BAY AREA
AIR QUALITY
MANAGEMENT
DISTRICT

ADVISORY COUNCIL
REGULAR MEETING

WEDNESDAY
MAY 13, 2015
9:00 A.M.

7TH FLOOR BOARD ROOM
939 ELLIS STREET
SAN FRANCISCO, CA 94109

AGENDA

CALL TO ORDER

1. Opening Comments — **Liza Lutzker, Chairperson**
Roll Call — **Clerk**

The Chairperson shall call the meeting to order and make opening comments. The Clerk of the Boards shall take roll of the Advisory Council members.

2. PUBLIC COMMENT ON NON-AGENDA MATTERS

Pursuant to Government Code Section 54954.3, the public has the opportunity to speak on any agenda item. All agendas for Advisory Council meetings are posted at the District, 939 Ellis Street, San Francisco, California 94109 at least 72 hours before a meeting. At the beginning of the meeting, an opportunity is also provided for the public to speak on any subject within the Advisory Council's purview. Speakers are limited to three minutes each.

Staff/Phone (415) 749-

3. APPROVAL OF THE MINUTES OF APRIL 8, 2015 — **Clerk of the Boards/5073**

The Advisory Council will consider approving the draft minutes of the Advisory Council Regular Meeting of April 8, 2015.

DISCUSSION

4. Discussion of Draft Report on the Advisory Council's Meetings on January 14, 2015, February 11, 2015, and March 11, 2015

S. Tanrikulu, Advisory Council Liaison/4787

The Advisory Council will discuss, finalize and consider approval of the draft report on the January 14, 2015, February 11, 2015, and March 11, 2015 meetings on "Urban Heat Island Effects on Energy Use, Climate, Air Pollution, Greenhouse Gases and Health."

5. Discussion of Advisory Council Presentation to the Board of Directors

S. Tanrikulu, Advisory Council Liaison/4787

The Advisory Council will discuss a presentation summarizing the Advisory Council's 2015 activities to the Board of Directors.

OTHER BUSINESS

6. Chairperson's Report **Liza Lutzker, Chairperson**

The Chairperson will provide the Advisory Council a report of recent and upcoming activities.

7. Advisory Council Member Comments/Other Business

Advisory Council members may make a brief announcement, provide a reference to staff about factual information or ask questions about subsequent meetings.

8. Time and Place of Next Meeting

Wednesday, June 10, 2015 at 9:00 a.m. at 939 Ellis Street, San Francisco, California 94109.

9. Adjournment

The Advisory Council meeting shall be adjourned by the Chairperson.

CONTACT:

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- To submit written comments on an agenda item in advance of the meeting. Please note that all correspondence must be addressed to the "Members of the Advisory Council" and received at least 24 hours prior, excluding weekends and holidays, in order to be presented at that Council meeting. Any correspondence received after that time will be presented to the Council at the following meeting.

- To request, in advance of the meeting, to be placed on the list to testify on an agenda item.

- To request special accommodations for those persons with disabilities notification to the Clerk's Office should be given in a timely manner, so that arrangements can be made accordingly.

Any writing relating to an open session item on this Agenda that is distributed to all, or a majority of all, members of the body to which this Agenda relates shall be made available at the District's offices at 939 Ellis Street, San Francisco, CA 94109, at the time such writing is made available to all, or a majority of all, members of that body.

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

939 ELLIS STREET, SAN FRANCISCO, CALIFORNIA 94109

FOR QUESTIONS PLEASE CALL (415) 749-5016 or (415) 749-4941

EXECUTIVE OFFICE:
MONTHLY CALENDAR OF AIR DISTRICT MEETINGS

MAY 2015

TYPE OF MEETING	DAY	DATE	TIME	ROOM
Advisory Council Regular Meeting *(Meets on the 2nd Wednesday of each Month)*	Wednesday	13	9:00 a.m.	Board Room
Board of Directors Executive Committee *(Meets on the 3rd Monday of each Month)* - **CANCELLED**	Monday	18	9:30 a.m.	Board Room
Board of Directors Personnel Committee *(At the Call of the Chair)*	Monday	18	9:30 a.m.	Board Room
Board of Directors Stationary Source Committee *(Meets on the 3rd Monday of each Month* **- CANCELLED**	Monday	18	10:30 a.m.	Board Room
Special Board of Directors Meeting - Budget Hearing *(At the Call of the Chair)*	Wednesday	20	9:45 a.m.	Board Room
Board of Directors Regular Meeting *(Meets on the 1st & 3rd Wednesday of each Month)*	Wednesday	20	9:45 a.m.	Board Room
Board of Directors Climate Protection Committee *(Meets on the 3rd Thursday of Every Other Month)*	Thursday	21	9:30 a.m.	Board Room
Board of Directors Budget & Finance Committee *(Meets on the 4th Wednesday of each Month)* **- CANCELLED**	Wednesday	27	9:30 a.m.	Board Room
Board of Directors Stationary Source Committee *(Meets on the 3rd Monday of each Month)*	Wednesday	27	9:30 a.m.	Board Room
Board of Directors Mobile Source Committee *(Meets on the 4th Thursday of each Month)*	Thursday	28	9:30 a.m.	Board Room

JUNE 2015

TYPE OF MEETING	DAY	DATE	TIME	ROOM
Board of Directors Regular Meeting *(Meets on the 1st & 3rd Wednesday of each Month)*	Wednesday	3	9:45 a.m.	Board Room
Board of Director Public Engagement Committee Meeting *(At the Call of the Chair)*	Thursday	4	9:30 a.m.	Board Room
Advisory Council Regular Meeting *(Meets on the 2nd Wednesday of each Month)*	Wednesday	10	9:00 a.m.	Board Room

JUNE 2015

TYPE OF MEETING	DAY	DATE	TIME	ROOM
Board of Directors Personnel Committee *(At the Call of the Chair)*	**Thursday**	**11**	**9:30 a.m.**	**Board Room**
Board of Directors Executive Committee *(Meets on the 3rd Monday of each Month)*	**Monday**	**15**	**9:30 a.m.**	**Board Room**
Board of Directors Stationary Source Committee *(Meets on the 3rd Monday of each Month)*	**Monday**	**15**	**10:30 a.m.**	**Board Room**
Board of Directors Regular Meeting *(Meets on the 1st & 3rd Wednesday of each Month)*	**Wednesday**	**17**	**9:45 a.m.**	**Board Room**
Board of Directors Budget & Finance Committee *(Meets on the 4th Wednesday of each Month)* **- CANCELLED**	**Wednesday**	**24**	**9:30 a.m.**	**Board Room**
Board of Directors Mobile Source Committee *(Meets on the 4th Thursday of each Month)*	**Thursday**	**25**	**9:30 a.m.**	**Board Room**

JULY 2015

TYPE OF MEETING	DAY	DATE	TIME	ROOM
Board of Directors Regular Meeting *(Meets on the 1st & 3rd Wednesday of each Month)*	**Wednesday**	**1**	**9:45 a.m.**	**Board Room**
Board of Directors Regular Meeting *(Meets on the 1st & 3rd Wednesday of each Month)*	**Wednesday**	**15**	**9:45 a.m.**	**Board Room**
Board of Directors Climate Protection Committee *(Meets 3rd Thursday of Every Other Month)*	**Thursday**	**16**	**9:30 a.m.**	**Board Room**
Board of Directors Executive Committee *(Meets on the 3rd Monday of each Month)*	**Monday**	**20**	**9:30 a.m.**	**Board Room**
Board of Directors Stationary Source Committee *(Meets on the 3rd Monday of each Month*	**Monday**	**20**	**10:30 a.m.**	**Board Room**
Board of Directors Budget & Finance Committee *(Meets on the 4th Wednesday of each Month)*	**Wednesday**	**22**	**9:30 a.m.**	**Board Room**
Board of Directors Mobile Source Committee *(Meets on the 4th Thursday of each Month)*	**Thursday**	**23**	**9:30 a.m.**	**Board Room**

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
Memorandum

To: Chairperson Liza Lutzker and Members
of the Advisory Council

From: Jack P. Broadbent
Executive Officer/Air Pollution Control Officer

Date: April 29, 2015

Re: Approval of the Minutes of April 8, 2015

RECOMMENDED ACTION

Approve the attached draft minutes of the regular meeting of the Advisory Council (Council) of April 8, 2015.

DISCUSSION

Attached for your review and approval are the draft minutes of the Council regular meeting of April 8, 2015.

Respectfully submitted,

Jack P. Broadbent
Executive Officer/APCO

Prepared by: Sean Gallagher
Reviewed by: Maricela Martinez

Attachment: Draft Minutes of the Council Regular Meeting of April 8, 2015

Draft Minutes – Advisory Council Regular Meeting of April 8, 2015

Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109
(415) 749-5073

DRAFT MINUTES

Advisory Council Regular Meeting
Wednesday, April 8, 2015

Note: An audio recording of the meeting is available on the website of the Bay Area Air Quality Management District at http://www.baaqmd.gov/The-Air-District/Board-of-Directors/Advisory-Council/Agendas-and-Minutes.aspx.

1. CALL TO ORDER

Chairperson Liza Lutzker called the meeting to order at 9:02 a.m.

Opening Comments: None.

Roll Call:

Present: Chairperson Liza Lutzker, M.P.H.; Vice-Chairperson Jessica Range, LEED A.P.; Secretary Jonathan Cherry, A.I.A.; and Members Sam Altshuler, P.E., Harold Brazil, Stan Hayes, Kraig Kurucz, Rick Marshall, P.E., P.L.S., SaraT L. Mayer, M.P.P., and Laura E. Tam.

Absent: Members Ana M. Alvarez, D.P.P.D., Robert Bornstein, Ph.D., Frank Imhof, Bruce Mast and Timothy O'Connor, Esq.

Also Present: None.

2. PUBLIC COMMENT ON NON-AGENDA MATTERS: No requests received.

3. APPROVAL OF THE MINUTES OF MARCH 11, 2015

Advisory Council (Council) Comments: None.

Public Comments: No requests received.

Council Action:

Member Cherry made a motion, seconded by Member Altshuler, to approve the minutes of the Council meeting of March 11, 2015; and the motion carried by the following vote of the Council:

AYES:	Altshuler, Brazil, Cherry, Hayes, Kurucz, Lutzker, Marshall, Mayer, Range and Tam.
NOES:	None.
ABSTAIN:	None.
ABSENT:	Alvarez, Bornstein, Imhof, Mast and O'Connor.

DISCUSSION

4. Discussion of Council Presentation to the Board of Directors (Board) (Out of Order Agenda Item 5)

Council Comments:

The Council and staff deliberated upon proposed revisions to the draft presentation to the Board on Council activities in 2014.

Public Comments: No requests received.

Council Action:

Chairperson Lutzker made a motion, seconded by Member Range, to approve the presentation of to the Board on Council activities in 2014, as amended at today's meeting; and the motion carried by the following vote of the Council:

AYES:	Altshuler, Brazil, Cherry, Hayes, Kurucz, Lutzker, Marshall, Mayer, Range and Tam.
NOES:	None.
ABSTAIN:	None.
ABSENT:	Alvarez, Bornstein, Imhof, Mast and O'Connor.

5. Discussion of Draft Report on the Council's Meetings on January 14, February 11, and March 11, 2015 (Agenda Item 4)

Council Comments:

The Council and staff deliberated upon proposed revisions to the draft report on the Council meetings on January 14, February 11, and March 11, 2015.

Public Comments: No requests received.

Council Action: None; receive and file.

OTHER BUSINESS

6. Chairperson's Report:

Chairperson Lutzker announced the Council members attending the upcoming Air & Waste Management Association's 108th Annual Conference and Exhibition on June 22-25, 2015, in

Raleigh, North Carolina; requested an update on the Council transition plan at the next Council meeting; and suggested the presentation to the Board on Council activities in 2015 be prepared by the report writing work group.

7. Council Member Comments / Other Business:

The Council and staff discussed agendizing a discussion of a draft presentation to the Board on Council activities in 2015 for the Board meeting in May 2015 and logistics relative to finalizing the presentation to the Board on Council activities in 2014.

8. Time and Place of Next Meeting

Wednesday, May 13, 2015, Bay Area Air Quality Management District Headquarters, 939 Ellis Street, San Francisco, CA 94109 at 9:00 a.m.

9. Adjournment: The meeting adjourned at 11:48 a.m.

Sean Gallagher
Clerk of the Boards

AGENDA: 4

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
Memorandum

To: Chairperson Liza Lutzker and Members
of the Advisory Council

From: Jack P. Broadbent
Executive Officer/Air Pollution Control Officer

Date: May 6, 2015

Re: Discussion of Draft Report on the Advisory Council's Meetings on January 14, 2015, February 11, 2015, and March 11, 2015

The draft report of the January 14, 2015, February 11, 2015, and March 11, 2015, Advisory Council Meetings on Urban Heat Island Effects on Energy Use, Climate, Air Pollution, Greenhouse Gas and Health will be discussed, finalized and considered for approval.

Respectfully submitted,

Jack P. Broadbent
Executive Officer/APCO

Prepared by: Saffet Tanrikulu
Reviewed by: Jean Roggenkamp

Attachment: Draft Report of the Advisory Council's Meetings on January 14, February 11 and March 11, 2015.

EXECUTIVE SUMMARY

This report summarizes activities of the Advisory Council during January-May 2015, consolidating three presentations received, and subsequent discussion and consideration by Council members during this period.

The following presentation was made at the January 14, 2015 Advisory Council meeting:

> *BAAQMD [Bay Area Air Quality Management District] Urban Forestry Overview* by John Melvin, State Urban Forester, California Department of Forestry and Fire Protection (CAL FIRE), Sacramento, CA.
>
> An audio recording of this presentations and the Council's discussion can be reviewed at http://75616d429db7e15d2a6a-9e30cedb57e7d60eeae8665296278a13.r83.cf2.rackcdn.com/AC%20011415.MP3

The following presentation was made at the February 11, 2015 Advisory Council meeting:

> *The Urban Heat Island In Coastal/Urban Environments* by Jorge E. Gonzalez, PhD, NOAA CREST Professor, The City College of New York (in absentia). Presentation given by Member Bob Bornstein, PhD, Professor of Meteorology, San Jose State University, on behalf of Professor Gonzalez.
>
> An audio recording of this presentations and the Council's discussion can be reviewed at http://75616d429db7e15d2a6a-9e30cedb57e7d60eeae8665296278a13.r83.cf2.rackcdn.com/AC%20021115.MP3

The following presentation was made at the March 11, 2015 Advisory Council meeting:

> *Urban Heat Island Effects on Energy Use, Climate, Air Pollution, and Greenhouse Gases* by Ronnen Levinson, PhD, Staff Scientist, Heat Island Group, Lawrence Berkeley National Laboratory, Berkeley, CA.
>
> A video recording of this presentations and the Council's discussion can be reviewed at http://baaqmd.granicus.com/MediaPlayer.php?publish_id=db060b7b-c83c-11e4-b5ce-00219ba2f017

The Advisory Council was presented information on the definition of an Urban Heat Island (UHI) and on the causes and impacts of excess heating and slow cooling, including localized temperature increases which cause direct health effects, increased formation of ozone, and increased energy usage for cooling. Causes of the UHI effect include the replacement of moist permeable ground with tall, dark structures, dark-colored roofs, and dark-colored streets; and the loss of moisture and shade from loss of trees and vegetation. Solutions were explored, including use of more reflective roofs and the planting of trees to provide urban cooling.

Some key points identified by the Advisory Council were:

1. While localized temperature increases are most relevant for local pollution and heat, consideration of ozone precursor transport downwind from areas with increased localized temperatures needs to be considered.
2. Trees can help cool an area and provide health and property value benefits.
3. It remains to be determined whether the investment required to achieve air quality benefits via urban cooling strategies represents the most cost-effective pathway to achieving those benefits.

While further research is required to quantify the geographical variation in air quality benefits of future urban cooling strategies, urban forests and photovoltaic systems offer important co-benefits regardless of geography. Likewise, cool roofs offer important co-benefits for buildings with significant cooling loads. These co-benefits provide grounds for the Air District to take initial steps in promoting these measures in specific geographies, pending further research into the magnitude of air quality impacts.

Specifically, the Advisory Council recommends that the Air District:

1. Provide technical support to local governments to include air quality criteria into their street tree selection processes. Criteria should include carbon sequestration capacity, VOC emissions, potential for PM capture, and allergenicity.
2. Collaborate with local governments with warmer climates to incorporate cool roof requirements into their local building codes. The Air District can add value to this effort by highlighting associated air quality benefits.
3. Communicate benefits of urban cooling measures as part of geographically-targeted public education campaigns.

BACKGROUND

Member Bob Bornstein, PhD standing in for Jorge E. Gonzalez, PhD, NOAA CREST Professor, The City College of New York

1. An Urban Heat Island (UHI) is a relative term: it compares temperatures of urban areas to those of surrounding areas.
2. The nature of the UHI effect varies greatly by city, by time of day and season, and by prevailing meteorological conditions, such as wind speed and direction.
3. An UHI typically extends from the earth's surface up to about 300-400 meters.
4. Some UHI effect is about a city getting hotter, but a larger part is about it not being able to cool at night.
5. There are five major factors that contribute to UHI development:
    a. Vegetation: less shading from trees and less evapotranspiration from vegetation increases the sensible heat going into the atmosphere.
    b. Lower surface albedo/solar reflectance of dark urban roofs, roads, and walls.

c. Geometry of tall buildings: traps outgoing heat energy at night.
d. Polluted air absorbs longwave radiation released from the surface of earth and emits it back to the earth.
e. Anthropogenic heat sources (e.g., cars, air conditioning, industry).

6. High urban temperatures lead to four types of problems:
   a. Increased ozone due to an accelerated rate of photochemical formation reactions. (In general, a 1°C increase results in a 2 ppb ozone increase. This is relative to the 75 ppb National Ambient Air Quality Standard for 8-hour ground-level ozone.) Additional increases in ozone are possible due to increased emission of precursors, depending upon urban vegetation coverage.
   b. Increased heat-related illness, including heat stress, cardiovascular disease, stroke, renal failure, and diabetes.
   c. Increased emission of pollutants and precursors associated with increased electrical energy production due to increased demand for air conditioning.
   d. Contribution to global warming.
7. Dr. Bornstein presented urban cooling strategies, including urban greening, increasing the albedo of building and construction materials, smart urban planning (e.g., land use planning, ventilation, shading), and increasing energy efficiency/ decreasing energy use (to reduce anthropogenic heat). Models run for certain cities (i.e., Sacramento and Houston) confirm the success of these approaches.
8. Roofs tend to be the hottest part of urban areas during the day, while roads are the hottest at night.
9. When considering the long-term spatial variation in the UHI effect, it is important to account for the geographical diversity of the Bay Area. For example, modeling results indicating that low elevation areas of the Bay Area, especially valleys and coastal areas, are expected to cool during summer daytime periods, and not warm as climate change proceeds. This could reduce air conditioning demand. Coastal cooling needs to be better understood to determine if it constitutes an important consideration in crafting long-term urban cooling strategies.

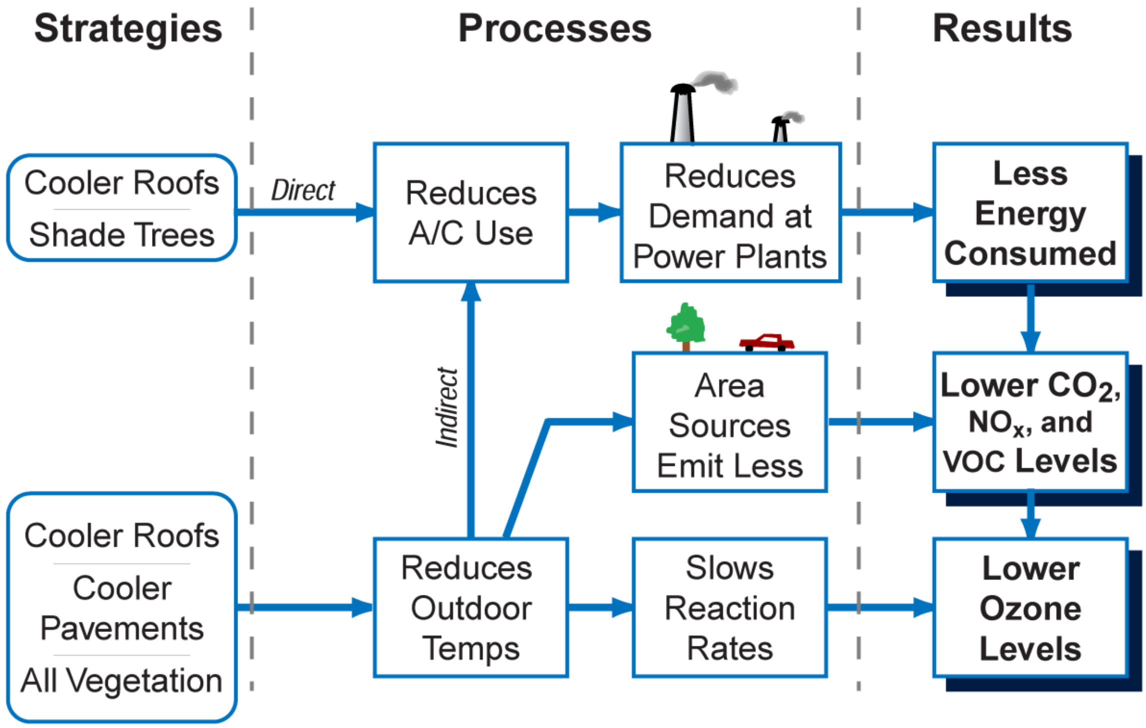
Ronnen Levinson PhD Staff Scientist, Lawrence Berkeley National Laboratory, Heat Island Group

Dr. Levinson's presented information primarily concerned with the daytime summer UHI effect.

Urban Cooling Strategies Background

1. Dr. Levinson presented four urban cooling strategies: (1) cooler roofs (including reflective and vegetation roofs), (2) cooler pavements, (3) shade trees, and (4) all vegetation (see Fig. 1). These strategies have the ultimate effects of lowering energy use, reducing pollutant emission, and reducing secondary pollutant formation. (Note that smart urban planning and energy efficiency are strategies not covered in the figure, and reducing heat-related illness is a benefit not mentioned.)

Figure 1. Cool Strategies and their Results



2. Work is currently being done on a 5th "cool strategy": cooler walls.

Roof Albedos

3. Albedo, also known as Solar Reflectance (SR), measures the fraction of incident sunlight reflected by a surface. Also relevant is Thermal Emittance (TE), a measure of a surface's efficiency of emitting thermal radiation (or heat) versus absorbing that heat. A helpful example to distinguish between SR and TE is white painted vs. unpainted metal: both have high albedos (or SRs), but the unpainted metal has a much lower TE (it will feel hot to the touch).
4. The most common type of roofing for residential buildings is asphalt shingle, which typically has a low albedo, around 5%. White roofs (now required on all large industrial buildings per Title 24), have an albedo around 80% when brand new, but the albedo drops to 55-65% after about three years of use (the roof material simply gets dirty). After three years, the albedo stabilizes and stays relatively constant for the remaining life of the roof.
5. The Heat Island Group at Lawrence Berkeley National Laboratory (LBNL) has mapped the average albedo of every roof in seven California cities. In no city did the mean albedo exceed 20%, a typical gray reflectance. Both San Francisco and San Jose had a mean albedo of 18%. Great potential exists to increase average roof albedo.
6. While white roofs have high albedos, American preference remains for darker roof colors on residential buildings. Several strategies are thus being developed to increase albedo, while keeping roofing material relatively dark in color. Three possible strategies for California are:

a. Using coatings that absorb light in the visible spectrum, but that reflect light in the near infrared (NIR) and also fluoresce (see Glossary). One such coating is created by using ruby (Cr_2O_3) pigments. While this approach is highly effective (it creates visibly dark tiles with a 60% albedo), it is currently expensive to manufacture and install.
b. A less expensive approach is to create modified asphalt shingles using a white synthetic "rock" (limestone, or $CaCO_3$) that is mixed with a pigment during formation to lie atop the asphalt. By virtue of being combined with the limestone during synthesis, the colored coating gives the shingle a dark look. At the same time, the whiteness of the limestone is opaque enough to protect the underlying asphalt, but is reflective enough to boost the albedo to 30-40%. An ancillary benefit of these shingles is that they also can capture CO_2 in the manufacture of synthetic rock granules.
c. A third approach is a vegetation roof, or a "green roof". Although vegetation is not reflective, it is cool due to high evapotranspiration and high thermal emittance (TE). However, green roofs are often expensive, have high maintenance costs, and are too heavy for the sub-roof structure of many homes in California.

Effects of Changing Roof and Pavement Albedo

7. Climate modeling of a hot, high-ozone day in the Bay Area by H. Taha (2013) predicts that by increasing all roof albedos by 25-55% and all pavement albedos by 22-27%, temperatures can be reduced by up to 1°C and ozone can be lowered by 2-6 ppb, using emissions estimates from 2000. (Note that present day reductions in ozone would more likely be on the lower end of this range due to reductions in ozone-precursor emissions today compared to 15 years ago.) These changes in albedo are achievable with current technology, especially in the case of roofs.
8. Energy use was compared for two similar side-by-side homes in Fresno with different roof types: one used older style asphalt shingles and the other new high-albedo tiles. The new roof used less energy for cooling (as well as for heating). The annual cost savings was $170/year, about 25% of the cooling energy costs. Additionally, the high albedo roof resulted in an estimated annual power-plant emission savings of 307 kg CO_2, 117g NO_x, and 8.7g SO_2 (though this assumes some power is being generated at non-California power plants).
9. Numerous California schools are effectively using cool color coatings on pavement in their schoolyards to make play more comfortable in warm climates. This technique is especially important in areas using a year-round school calendar.

Title 24 Requirements and Related Incentives

10. Part 6 of the California Building Standards Code (Title 24) establishes standards to address the energy efficiency of new (and altered) buildings. Title 24 standards impose requirements for roofs on residential and non-residential buildings that vary by climate zone (see California Climate Zone map at: http://www.energy.ca.gov/maps/renewable/building_climate_zones.html).
    a. All non-residential buildings (regardless of climate zone) must meet certain cool roof standards. These stringent standards for the majority of non-

residential buildings require a roofing material with a minimum albedo of 63% (unless the roof is highly sloped, in which case the minimum prescribed albedo is 20%).

b. Residential buildings are held to a much lower standard under Title 24 and the regulations are specific to climate zone. Although some residential roofs are held to the 63% minimum albedo requirement, these are limited to the two hottest California climate zones, neither of which is in the Bay Area. The 20% minimum albedo requirement is also limited by: (a) climate zone – only a portion of the Bay Area is covered in this requirement (climate zone 12, primarily encompassing eastern Contra Costa, Alameda, and Solano Counties,), and (b) roof slope – only highly sloped roofs are covered by this requirement (though most residential roofs qualify as high slope).

11. To meet Title 24 requirements for roof materials, products must be rated based on their "aged" performance over three years of "natural exposure" to determine their relevant albedo and thermal reflectance values. In the past, it has taken three years to bring a material to market. However, LBNL has developed a ~$16,000 laboratory process that simulates the aging process, allowing a roof material to "age by 3 years" in less than three days. The US Cool Roof Rating Council has approved this laboratory method as an interim roof material rating process for Title 24 Standards for new construction. This means that, during three years of waiting for "true" test results, these lab results can stand in as sufficient evidence of a roofing material meeting the appropriate standards, thus allowing for new cool roofing material to be brought to market faster.

Cool Roofs and Solar Photovoltaic (PV)

12. Typically, PV panels absorb 60-70% of solar radiation (this includes the 5-15% conversion to electricity) and reflects about 25% of solar radiation. Note that this solar reflectance, or albedo, exceeds any Title 24 residential requirements that might apply to the Bay Area.
13. PV is a good strategy and should not be abandoned in favor of cool roofs. While a 25% albedo is higher than that of most standard roofs, a "cooling penalty" is associated with PV because roof albedo without the PV could be higher. However, this cooling penalty is negligible compared to the benefits of clean power generation.

Local Action on Urban Cooling

14. From an energy and air pollution perspective, urban cooling strategies will be most important in areas that: (a) have a real summer, i.e., see map for climate zones 2 (blue), 4 (magenta) and 12 (orange); and (b) have an air pollution (or precursor) issue.
15. Actions are already being taken by governments in California. At the state level, this includes cool pavement legislation (AB 296) and stricter cool roof requirements in the 2013 revision of Title

24. Some local jurisdictions are putting into place requirements and practices more stringent than by the State. This is only important for jurisdictions having either of the considerations in #14 above.
16. Resources exist to help local governments create cool communities and develop best policies around UHI effects. These include CoolCalifornia.org and CoolRoofToolkit.org.

John Melvin, State Urban Forester, CAL FIRE

Trees as an Urban Cooling Strategy in the Bay Area

1. Tree canopy cover in the Bay Area ranges from 12-20% (with 14% in San Francisco and 15% in San Jose), but is often driven by large open spaces (e.g., Golden Gate Park), rather than trees interspersed in inhabited areas. For reference, the average national urban forest canopy cover is 21%; Portland's cover is 42%, New York City's is 24%, Sacramento's is 27%, and Chicago's is 17%.
2. Currently, most cities (including San Francisco) have a declining canopy, as they lose more trees annually than are planted.
3. Urban forests cool urban areas in two ways. First, the evapotranspiration of plants diverts sensible heat from going into the air. Second, the tree canopy itself provides shade to directly decrease ground surface temperature.
4. Not only do trees reduce temperature, they also reduce the length of time that heat is present throughout the day.

Other Benefits of Urban Forests

5. Urban forests have multiple benefits, including carbon sequestration, improved air quality (through deposition of PM on leaves), storm-water capture, water quality improvement, increased property values, and reduced energy use.
6. The benefits of the Bay Area's urban forest are estimated as $5.1 billion per year. Further, a 3% increase in the Bay Area's urban canopy is projected to increase benefits by an additional $475 million per year.

Considerations in Choosing Trees to Plant

7. Despite the multiple long-term benefits of increasing urban forests, the short-term costs and ongoing maintenance costs often make it difficult for local jurisdictions to decide to plant more trees. However, a tree that is well established in its first five years will cost very little to maintain over the course of its life.
8. Health and air quality considerations for choosing tree species to plant include a species' carbon sequestration capacity, level of VOC emissions, pollen allergenicity, size and density of canopy for providing shade (UHI reduction), and leaf surface areas for collecting PM. Other considerations include a species' water requirements, stormwater capture capacity, fruit and flower debris, maintenance requirements, and sidewalk damaging potential.
9. While it is important to analyze individual tree species' characteristics when selecting trees for an urban forest, it is more important to select a wide diversity of trees for a healthy urban forest ecosystem.

10. Tools exist and technical assistance is available to help jurisdictions choose the appropriate trees/mix of trees to plant given siting and other goals. Example tools include http://www.fs.fed.us/psw/publications/documents/psw_gtr228/psw_gtr228.pdf, http://selectree.calpoly.edu/, and http://www.fs.usda.gov/ccrc/tools/cufr-tree-carbon-calculator-ctcc.

Urban Forestry Opportunities and Resources

11. Sacramento and Pasadena are two cities to look to for great urban forestry work. Each has used trees to improve the local environment and reduce cooling costs. The Sacramento Municipal Utility District (SMUD) financially supports the planting and care of trees.
12. The US Forest Service Tree Guide for Northern Coastal Communities quantifies the benefits and costs of planting trees on a per-tree basis, accounting for location and for whether trees are publically or privately owned.

Emerging Issues

UHI EFFECT IN THE BAY AREA

1. To better evaluate the effect of urban cooling efforts in the Bay Area, which is diverse in both climate and pollution, the Air District needs to gain a clearer understanding of the factors that cause variation in the UHI effect. Important questions include:
    a. What is the relationship between temperature increase and ozone formation? Is the relationship linear or non-linear, and how does it vary by location, time of day, and season in the Bay Area?
    b. Atmospheric mixing, emission of precursors, and ozone formation are influenced by increases in temperature. How do these processes interact to affect air pollution formation and exposure, and how does this interaction vary by location, time of day, and season in the Bay Area?
2. While localized temperature increases are most relevant for local pollution and heat, consideration of ozone precursor transport downwind from areas with increased localized temperatures needs to be considered. In the Bay Area, high ozone areas are not over "urban" areas, but are rather over the cities and vicinity of San Martin, Livermore, and Concord (though the masses of air that cause high ozone in these areas may have originated in or travelled through other cities warmed by the UHI effect).

URBAN COOLING STRATEGIES: TREES

3. Trees have numerous air quality benefits to offer, and certain tree species may be more beneficial than others with respect to air quality benefits. Trees with large, dense canopies can provide shade and mitigate the UHI. Trees with high leaf surface areas (such as conifers) can collect PM and may be particularly useful in near-roadway settings. All trees, to varying degrees, have the ability to sequester carbon.
4. The public and local governments often fail to recognize that the long-term benefits of urban trees generally outweigh the short-term costs.

5. Large trees may shade solar panels. As tree planting and rooftop solar panels both increase, the strategy of planting trees in urban areas must be balanced with the ability to have unshaded rooftops available for solar panels, though large, healthy, established trees should not be cut down to install solar panels.
6. Disparities exist in percent canopy cover across the Bay Area – more disadvantaged neighborhoods have less canopy cover. Priority should be given to planting trees in areas that will yield the most immediate benefits from tree planting.

URBAN COOLING STRATEGIES: ROOFS AND OTHER SURFACES

7. Roof albedos are easier to increase than pavement albedos because: (a) pavement choice is governed more by other factors dictating suitability (currently, 90% of surfaces are asphalt concrete) and (b) roads get dirtier faster than roofs, so albedo will decrease faster. Cool walls represent a developing technology that holds promise as an urban cooling strategy.
8. It never makes economic sense to replace a roof only for the purposes of increasing albedo. However, since average roof lifespan is 20 years, about 5% of roofs are replaced annually. Creating requirements or incentives that get people to install cool roofs at time of replacement (in geographically appropriate areas) is important.
9. Asphalt shingle roofing is relatively cheap (both materials and installation). Therefore, the best approach for mass adoption of cool roofs is to encourage the use of high quality and high albedo asphalt shingles.
10. Cool roofs and PV are not mutually exclusive strategies. The Air District will need to stay abreast of advances in rooftop PV and cool roof materials.
11. The history of ratepayer-funded energy efficiency programs related to cool roofs may provide insight into the appropriate pathway for the Air District to pursue. Prior to 2015, PG&E offered rebates for multi-family (5+ unit) residential dwellings of 10-20 cents per square feet for newly purchased roofing products that exceeded minimum requirements for aged solar reflectance and aged thermal emittance, as rated by the Cool Roof Rating Council. Rebate eligibility was limited to buildings in California climate zones (2, 4, 11, 12, or 13). The cost-effectiveness of this incentive-based approach eroded over time as State building energy efficiency standards ratcheted up and the program was allowed to expire at the end of 2014. PG&E's current strategy is to encourage local governments to adopt local requirements for cool roofs that exceed State energy standards.

URBAN COOLING STRATEGIES: OVERALL

12. If urban cooling strategies are employed in areas with lower summer and winter temperatures, this could actually result in increased winter energy use by increasing the need for wintertime heat.
13. In addition to high daytime temperatures, the UHI effect is characterized by a lack of nighttime cooling. The inability for a person's body to cool for a prolong period is a significant driver of heat-related illness. Urban cooling strategies that promote faster nighttime cooling include: increased vegetation, cool pavement technologies, and smart urban planning (e.g., land use planning, ventilation, shading), while cool roofs are a less important strategy when targeting high nighttime temperatures.

14. A cost-benefit analysis of urban cooling strategies compared to alternative air quality strategies needs to be further evaluated. While UHI research has shown that the urban cooling strategies enumerated above can produce a measurable reduction in average urban temperatures, an associated improvement in local air quality, and related co-benefits, it remains to be determined whether the investment required to achieve those benefits via urban cooling represents the most cost-effective pathway to achieving those benefits.
15. A need exists to better understand how the US EPA might recognize UHI mitigation measures as ozone reduction strategies by regional air districts.

HEAT AND HEALTH

16. Not all populations are at equal health risk from heat. Factors such as socioeconomic vulnerability, social isolation, lack of air conditioning ownership, and underlying co-morbidities put certain populations at higher risk of suffering from heat-related illness.
17. While focusing urban cooling efforts in areas with high use of air conditioning is important for reduction of energy consumption and anthropogenic heat production, it may actually be more important to focus on neighborhoods with high temperatures but low air conditioning ownership to better mitigate the effects of heat-related illness on vulnerable populations.

Recommendations

While further research is required to quantify the geographical variation in air quality benefits from urban cooling measures, urban forests and photovoltaic systems offer important co-benefits regardless of geography. Likewise, cool roofs offer important co-benefits for buildings with significant cooling loads. These co-benefits provide grounds for the Air District to take initial steps in promoting these measures, pending further research into air quality impacts. Specifically, the Advisory Council recommends that the Air District:

1. Conduct modeling studies to quantify the spatial and temporal variation in current and projected temperatures and levels of ozone in the Bay Area, as well as the air quality and other health benefits that could accrue from various urban cooling measures. Include Bay Area-specific heat vulnerability assessments in the analysis. Apply the results to prioritize: (1) urban cooling strategies versus alternative methods of improving air quality and (2) Bay Area communities that would benefit from more aggressive adoption of targeted measures.
2. Based on prioritization results from Recommendation #1, explore options for promoting more aggressive adoption of urban cooling measures in high priority communities, including targeted grants, education, and regulatory options.
3. Provide technical support to local governments to include air quality criteria into their street tree selection processes. Criteria should include carbon sequestration capacity, VOC emissions, allergenicity, and adsorption of PM and other pollutants.
4. Encourage local governments within warmer climates to incorporate cool roof requirements into their local building codes. In practice, this effort will require collaboration with existing efforts underway through PG&E and the Bay Area

Regional Energy Network. The Air District can add value to this effort by highlighting the associated air quality benefits of cool roofs.

5. Communicate the benefits of urban cooling measures as part of geographically-targeted public education campaigns.
6. Encourage the California Energy Commission to incorporate quantified air quality benefits in cool roof cost-benefit analysis leading up to the 2019 building energy standards update. Inclusion of more comprehensive benefits will support the adoption of more rigorous standards. This effort may require collaboration with the Air Resources Board and/or other regional air districts.

Glossary

Adsorption: adhesion (or sticking) of molecules in the air onto a surface. As PM travels through the air, it can adhere (or adsorb) onto plant leaves.

Albedo: fraction of incident solar radiation reflected by a surface (as opposed to being absorbed). See also: Solar Reflectance.

Allergenicity: degree to which a substance causes or triggers allergies.

Cool roofs: roofs that reflect more sunlight than standard roofing materials, either through increased albedo or increased thermal emittance. Generally, cool roofs are either reflective or vegetation roofs.

Evapotranspiration: sum of evaporation (from soil and wet vegetation) and transpiration (release of water vapor from plant leaves) into the earth's atmosphere.

Fluoresce: absorption of electromagnetic visible radiation (light) and the immediate re-radiation of electromagnetic radiation (at a different, longer, wavelength and at a lower energy intensity).

LBNL: Lawrence Berkeley National Laboratory.

PM: Particulate Matter.

PV: Photovoltaic solar panels (used to convert solar radiation to electricity).

Solar Radiation: radiant energy emitted by the sun. About half of this energy is in the visible spectrum, with the remainder in the near-infrared and ultra-violet spectra.

Solar Reflectance (SR): fraction of incident solar radiation reflected by a surface (as opposed to being absorbed). See also: Albedo.

Thermal Emittance (TE): ability of a material to emit heat in the form of infrared radiation.

Title 24: California Building Standards Code of the California Code of Regulations. Also called, The Energy Efficiency Standards for Residential and Nonresidential Buildings, it outlines the energy standards that address the energy efficiency of new (and altered) buildings. It was created by the California Buildings Standards Commission in 1978; it has been periodically updated, most recently in 2013.

UHI: Urban Heat Island. excess temperature of an urban area, relative to that in surrounding non-urban areas.

Urban cooling strategies: strategies employed to reduce the temperature of an urban or suburban area. This includes urban greening, increasing the albedo of building and construction materials, smart urban planning (e.g., land use planning, ventilation, shading), and increased energy efficiency/decreased energy use (to reduce anthropogenic heat production).

VOC: Volatile Organic Compound.

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
Memorandum

To: Chairperson Liza Lutzker and Members
of the Advisory Council

From: Jack P. Broadbent
Executive Officer/Air Pollution Control Officer

Date: May 6, 2015

Re: Discussion of the Advisory Council Presentation to the Board of Directors

The draft presentation summarizing the Advisory Council's January-May, 2015 activities to the Board of Directors will be discussed.

Respectfully submitted,

Jack P. Broadbent
Executive Officer/APCO

Prepared by: Saffet Tanrikulu
Reviewed by: Jean Roggenkamp

Attachment: Draft Presentation of the Advisory Council January-May, 2015 activities.

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Urban Heat Island Impacts on Air Quality and Possible Air District Responses

2015 Efforts of Advisory Council

Prepared for the Board of Directors
2015

Advisory Council 2014 Activities

- Objective
  - NEED TO CITE LANGUAGE FROM THE BOARD'S DIRECTIVE TO ADDRESS THIS ISSUE
- 5 regular meetings
- 4 expert speakers
  - BAAQMD, University, national laboratory, CalFire
- 1 report

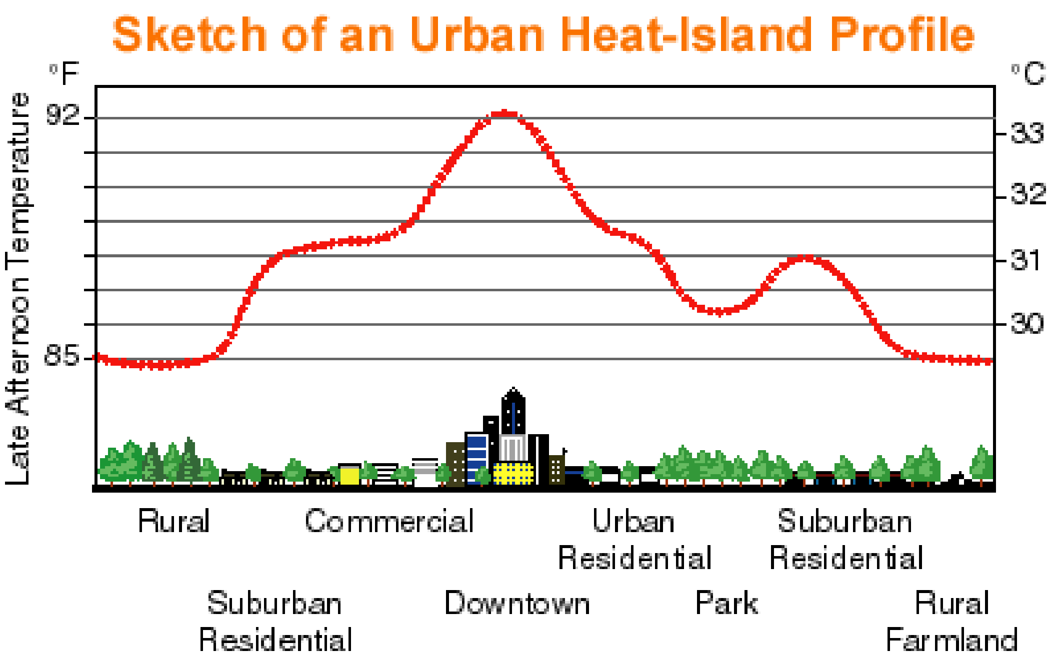
Advisory Council: Topics and Speakers

Urban Heat Island Impacts and Mitigation Strategies

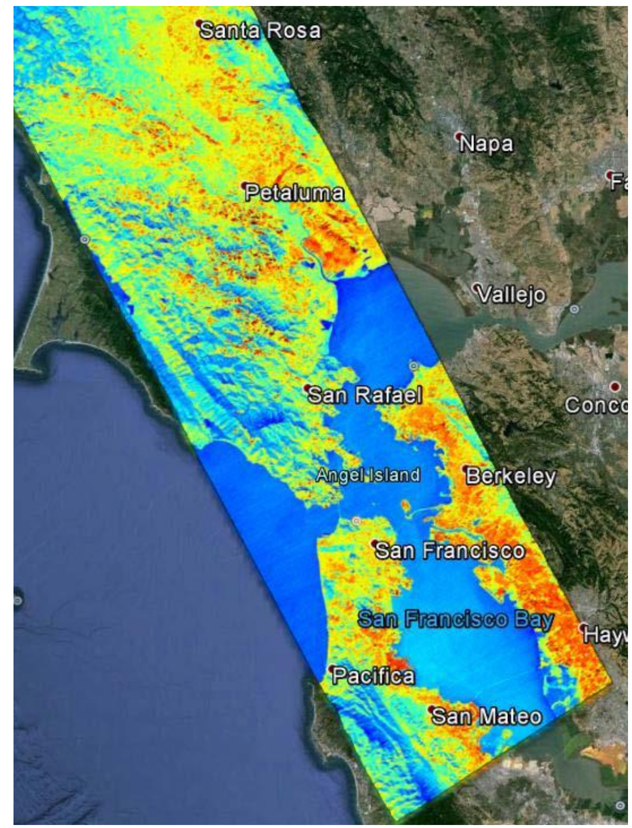
- **Saffet Tankrikulu, PhD,** BAAQMD (overview)
- **Bob Bornstein, PhD**, on behalf of **Jorge E. Gonzalez, PhD** (climate science of urban heat islands)
- **John Melvin**, CalFire (urban forestry)
- **Ronnen Levinson, PhD**, LBNL (cool roofs)

What is Urban Heat Island (UHI)?

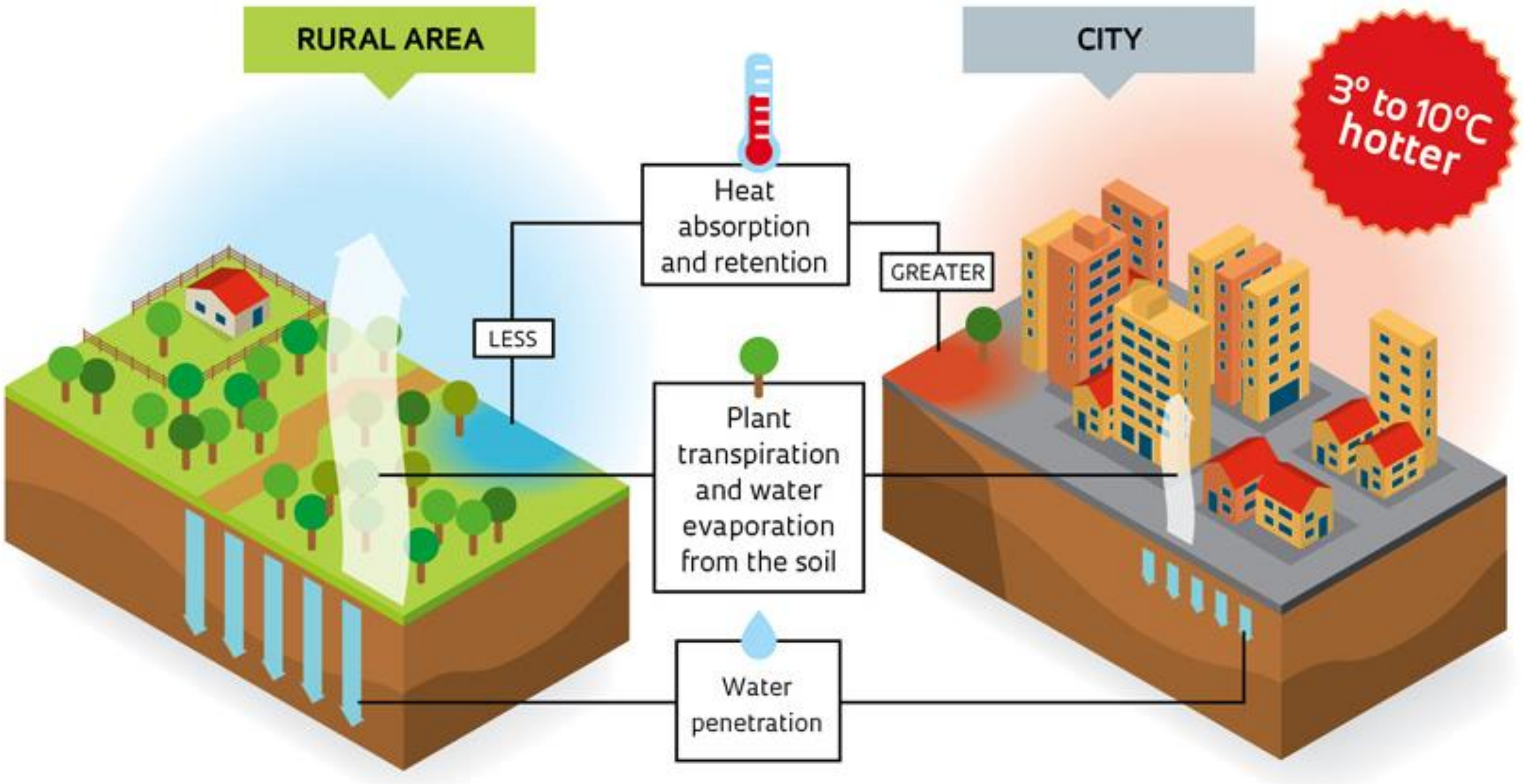
- UHI is a relative term comparing temperatures of urban area to surrounding area



Courtesy of LBNL



What causes UHI

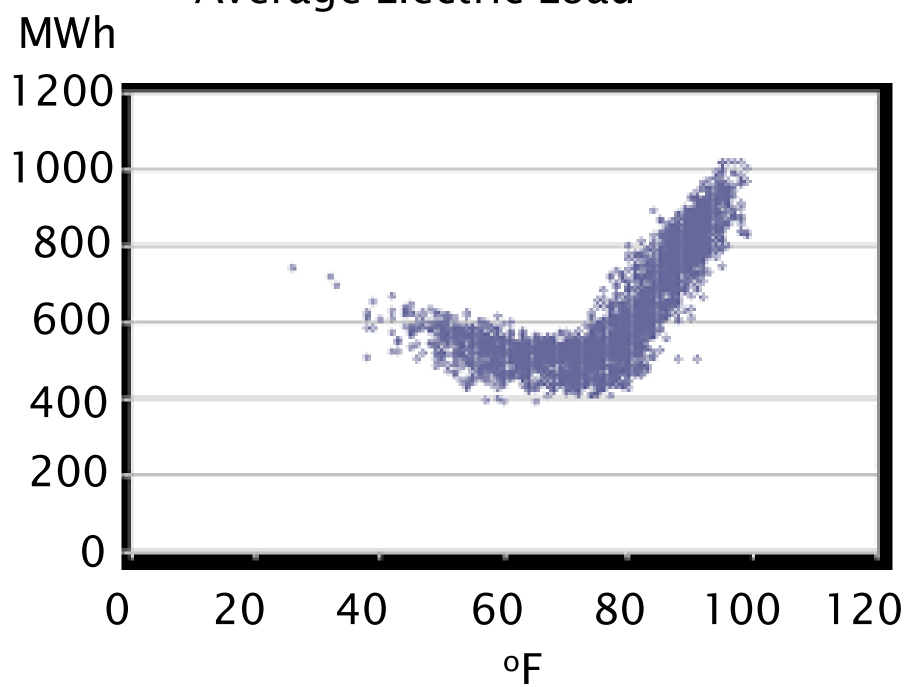


Courtesy Alexandre Affonso

Impacts from High Urban Temperatures

1. Increased ozone due to accelerated photochemical reactions
2. Increased heat-related illness
3. Increased building cooling loads, driving increased electricity generation, driving increased pollution
4. Contribution to global warming

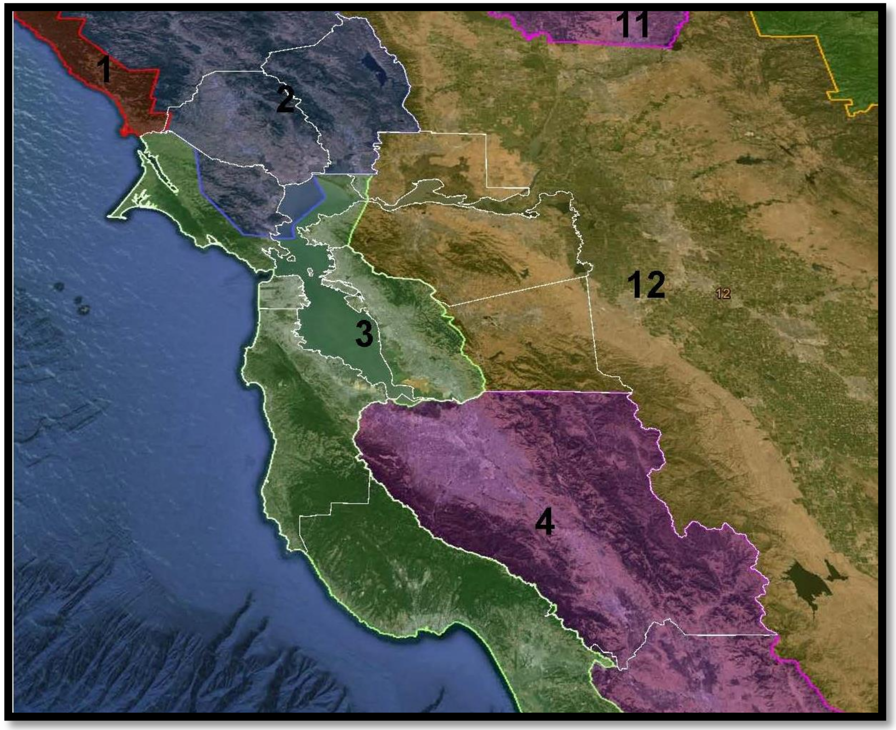
Maximum Daily Temperature vs Average Electric Load



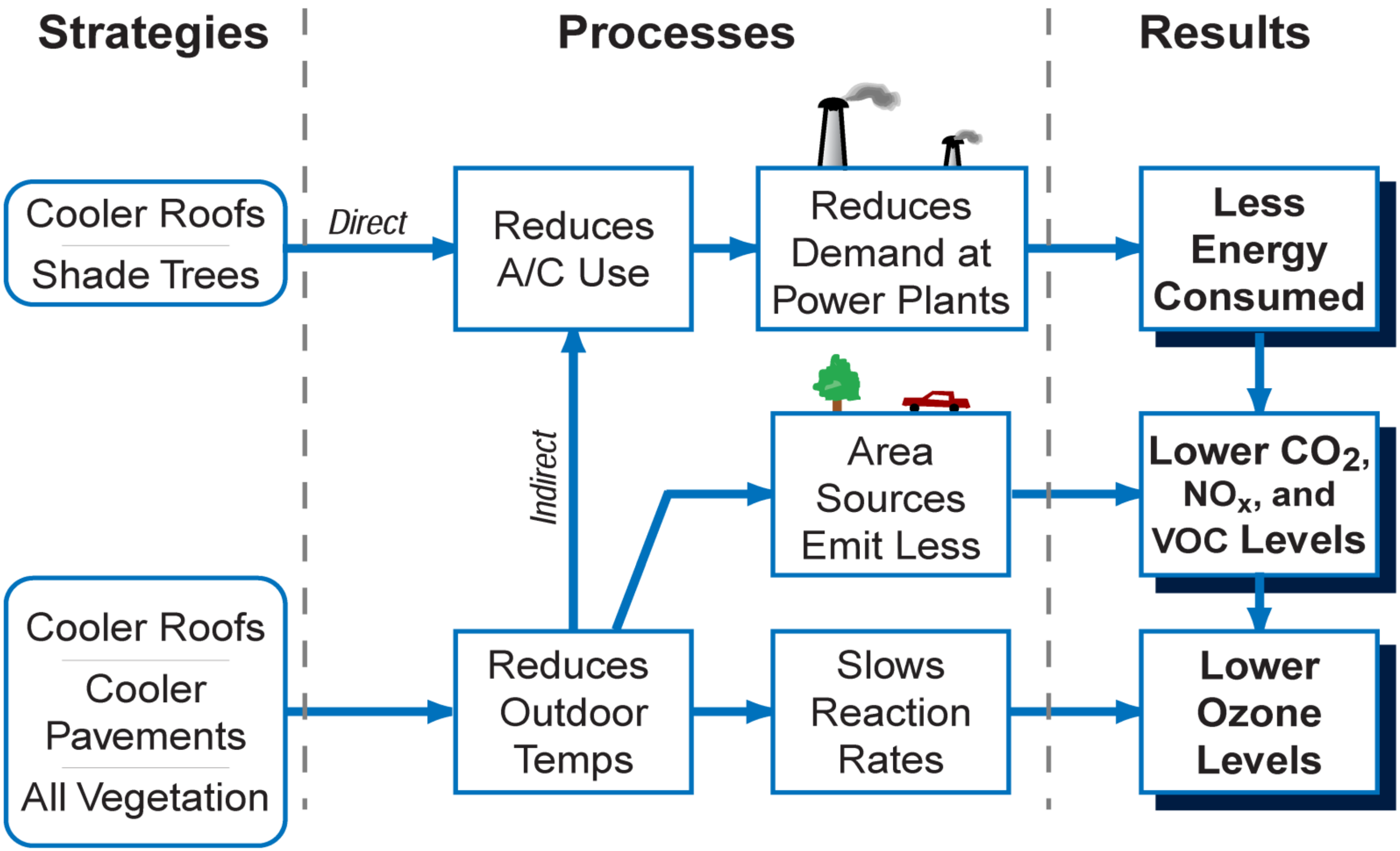
Courtesy US EPA

Geography and UHI variation in Bay Area

- Urban cooling strategies will be most important in areas that:
  - have hot summers
  - have an air pollution (or precursor) issue



Mitigation Strategies



Courtesy Ronnen Levinson, LBNL

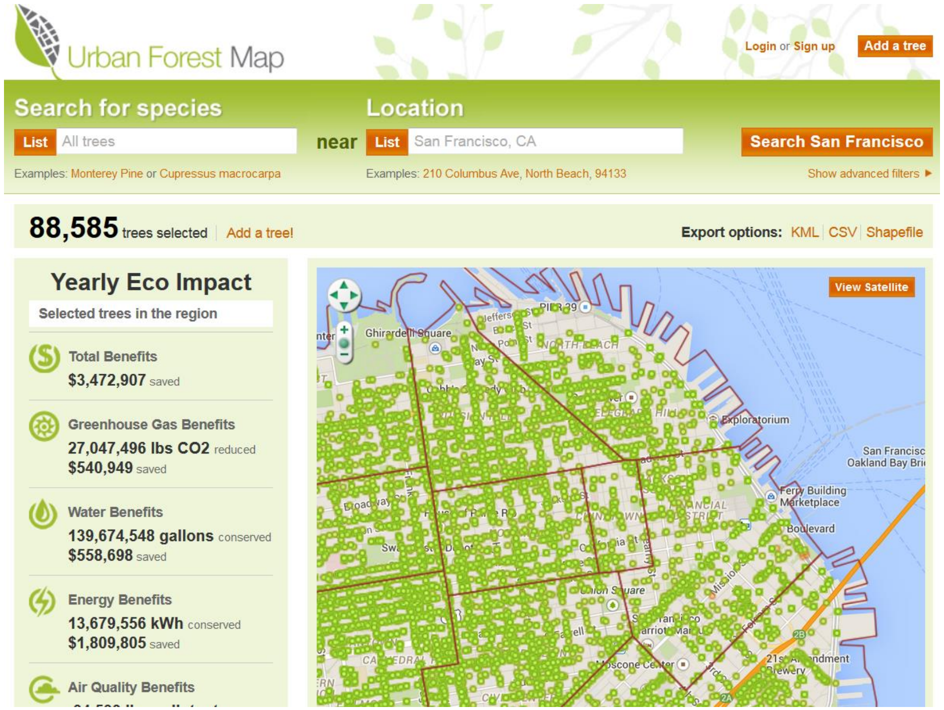
Trees as an Urban Cooling Strategy

- Urban cooling benefits:
  - Evapotranspiration increases humidity to absorb heat
  - Canopy provides shade to decrease surface temperatures
  - Reduce time that heat is present throughout the day

Courtesy John Melvin, CalFire

Trees Offer Important Co-benefits

- Carbon sequestration
- PM capture
- Storm-water capture
- Water quality improvement
- Increased property values
- Reduced energy use
- Annual regional benefits ≈ \$5.1B / yr
- 3% increase in region's urban canopy ≈ \$475M / yr



Courtesy urbanforestmap.org

Cool Roofs

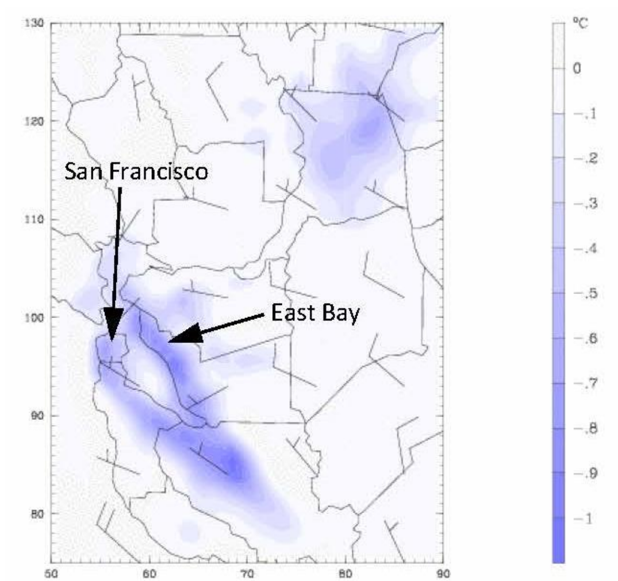
A cool tile roof in Fresno, CA saved both cooling *and* heating energy in a single-family home

Courtesy Ronnen Levinson, LBNL

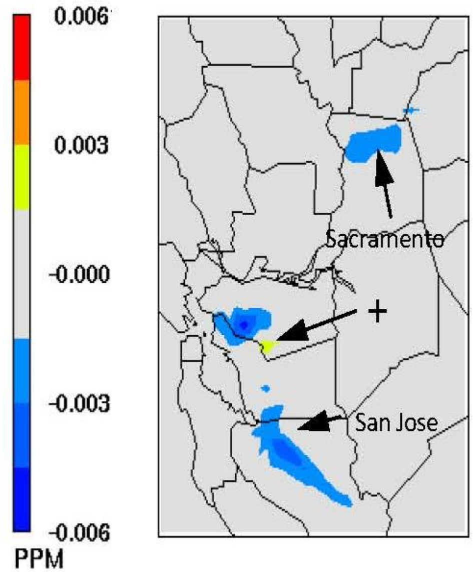
Cool Roof Impacts on Ozone Formation

Climate model predicts that increasing roof and pavement albedos can reduce temperatures up to 1˚C and lower ozone by 2-6 ppb.

Change in air temperature at 2 m AGL at 11:00 PDT on 27 July 2000



Corresponding change in ozone with year-2000 emissions



Study increased
roof albedo by 0.25 – 0.55
pavement albedo by 0.22 – 0.27

Results courtesy of Haider Taha, Altostratus Inc., http://altostratus.com .

Recommendation: Modeling

- Conduct modeling studies to prioritize
  - Urban cooling strategies versus alternative methods of improving air quality
  - Bay Area communities that would benefit from more aggressive adoption of targeted measures
- Explore options for promoting more aggressive adoption of urban cooling measures in high priority communities

Recommendation: Local Government Engagement

- Provide technical support to local governments to include air quality criteria into their street tree selection processes
- Encourage local governments with warmer climates to incorporate cool roof requirements into their local building codes

Recommendation: Public Outreach

- Communicate the benefits of urban cooling measures as part of geographically-targeted public education campaigns

Recommendation: State Standards

- Support adoption of more rigorous energy standards for cool roofs by helping CEC to incorporate quantified air quality benefits in cost-benefit analysis

Thank You!

- We appreciate your time and interest
- Questions or comments?