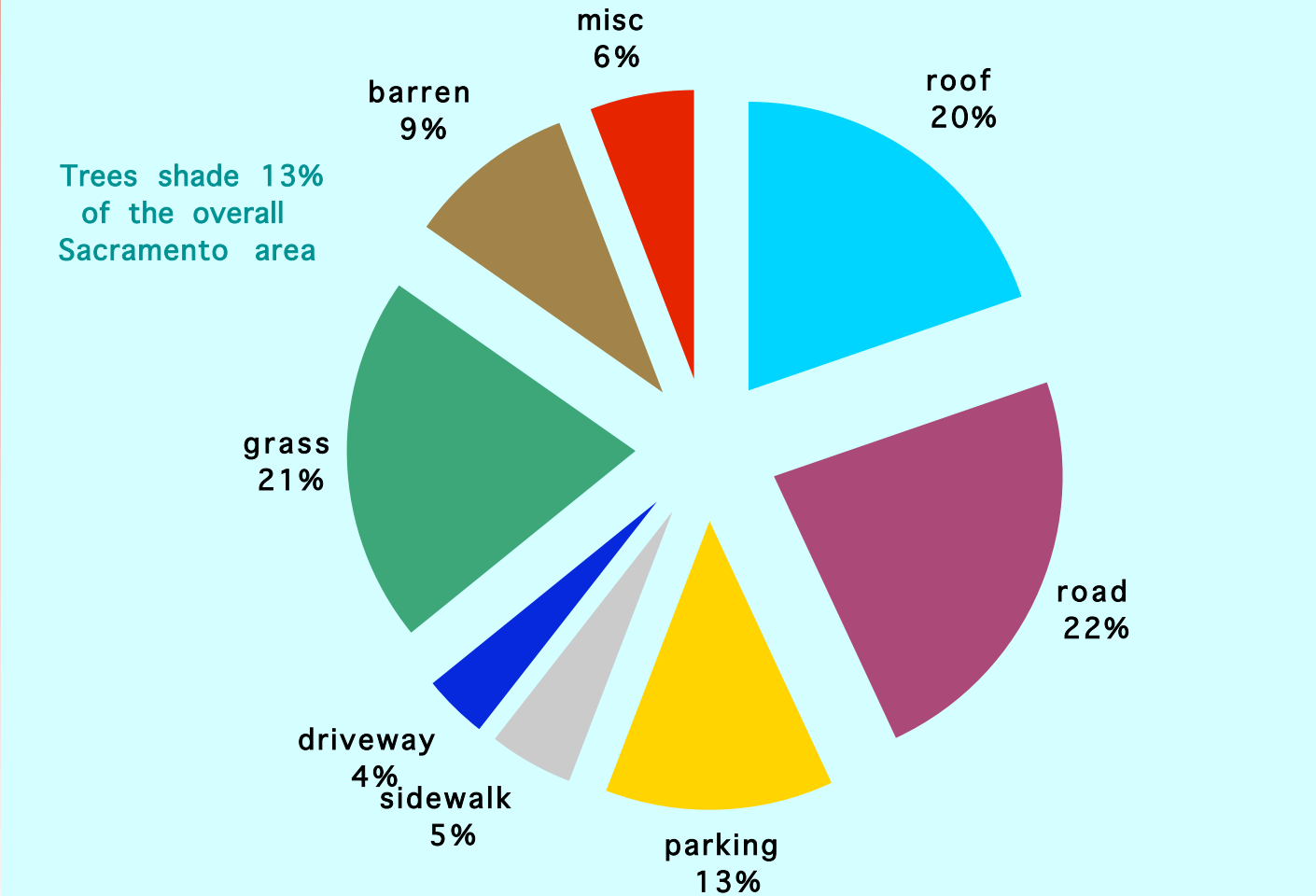
# Urban Heat Island Effect





# What's Hot and What's Not!

# Sacramento Land Cover Distribution





## **SMUD's Urban Heat Island mitigation efforts**

**✓ Increased Vegetation— SMUD's Shade Tree program (since 1990)**

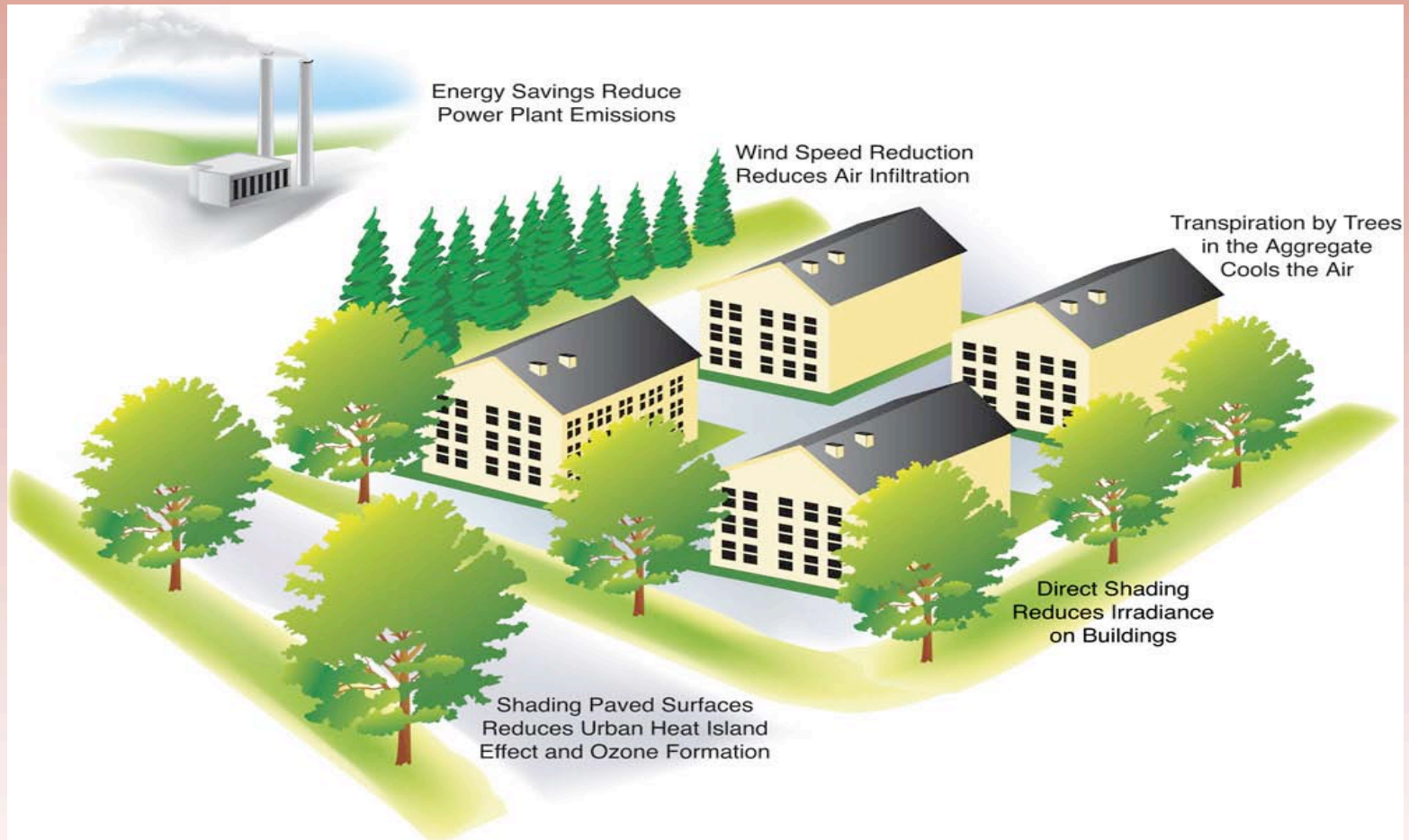
**Web site: SMUD.org**

**✓ Increased Roof's Albedo—SMUD's Cool Roof program (since 2001)**

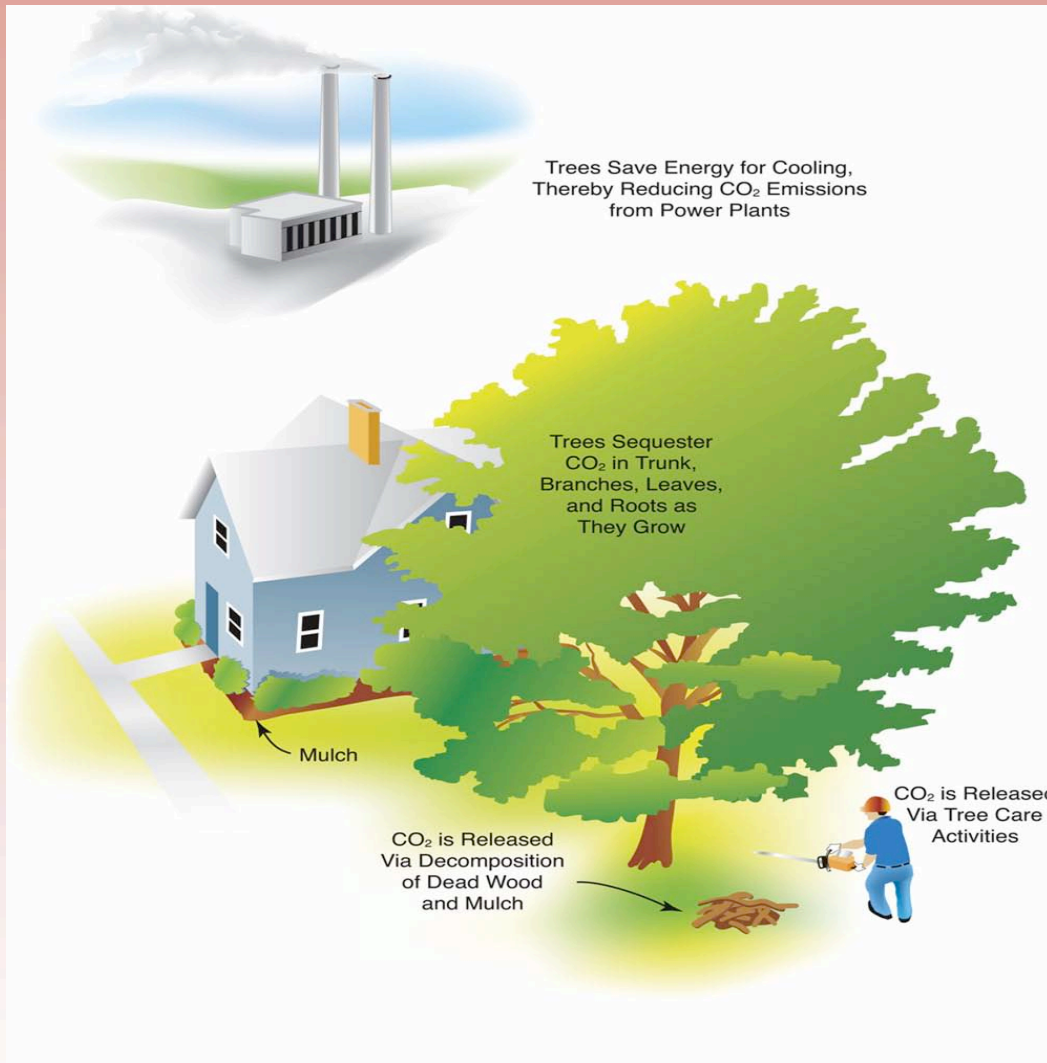
**Web site: SMUD.org**

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

# Energy Savings



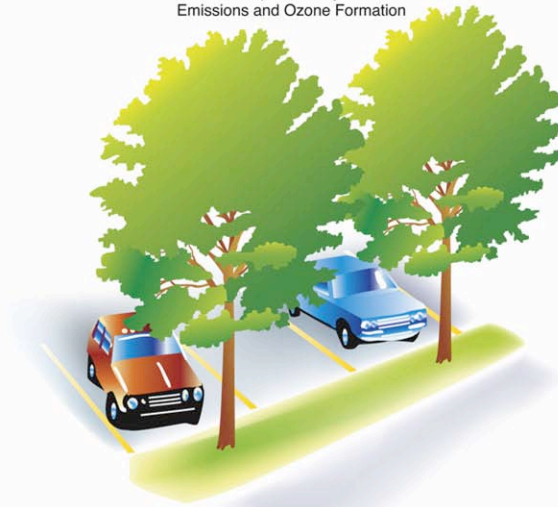
# Reducing Carbon Dioxide



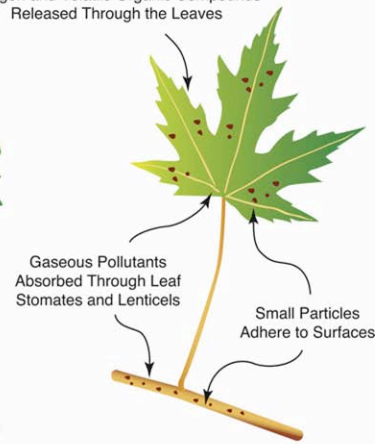


# Air Quality Improvements

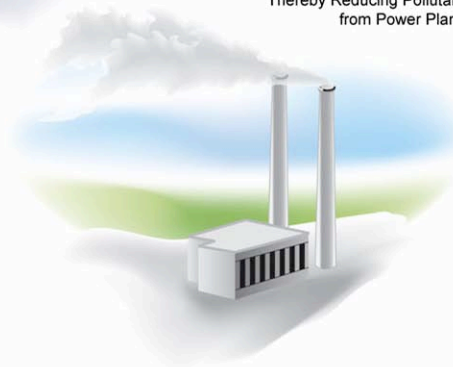
Shade on Paved Surfaces and Parked Cars Reduces Evaporative Hydrocarbon Emissions and Ozone Formation



Oxygen and Volatile Organic Compounds Released Through the Leaves



Trees Save Energy for Cooling and Heating, Thereby Reducing Pollutant Emissions from Power Plants





# 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.**

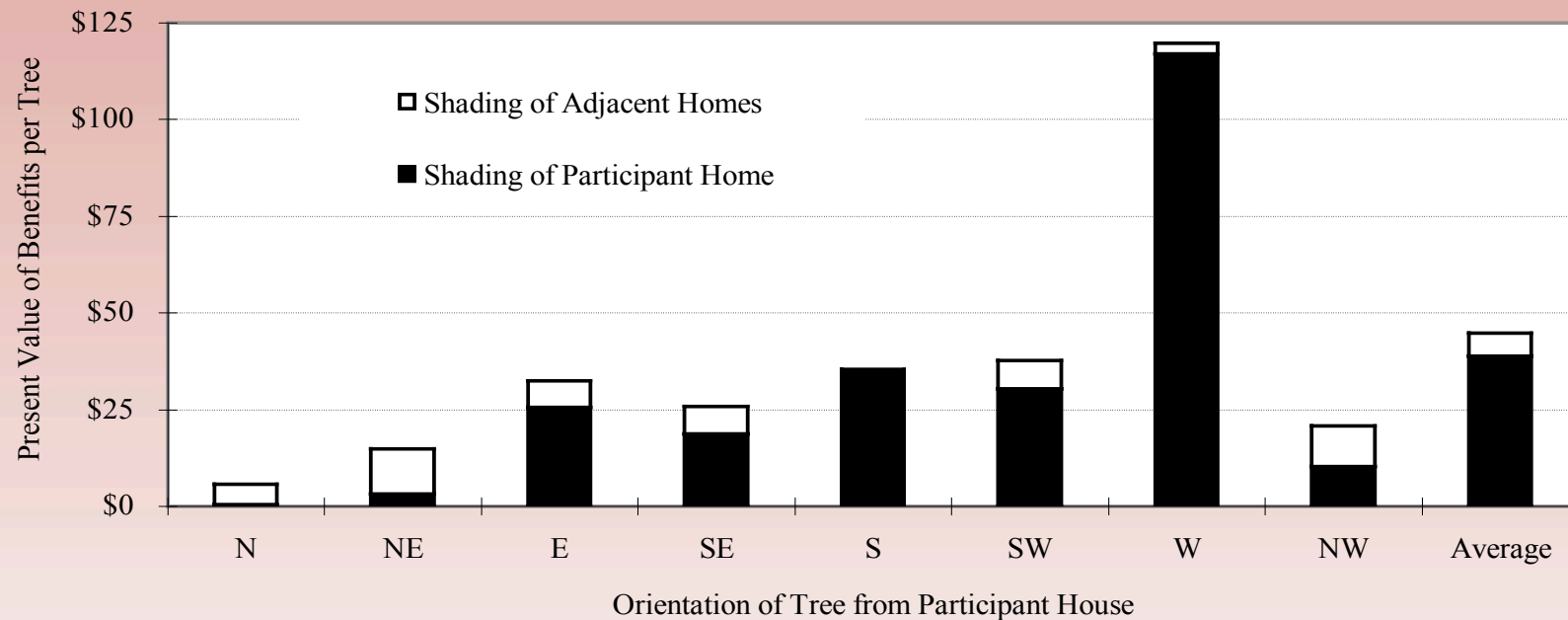


# SMUD Sacramento Shade

- **started in 1990**
- **implemented in collaboration with the local, non-profit, community based organization (Sacramento Tree Foundation ) -- STF is a contractor**
- **the program is 100% funded by SMUD**
- **Program provides free trees (5 gallon), stakes, ties, fertilizers and expert advice (STF)**
- **over 150,000 program participants**
- **over 450,000 trees planted**
- **annual budget over \$1.5 million**
- **over \$30 million invested since 1990**
- **received several national and state awards**

# SMUD Shade Tree Program

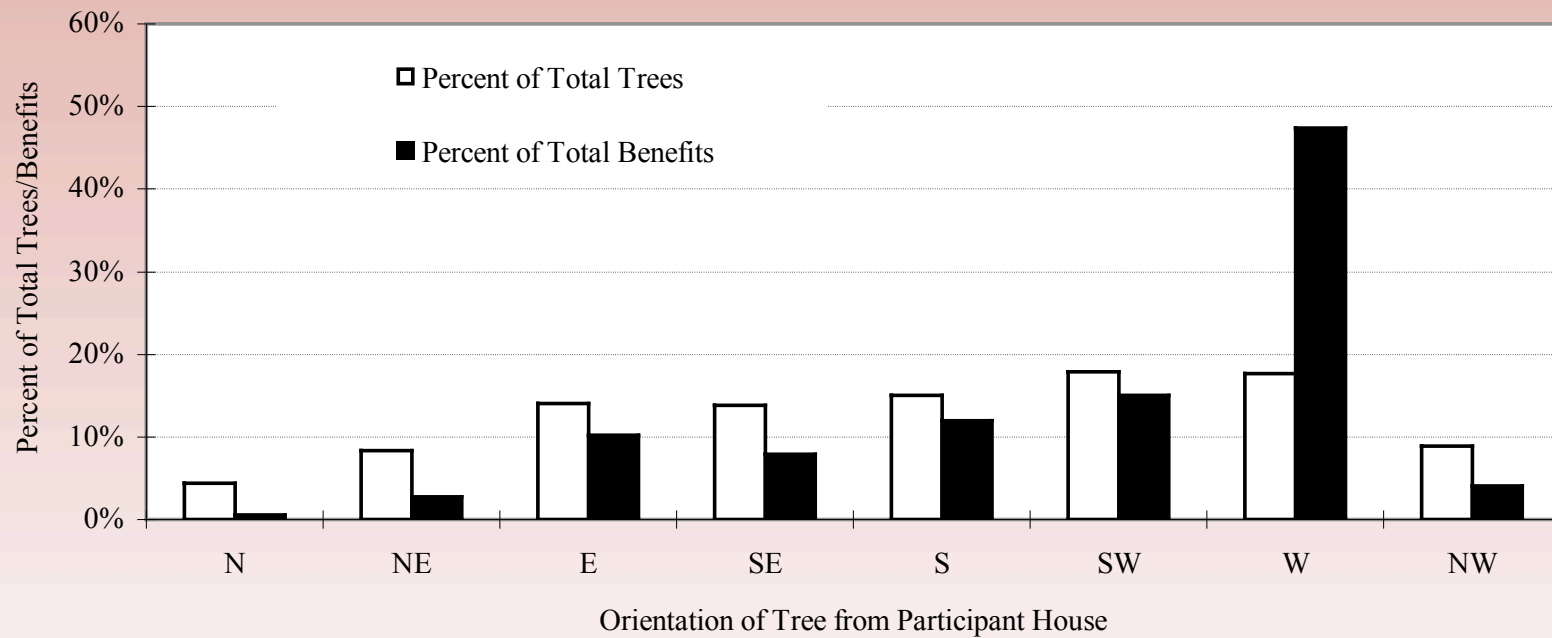
**Figure 1**  
**Total Average Present Value of Benefits (PVB) per Tree by Tree Orientation [1]**



[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

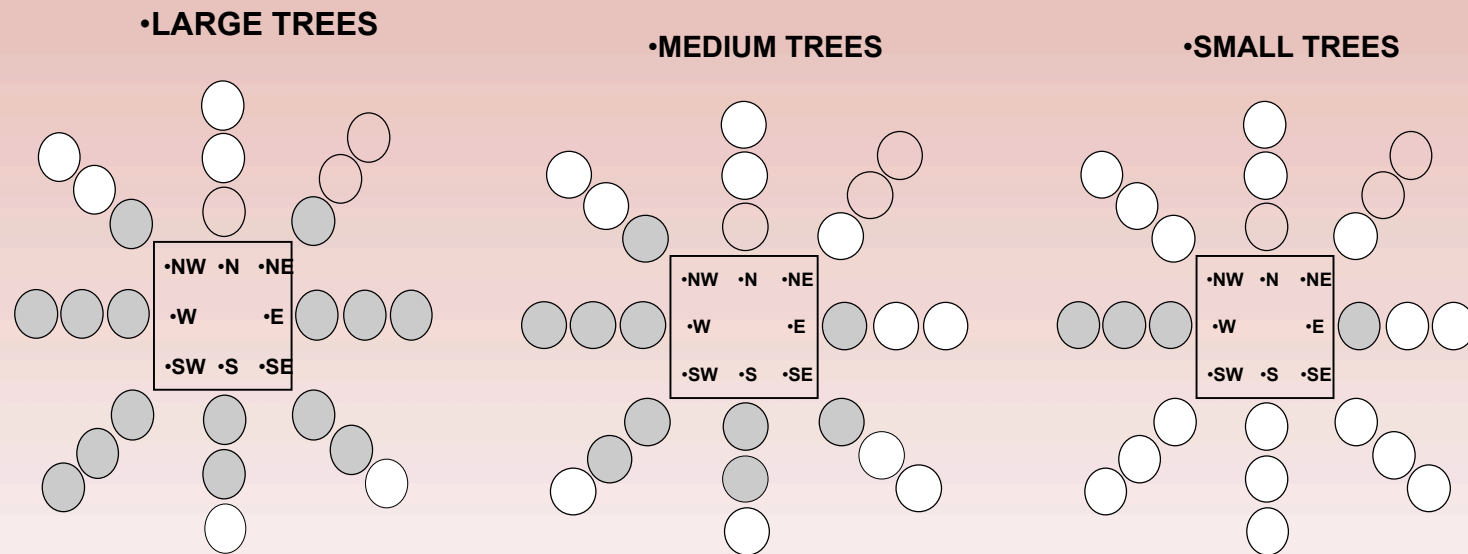
**Figure 2**  
**Percent of Total Trees Planted and Total Program Benefits by Tree Orientation**



# SMUD Shade Tree Program

•Figure 3

•What is Allowed Under the 1996 Tree-Siting Guidelines



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



# SMUD Community Shade

- **implemented in 1998 (trees for public places)**
- **implemented in collaboration with the Sacramento Tree Foundation (STF) -- STF is the contractor**
- **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 20,000 trees planted since 1998**
- **annual budget over \$300,000**
- **over \$2.5 million invested since 1998**



# Estimates of Savings

## Shade Tree Program

- **Average energy cooling load savings are 153 kWh/year/ per mature tree**
- **Average demand savings are 0.056 kW per mature tree**





# Tree Benefits Estimator

- **This free Web-based application can help utilities quantify and track the benefits of planting shade trees ([www.SMUD.org](http://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 Demand Side Management (DSM) utility practices.**



# Tracking the Benefits of Tree-Planting Efforts is Necessary

- It is increasingly important that power utilities not only take steps toward local environmental improvements, but measure the effectiveness of their efforts.
- The measurements are important to local communities in understanding how they can control their environmental future and the cost of doing so.
- It is also important for utilities to be able to measure environmental impacts that in the future may be reported to state and federal governments on a voluntary or mandatory basis.



# What You Need to Know About the Estimator

- **The Tree Benefit Estimator, developed by Sacramento Municipal Utility District (SMUD), was based on the experience of the SMUD's Shade Tree program.**
- **In developing this simplified and easy-to-use method for estimating the tree planting benefits, broad assumptions have been made regarding trees' impact on direct shading benefits, impacts of indirect or evapotranspiration effect, heating penalty in winter months, tree growth rates and tree survival rates.**

# 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

KWh Saved*	Direct Shading Annual KWh Saved*	Heating Penalty KWh Lost	Indirect Evapotranspiration Benefits	Total Summer Cooling Benefits	Total Winter Heating Penalty	Total Volume (m3) †*	Total Carbon Kg**	Stored CO2 Kg**	CO2 Seq./yr Kg**	Total Carbon Lbs**	Stored CO2 Lbs**	CO2 Seq./yr Lbs**
<b>Benefits From MATURE Tree:</b>												
1	45	30	0	\$ 8	\$ 7	8	2735	10039	98	6030	22128	216
<b>Benefits From Existing Tree of 20.0 DBH (incorporates tree age and tree growth rate):</b>												
1	23	16	0	\$ 4	\$ 4	1	285	1045	76	628	2304	168
<b>Benefits From Program Tree (trees planted by utilities) - utility perspective (incorporates tree growth rate and assumed tree mortality rate):</b>												
1	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(1988)

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

Close

# Tree Benefits Estimator results

Tree Benefits

Page 1 of 1

## Shade Trees: Estimated Benefits

**Climate Area:** Sacramento, Calif.  
**Heating Degree Days (HDD):** 2842  
**Cooling Degree Days (CDD):** 1157  
**Latent Enthalpy Hours (LEH):** 43  
**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:** \$ 0.105  
**Winter Rate:** \$ 0.105

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)**	Total Carbon Kg**	Stored CO2 Kg**	CO2 Seq/yr Kg**	Total Carbon Lbs**	Stored CO2 Lbs**	CO2 Seq/yr Lbs**
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### Benefits From MATURE Tree:

1	486	28	243	\$ 77	\$ 3	8	2735	10039	98	6030	22128	216
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### Benefits From Existing Tree of 20.0 DBH (incorporates tree age and tree growth rate):

1	252	14	126	\$ 40	\$ 2	1	285	1045	76	628	2304	168
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### Benefits From Program Tree (trees planted by utilities) - utility perspective (incorporates tree growth rate and assumed tree mortality rate):

1	144	8	72	\$ 23	\$ 1	2	535	1963	19	1179	4327	42
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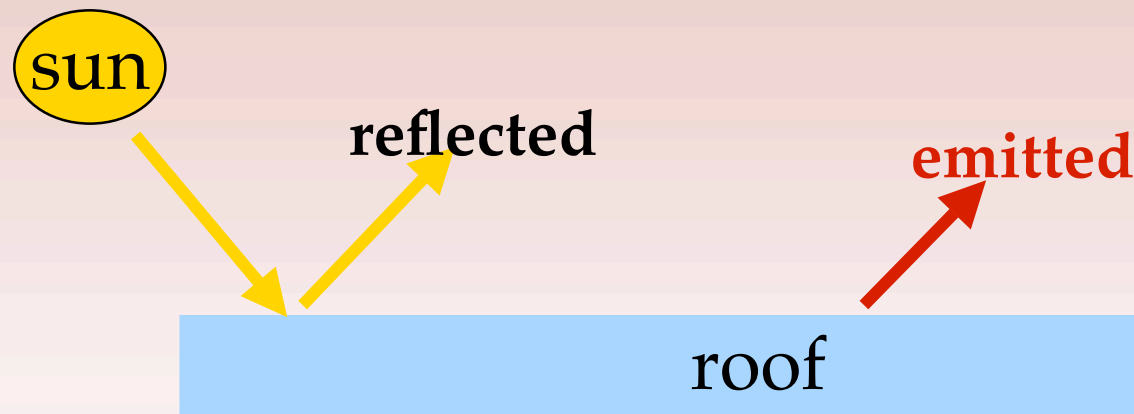
Source: SMUD & USDA Forest Service, Center for Urban Forest Research & Education, SMUD Shade Tree Program Impact Evaluation (1996)

\* 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



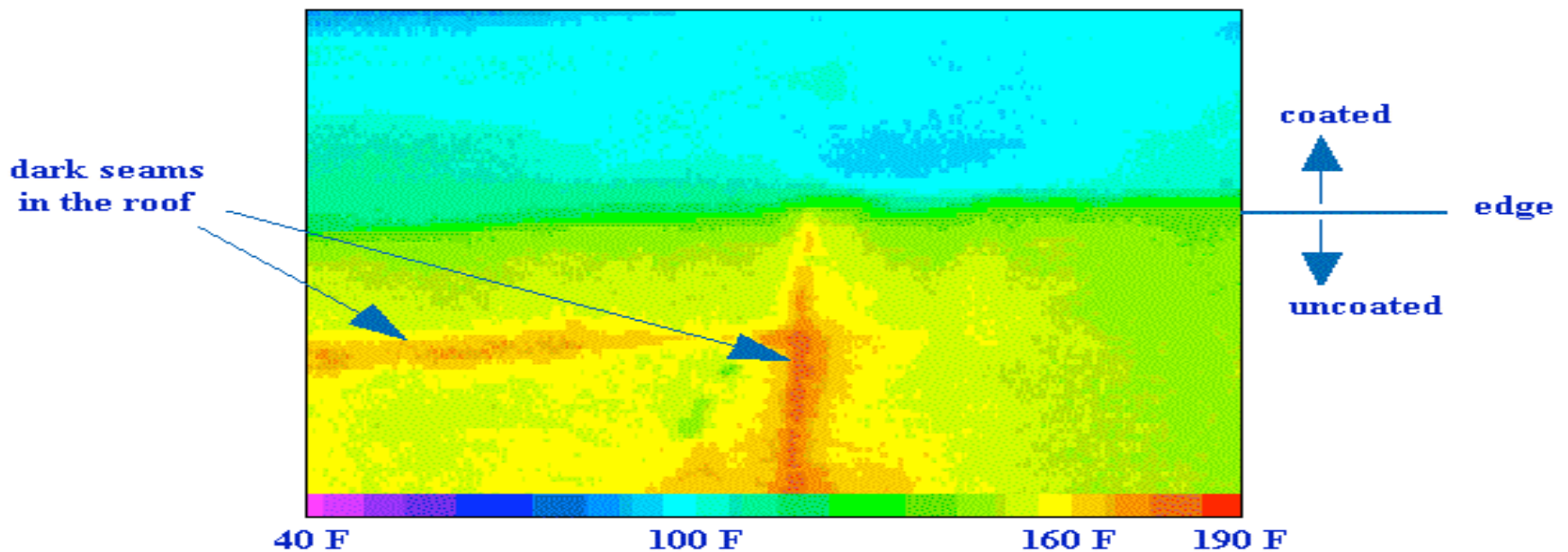


# White PVC 121°F



# 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

 **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

### 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

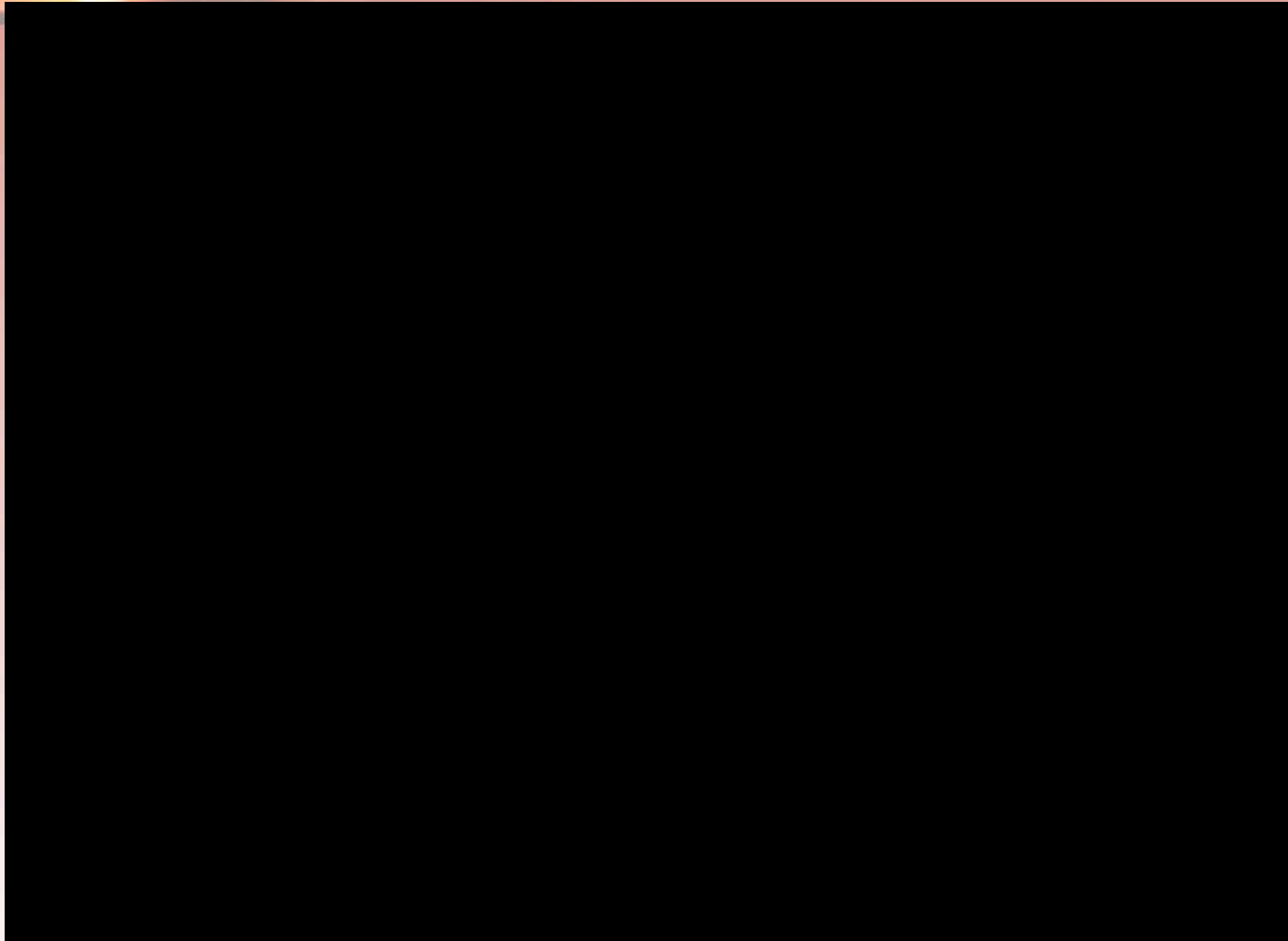


# Cool Roof Surfaces for steep-slope roofs

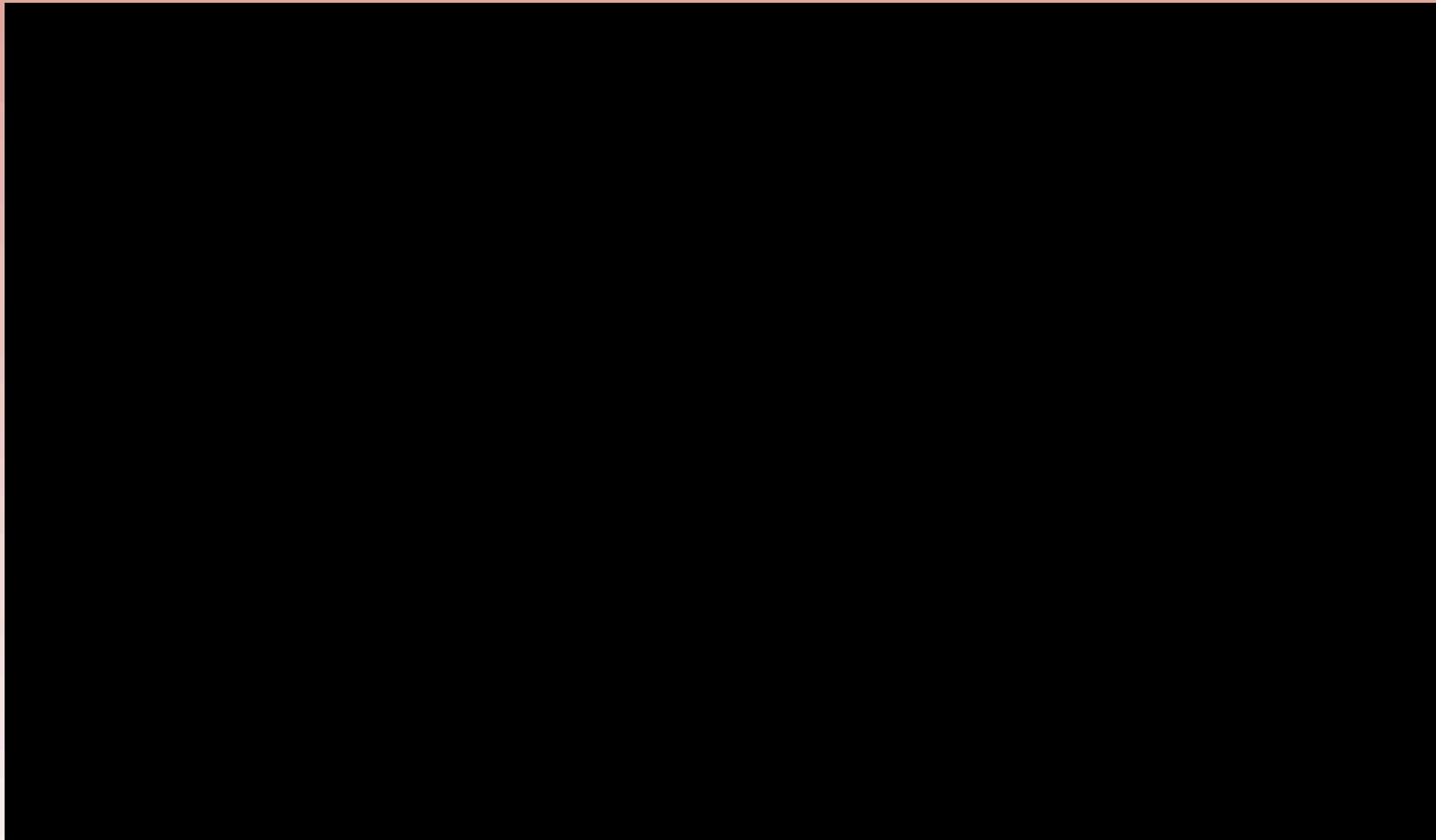
- Tile roofs (light weight light color concrete or clay tiles)**
- Coated metal roofs (elastomeric coatings)**
- Can be done in many different colors**
- More expensive than conventional asphalt shingle**



# 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%**
- **Average energy cooling load savings are 0.15 kWh/year•Sq.Ft.**
- **Average demand savings are 0.25 W/Sq.Ft.**



# 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 )**

## **Lessons Learned**

- ✓ **Cost effective strategies for SMUD**
- ✓ **Programs valued highly by utility customers**
- ✓ **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)**