GREEN PARKING COUNCIL™

Cool Pavement

A Green Parking Council Webinar – July 18, 2013

GREEN PARKING COUNCIL

Haley Gilbert

Principal Research Associate
Heat Island Group
Lawrence Berkeley National Laboratory (LBNL)

- "Cool Communities" project lead
- Heat Island Group liaison to industry partners, local government collaborators and other stakeholders
- LEED AP (Leadership in Energy & Environmental Design - Accredited Professional)
- Worked for the U.S. Environmental Protection Agency prior to joining LBNL
- Holds a Master's degree with a focus on environmental design from Yale University

Benjamin Mandel

Research Assistant
Heat Island Group
Lawrence Berkeley National Laboratory (LBNL)

- Provides support on “Cool Communities” including technical seminars and stakeholder meetings relating to the adoption of cool pavements and surfaces
- Provides research assistance on enhanced resilience to extreme heat events in U.S. cities and the use of cool roofs to improve indoor thermal comfort in India
- Holds an A.B. in Mathematical Economics and an A.B. in Hispanic Literature and Culture from Brown University
- Pursuing a Master of Public Policy (M.P.P.) and an M.S. in Energy & Resources from the University of California at Berkeley

Cool Pavements for Cool Parking

July 18, 2013

Heat Island Group
Lawrence Berkeley National Laboratory
http://HeatIsland.LBL.gov/

Outline

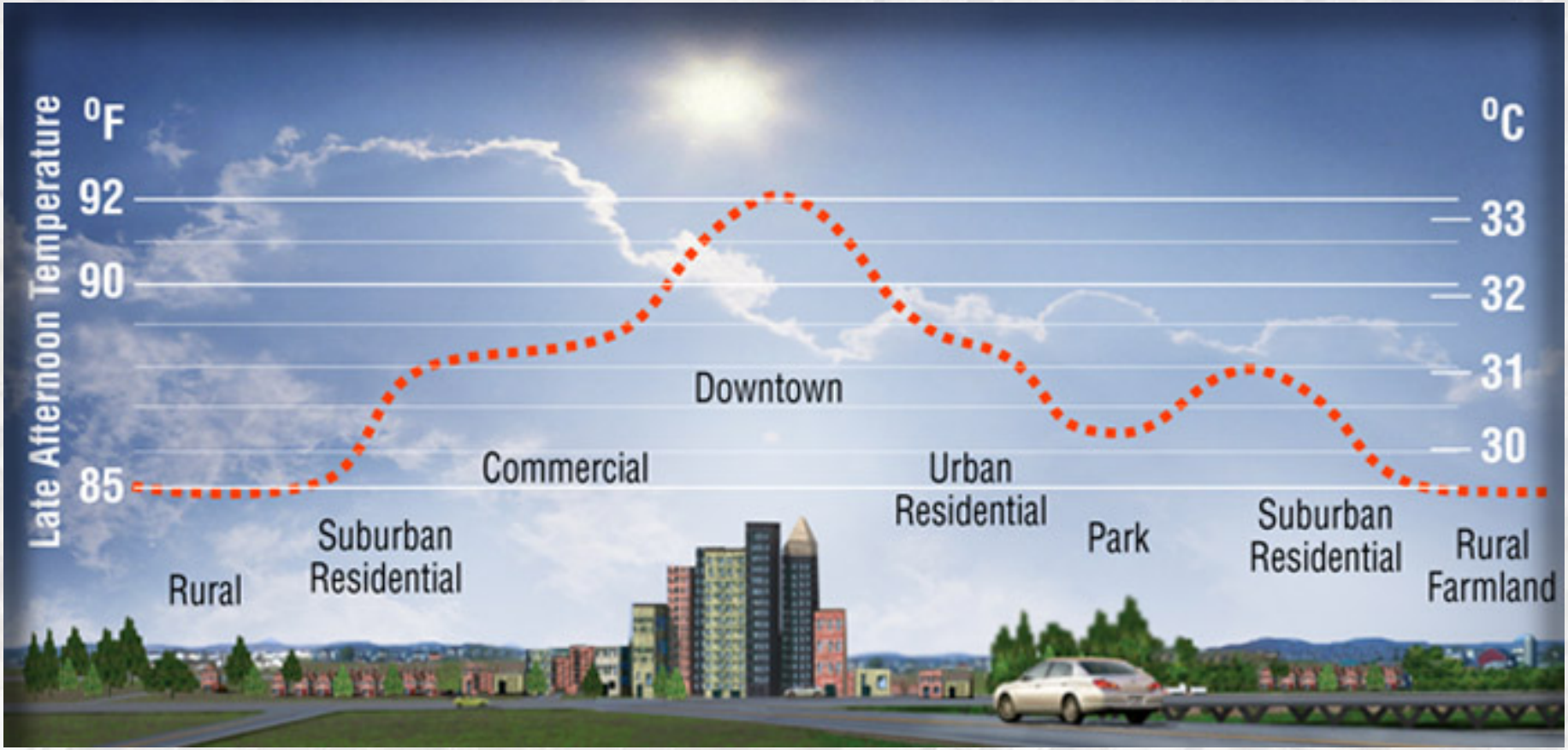
- Hot cities
- Cool science
- Benefits of reflective pavements
- Cool pavement options for the parking industry
- Cool parking lots in practice
- Things to consider
- Frequently asked questions

Cities can be HOT

NASA infrared Sacramento (1998)

Image: NASA/Marshall Space Flight Center

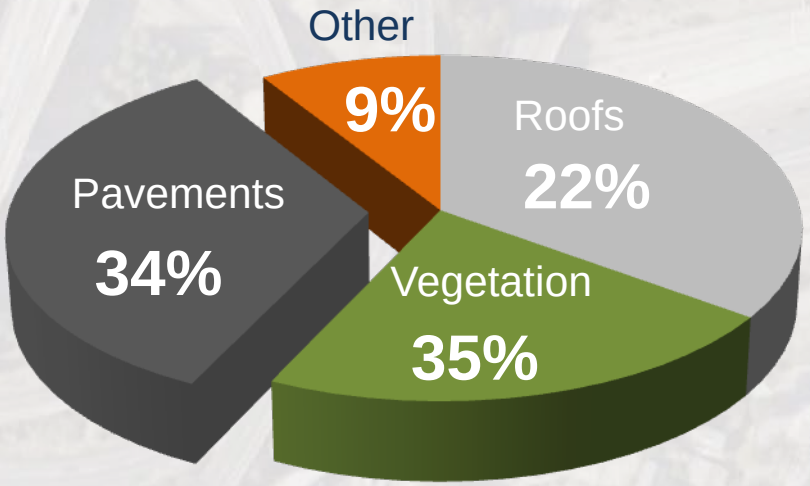
Summer afternoons in the city



Source: LBNL – Heat Island Group

One reason cities are hot is that they have many dark surfaces

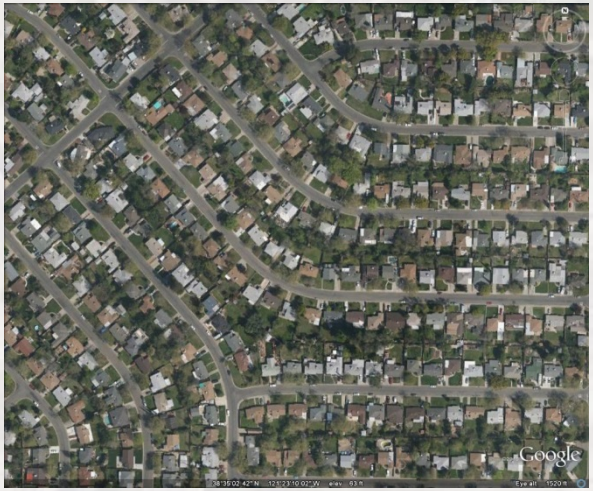
A square kilometer in Sacramento, CA



Average urban fabric above tree canopy in Chicago, IL, Houston, TX, Sacramento, CA, and Salt Lake City, UT

Sources: Akbari and Rose (2008), LBNL Heat Island Group

About 1/3 of urban surfaces are paved



Of that third, about

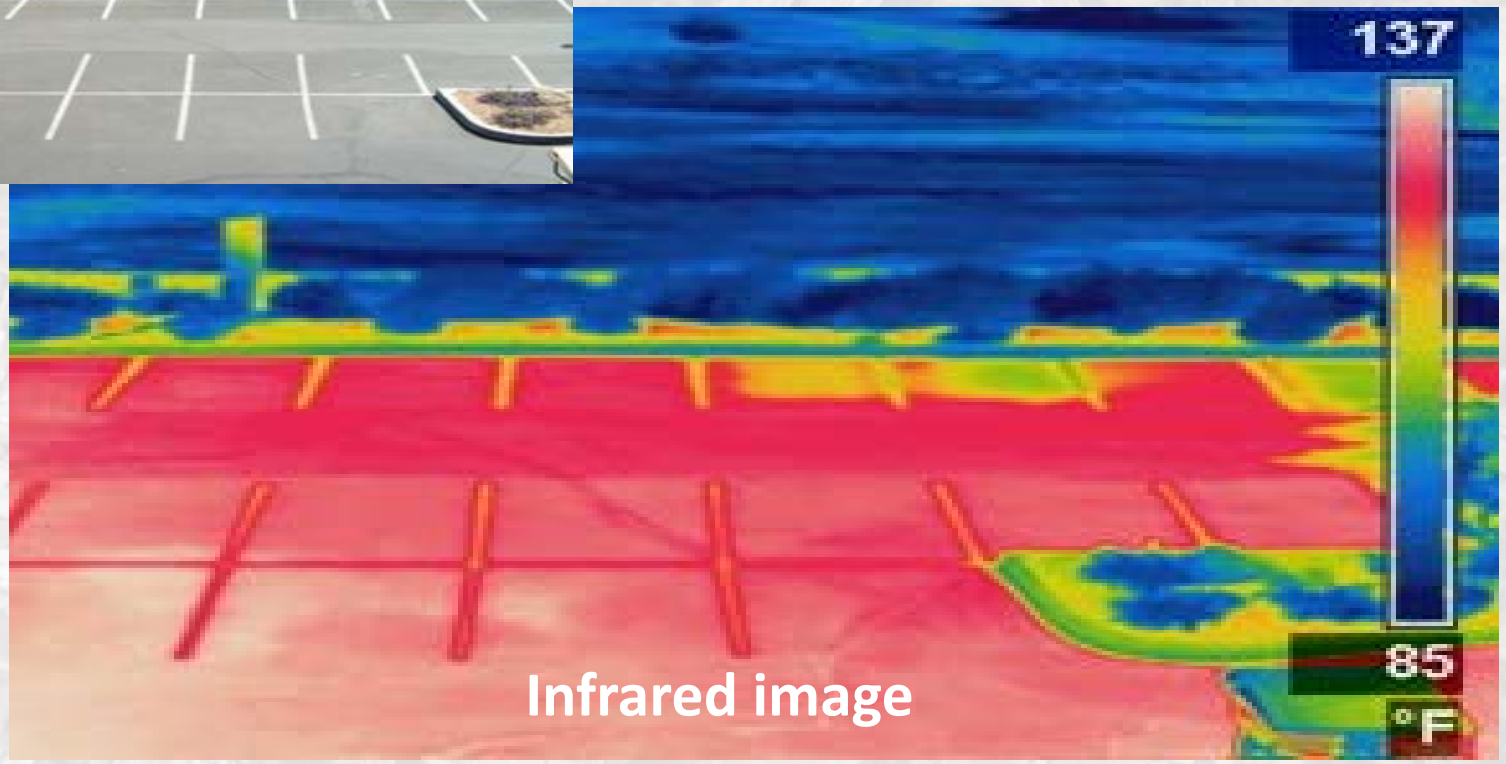
- **45% are streets (usually asphalt concrete)**
- **15% are sidewalks (usually cement concrete)**
- ***40% is exposed parking*** **(usually asphalt concrete)**

➔**Parking lots make up 10-15% of urban surface area**

Source: Akbari and Rose (2008)

And we all know that pavements can get HOT

Rio Verde, Arizona



Pavement is **> 30°F** hotter than vegetation

Image: Larry Scofield - APCA

Cool science

Hot city surfaces warm the air

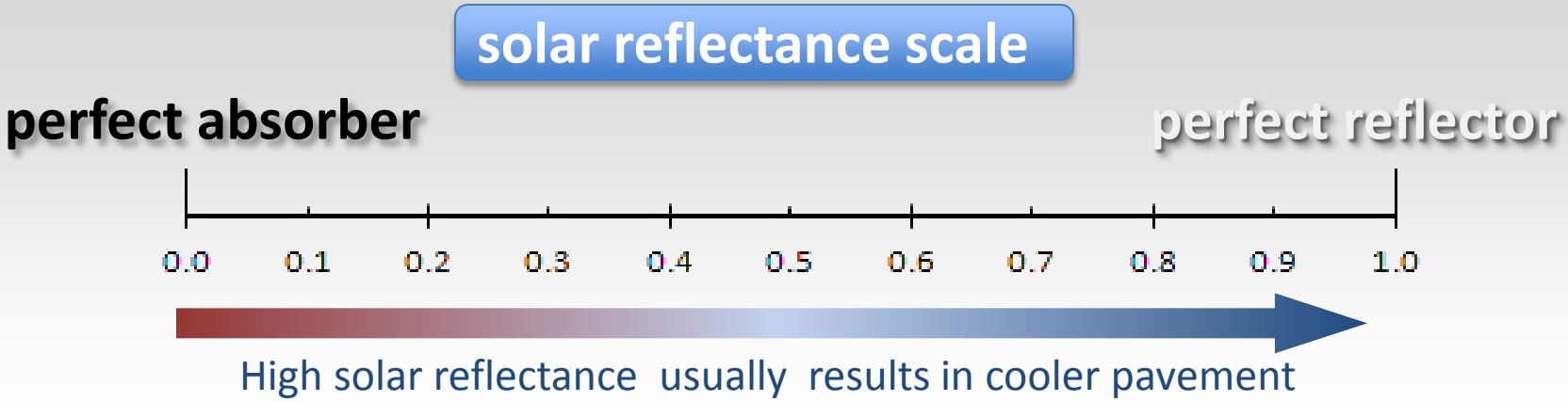
- Sunlight does not directly heat the air

- Opaque surfaces (e.g., pavements & roofs) absorb part of the sunlight & reflect part

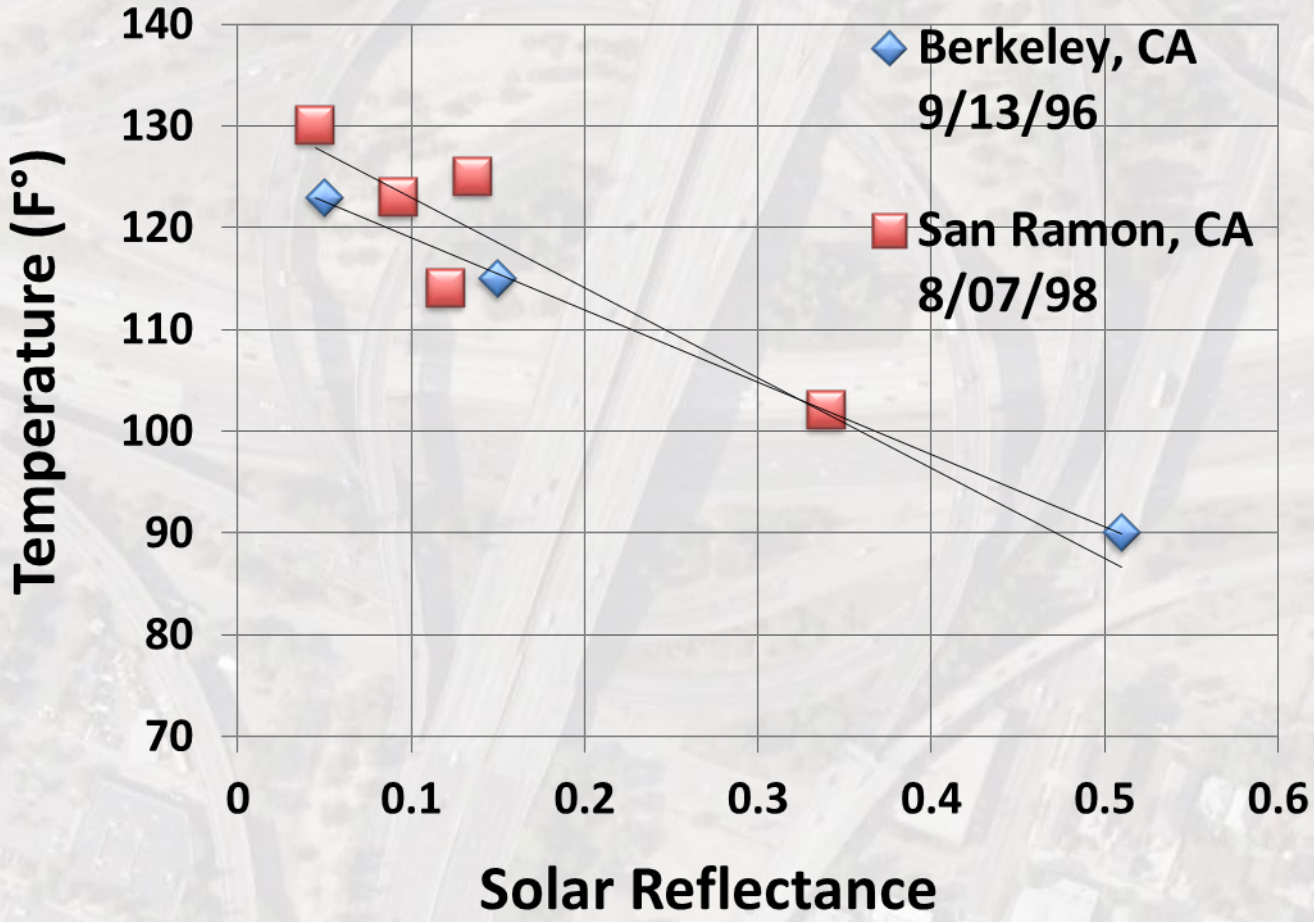
How do you measure reflective pavements?

Solar reflectance (SR) = fraction of sunlight reflected

= reflected sunlight ÷ incident sunlight



High solar reflectance ➡ low pavement temperatures



Increase SR of pavement by 0.1 decreases its temperature ~ 7°F.

Source: LBNL Heat Island Group

Benefits of reflective pavements

Longer pavement life

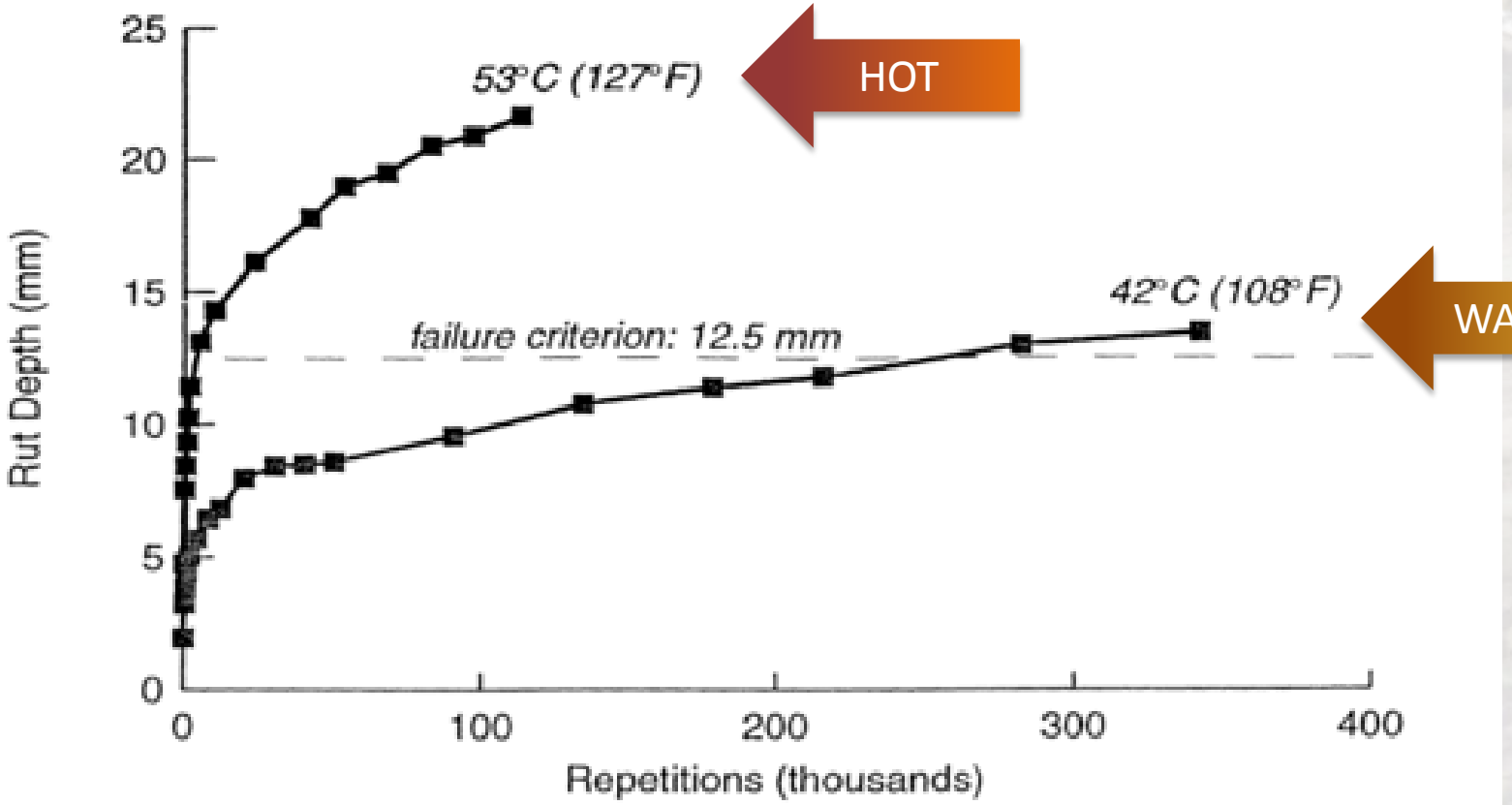


Fig. 2. Depth of Rutting vs Number of Repetitions of a Standard Axle Load, Wide-base Single Tire, at Pavement Surface Temperatures of 42°C and 53°C

Source: Pomerantz, Akbari, Harvey (2000)

Enhanced visibility and safety

- Nighttime illumination

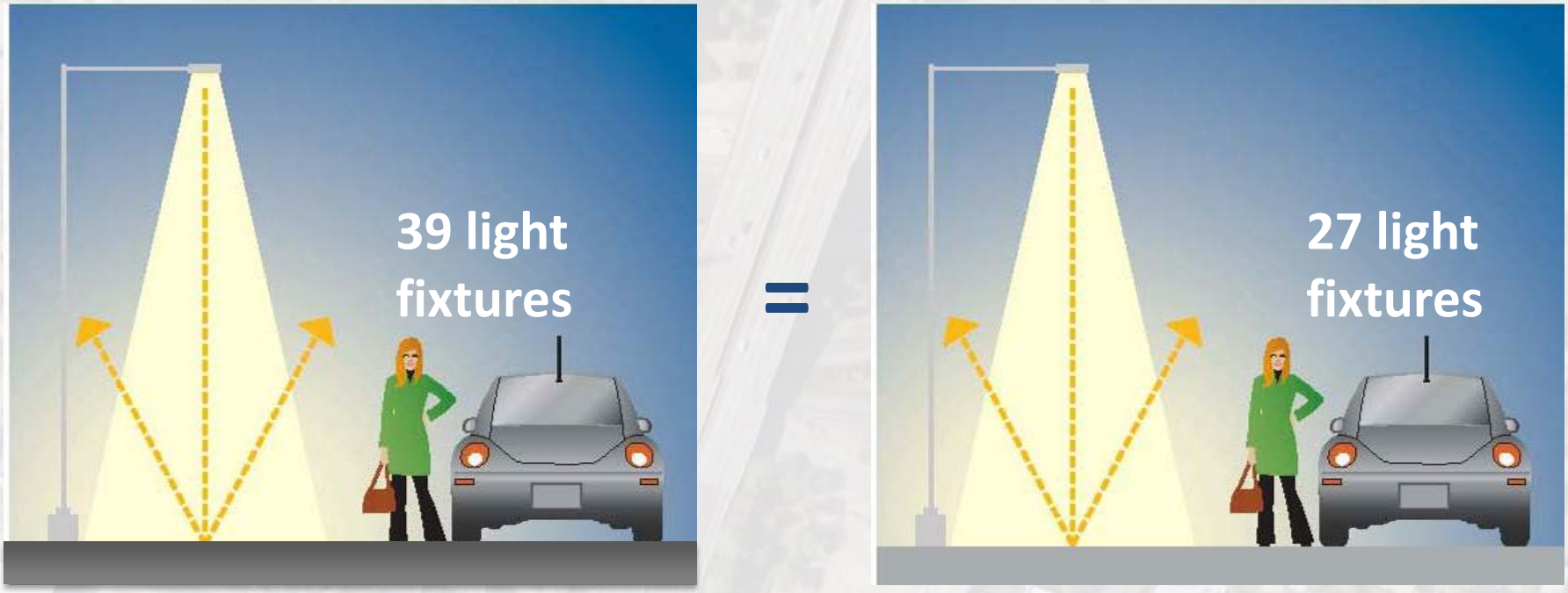
- Reflected illumination is roughly proportional to solar reflectance

Source: Pomerantz et al (2003)

Energy savings

- Reduced energy for street lighting
  - Enhanced illumination or fewer fixtures

Source: Stark, R.A. (1986)



Dark pavement **Light pavement**

- Also reduces indoor air conditioning demand

Improved outdoor comfort

- Improved outdoor comfort
  - An urban park in Athens, Greece installed 4500 m² of cool pavements
  - Reduced peak air temperatures by 2° C (Santamouris et al. 2012)

Flisvos Park in Athens, Greece (Santamouris et al. 2012)

Preserved water quality

- EPA's Clean Water Act addresses heat pollution – temperature is "pollutant of concern"
- Ultra urban streams warm by 8° F one hour after summer squalls
- A change of 5° F over 5 hours can induce stress in most desirable species of fish

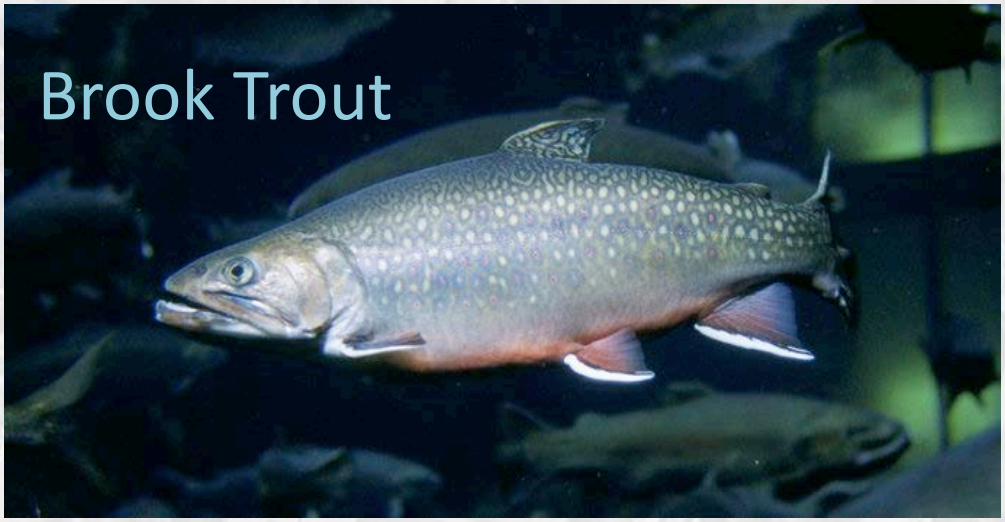


Photo: Eric Engbretson

Source: US EPA

Other benefits

- Reduced heat related stress
- Improved air quality
  - Increases in temperature lead to increases in smog
- Canceled emissions of CO_2
  - 44 billion tons of emissions would be "canceled" if hot cities converted to cool roofs and pavements
  - About 1.5 years' worth of current CO_2 emissions

Can result in monetary savings!

- Example - LBNL study of Los Angeles Basin
  - Rosenfeld et al. (1998) considered only energy and air pollution savings
  - Cooler pavements (ΔSR = 0.25)
    - Reduce peak air temperature by 5.4°F (3°C) ->
      - Reduces peak power demand by 1.6 GW
      - Reduces smog exceedance by 12%
      - Annual savings from cool pavements ≈ $91 million (1998)

Cool pavement options for the parking industry

Pavement materials span a range of solar reflectance

Material	*Solar Reflectance*
Black acrylic paint	0.05
New asphalt concrete	0.05 – 0.10
Aged asphalt concrete	0.10 – 0.15
Aged gray-cement concrete	0.20 – 0.35
New gray-cement concrete	0.30 – 0.50
New white cement concrete	0.70 – 0.80
White acrylic paint	0.80

Source: Rowland "Concrete for Cool Communities"

Cooler asphalt concrete pavements

Cool: Use light-colored aggregate*

Aggregate shows as asphalt binder rubs off

Initial SR ≈ 0.05 (increases over time)

Coolest: Use reflective coatings, slurries, overlays on top of asphalt

Initial SR ≈ 0.25-0.55

*** Depends on availability of <u>suitable</u> aggregate.**
Don't want to ship heavy rocks over long distances.

Cooler cement concrete pavements

Source: Concrete Technology Laboratory

Cool: Gray-cement concrete with light colored fine aggregate

Initial SR ≈ 0.30-0.40

Source: Slag Cement Association

Coolest: Slag concrete, in which slag replaces about 50% of gray cement

Initial SR ≈ 0.40 – 0.60

Other cool pavements

Source: Concrete Technology Laboratory

Permeable

- Work best in climates where it is hot & rainy

Source: Natural Pave

Resin binders

- Clear binders therefore solar reflectance of aggregate most important factor

Reinforced grass pavement

Cool parking lots in practice:
Reflective coatings & overlays

ArmorTop - Western Colloid

Mission Viejo, CA

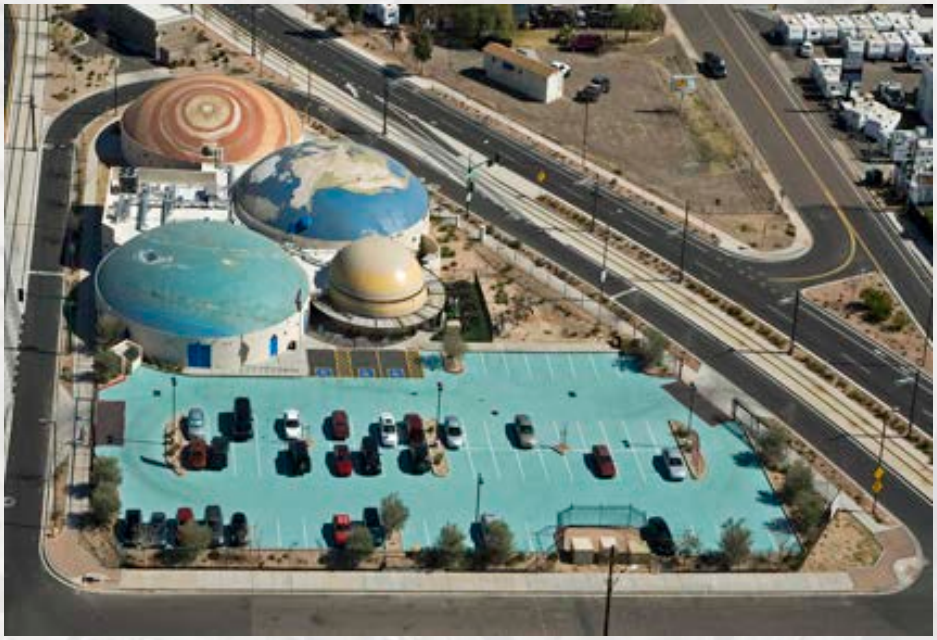
Before

After

Example of a modified asphalt emulsion seal coat

Nano-crete - Emerald Cities

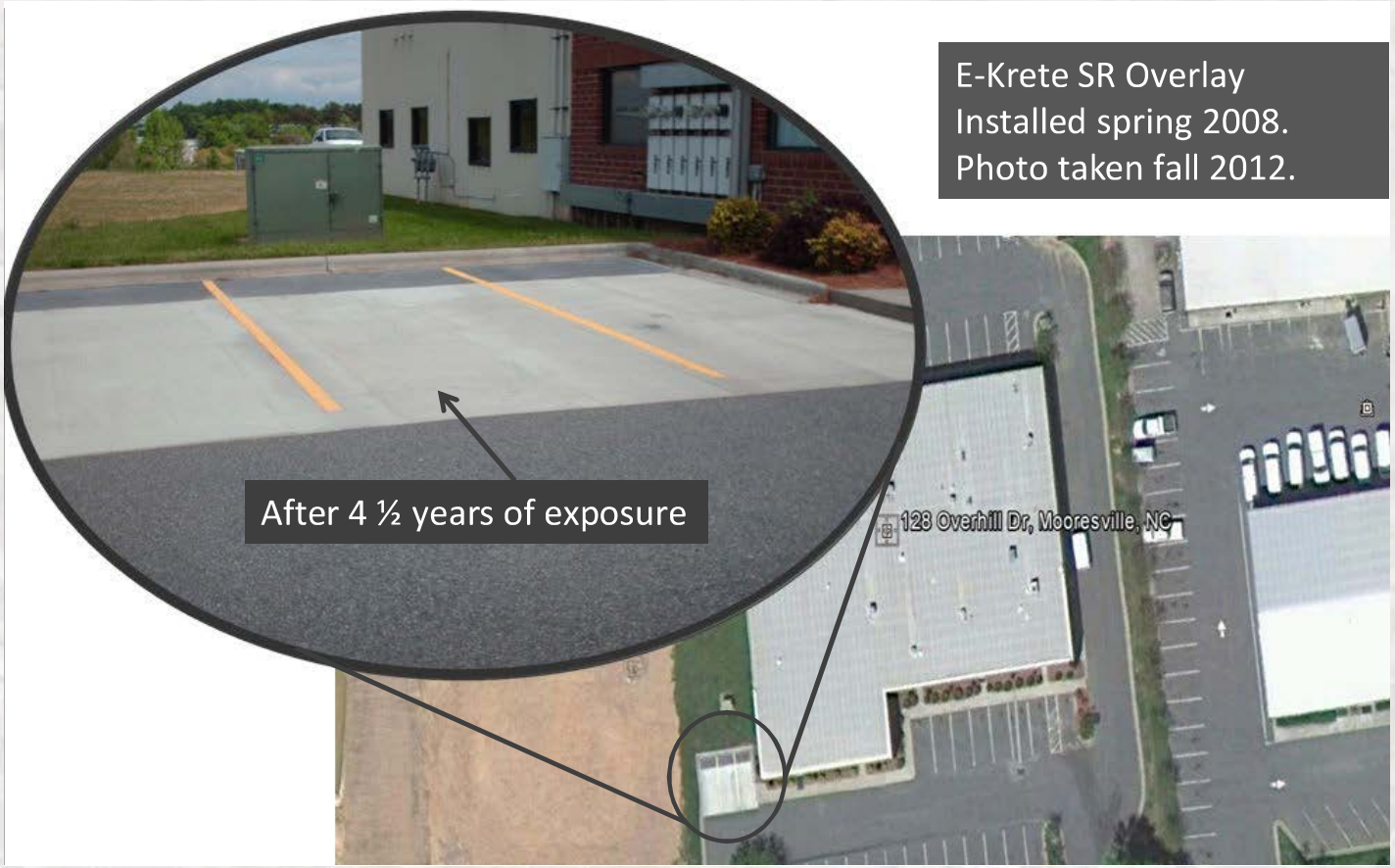
Phoenix, AZ



Example of a cool cementitious coating

E-Krete - Polycon, USA

Mooresville, NC

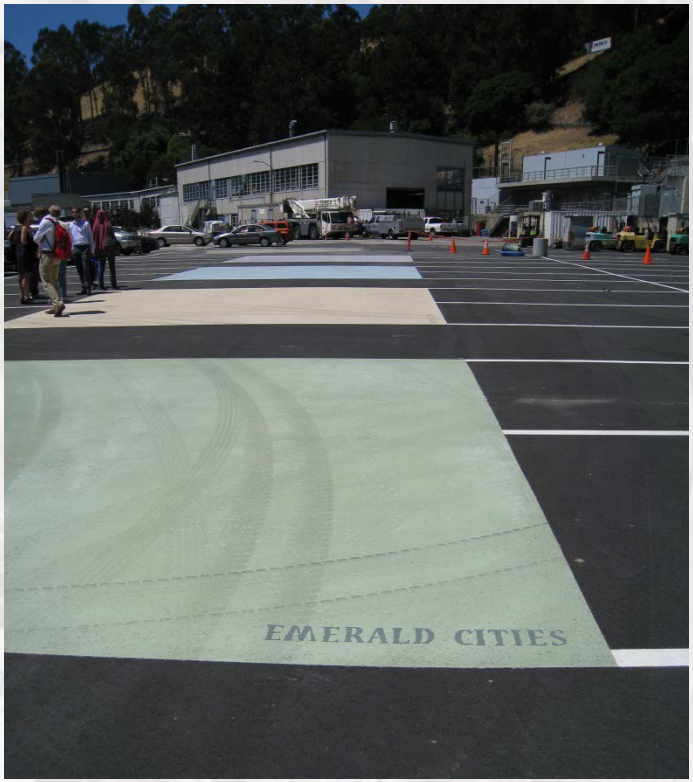


Example of a polymer composite micro-overlay

Berkeley Lab

Cool Pavement Showcase

Rubberized Cool Slurry: Emerald Cities (Celadon, Latte, Teal, Aubergine)



Epoxy-modified acrylic: StreetBond 150 (Slate, Limestone)

Asphalt emulsion: Western Colloid ArmorTop (Stealth Gray, California Tan)

Things to consider

Solar reflectance changes over time

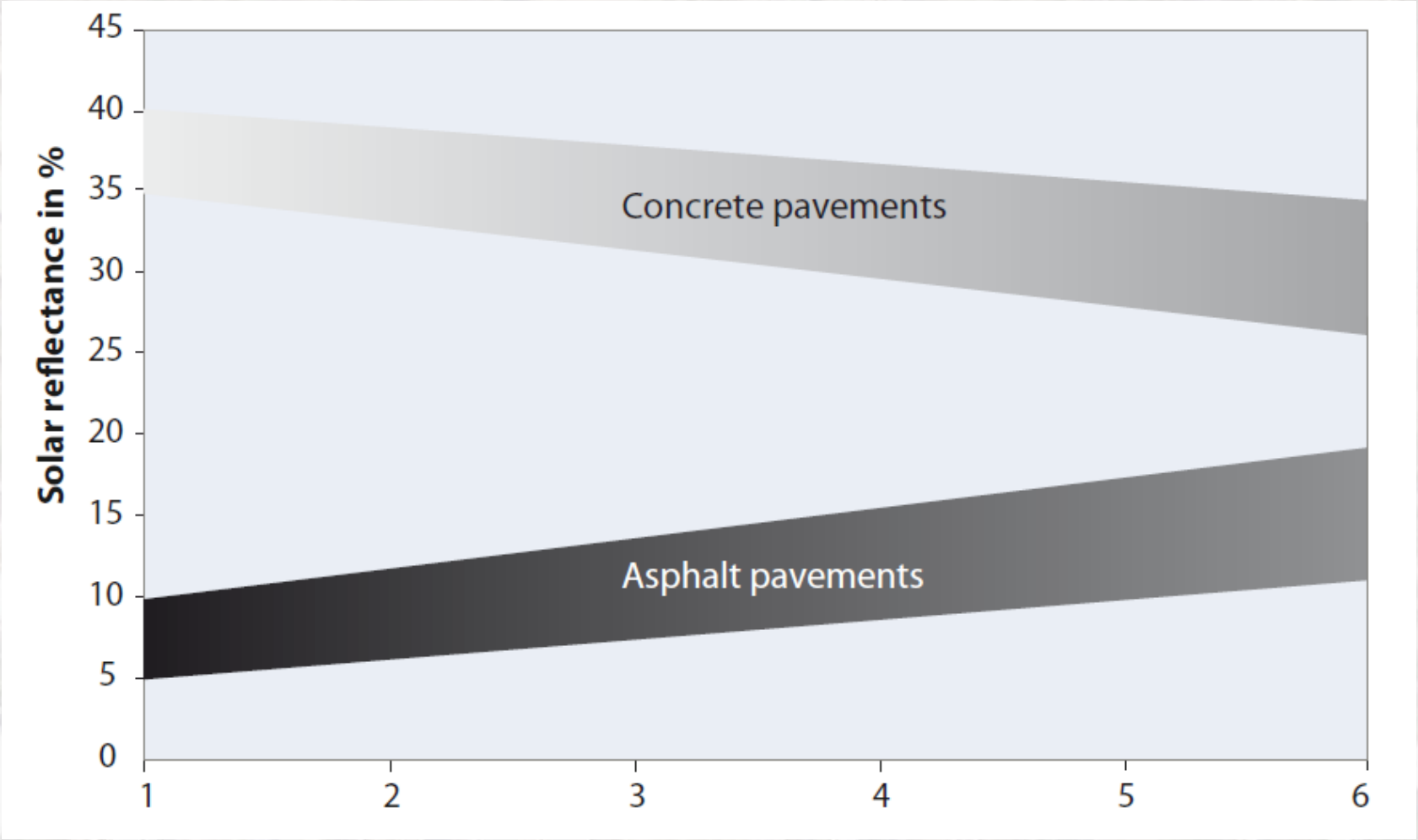


Image: US EPA

Shading

- Buildings, cars, vegetation

Availability of materials

Image: Caltrans

Design & project context

Benefits & costs

- Mismatch between those who pay for cool pavements and those who benefit
  - Example:
    - City A uses cool coatings for its parking lots
    - Lower air temperatures on hot days
    - Reduces air conditioning needed in private buildings

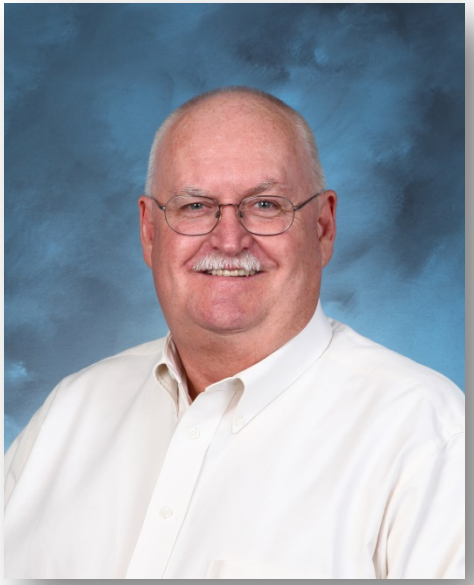
Acknowledgments

The Heat Island Group at Lawrence Berkeley National Laboratory would like to acknowledge and thank our sponsors:

California Energy Commission

California Air Resources Board

U.S. Department of Energy



Brian McKelligett

Parking Services Manager
City of Fort Lauderdale

- Spent 24 years with Eckerd Drug Company as a Store Manager, District Operations Manager, and Project and Construction Manager for the state of Florida
- When Eckerd Drugs was sold to CVS Pharmacy in 2003 Brian began converting Eckerd drug stores throughout the country into CVS stores
- Began with the city of Fort Lauderdale in August of 2005 as the Parking Operations Supervisor

Greening the Lot

Access to Mass Transit. City Hall, and the Orchid Lot, are located within ½ mile of the bus station, just a few blocks away.

Automated Payment Systems. The city participates in mobile payment technology, including pay by cell.

Marketing/Educational Program. This tour offers insight and education into the possibilities and realities of implementing sustainable strategies into a pilot program. The city intends the pilot program itself to be a learning experience for a Phase II to "green" all the city's lots.

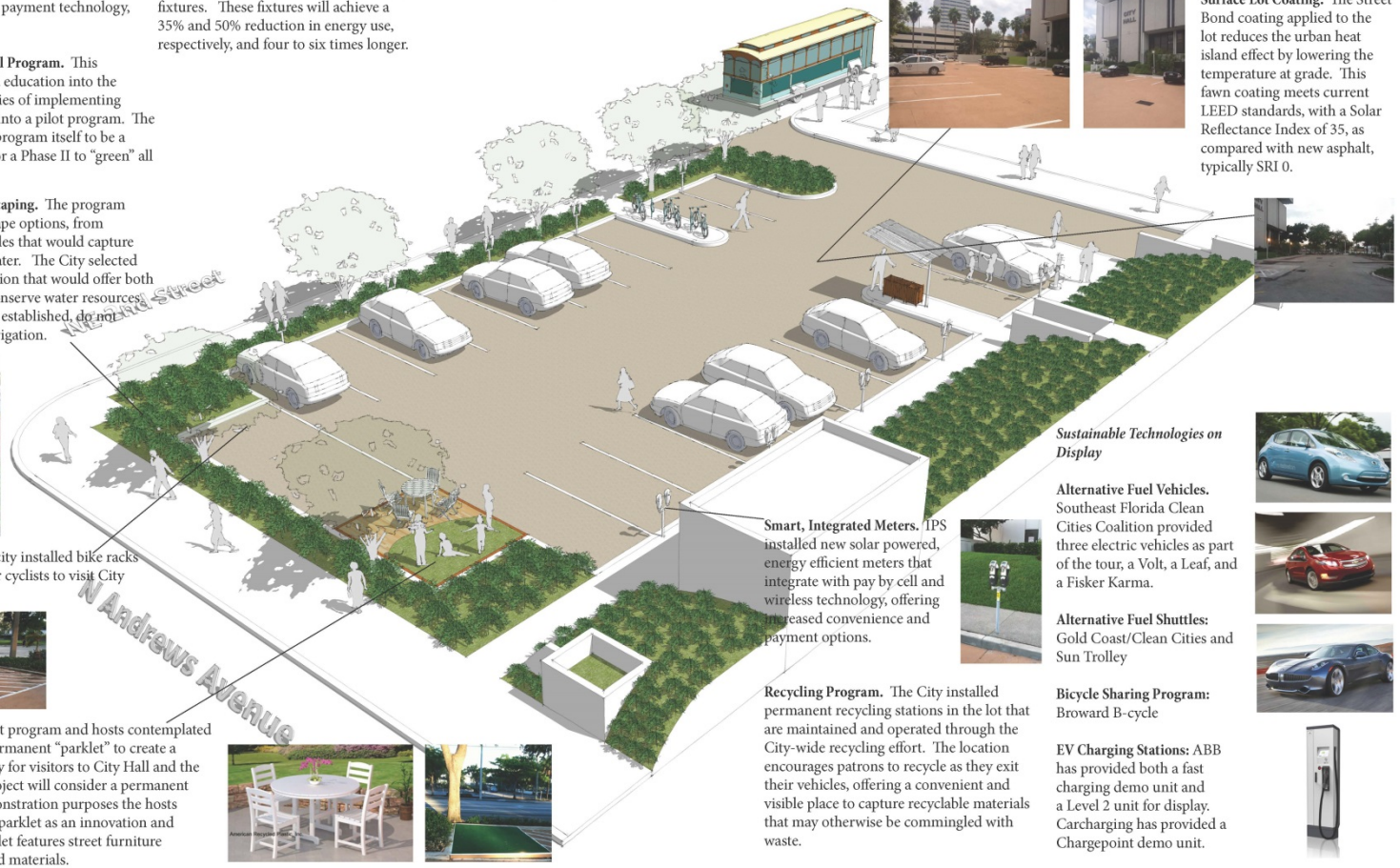
Water Efficient Landscaping. The program considered all landscape options, from xeriscaping to bioswales that would capture and infiltrate stormwater. The City selected water efficient vegetation that would offer both aesthetic value and conserve water resources. These plantings, once established, do not require permanent irrigation.

Bicycle Parking. The city installed bike racks to increase options for cyclists to visit City Hall.

Placemaking. The pilot program and hosts contemplated the installation of a permanent "parklet" to create a pocket park as amenity for visitors to City Hall and the lot. Phase II of the project will consider a permanent installation – for demonstration purposes the hosts included a temporary parklet as an innovation and inspiration. This parklet features street furniture constructed of recycled materials.

Energy Efficient Lighting and Controls. Eco Parking Lights provided retrofits of eight fixtures, including the ECO Bracket Induction retrofit solution as well as an LED solution on the four low profile lighting fixtures. These fixtures will achieve a 35% and 50% reduction in energy use, respectively, and four to six times longer.

Pervious Paving. The pilot project explored options for pervious paving, and will consider implementation during Phase II. The pilot showcases two parking spaces constructed of pervious concrete, located east of the drive-thru at the metered parking spaces.



Surface Lot Coating. The Street Bond coating applied to the lot reduces the urban heat island effect by lowering the temperature at grade. This fawn coating meets current LEED standards, with a Solar Reflectance Index of 35, as compared with new asphalt, typically SRI 0.

Smart, Integrated Meters. IPS installed new solar powered, energy efficient meters that integrate with pay by cell and wireless technology, offering increased convenience and payment options.

Recycling Program. The City installed permanent recycling stations in the lot that are maintained and operated through the City-wide recycling effort. The location encourages patrons to recycle as they exit their vehicles, offering a convenient and visible place to capture recyclable materials that may otherwise be commingled with waste.

Sustainable Technologies on Display

Alternative Fuel Vehicles. Southeast Florida Clean Cities Coalition provided three electric vehicles as part of the tour, a Volt, a Leaf, and a Fisker Karma.

Alternative Fuel Shuttles: Gold Coast/Clean Cities and Sun Trolley

Bicycle Sharing Program: Broward B-cycle

EV Charging Stations: ABB has provided both a fast charging demo unit and a Level 2 unit for display. Carcharging has provided a Chargepoint demo unit.

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Questions

Thank You Presenters!

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This webinar and additional supplemental materials will be available at:

http://greenparkingcouncil.org/

For more information please contact:

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Suggestions for future webinars?

Please email: trevyr@greenparkingcouncil.org

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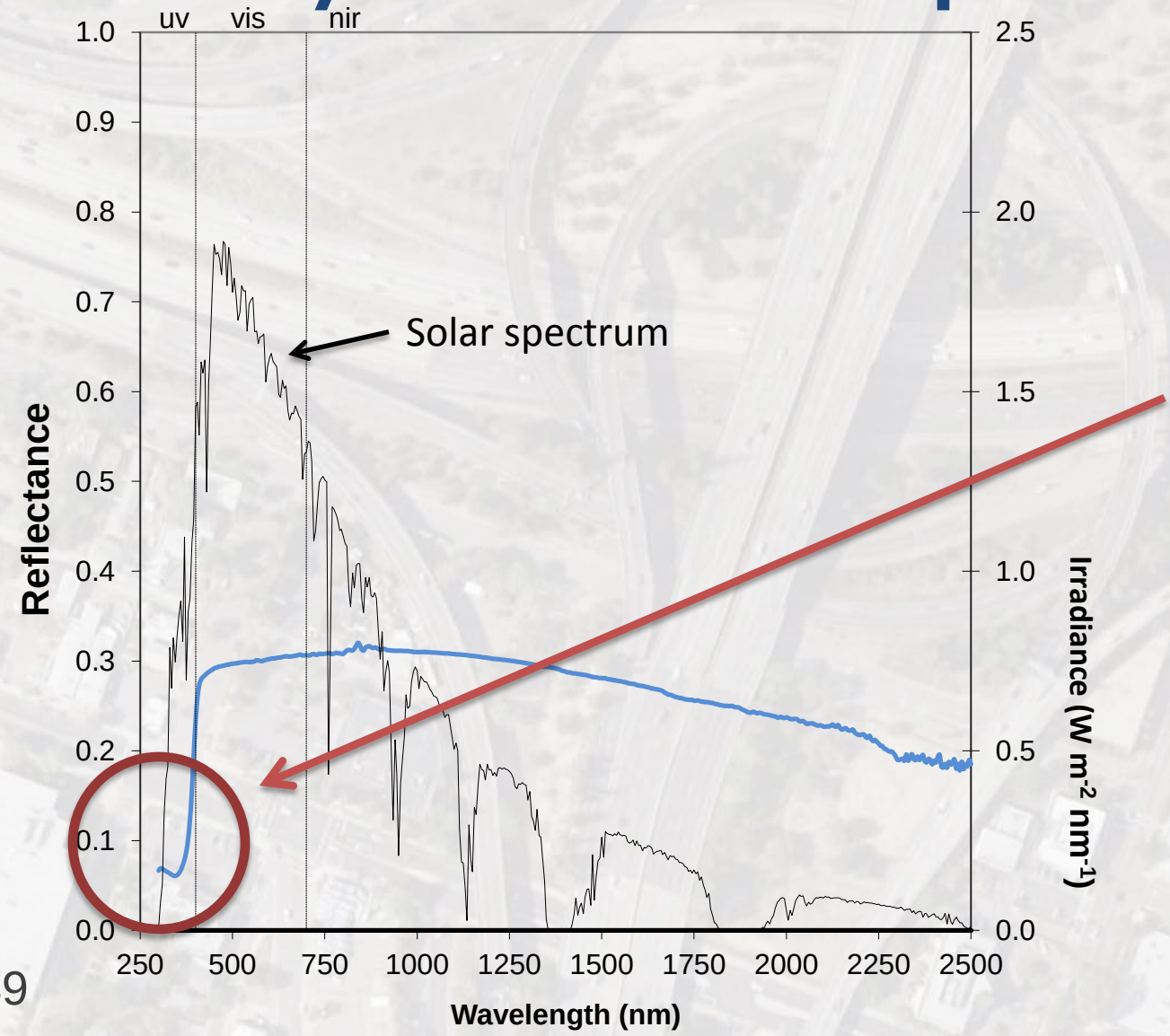
Addendum

Frequently asked questions

Reflective pavements do not always increase exposure to UV



The cool coating absorbs the sun's energy in the UV part of the solar spectrum & reflects in the visible & near infrared

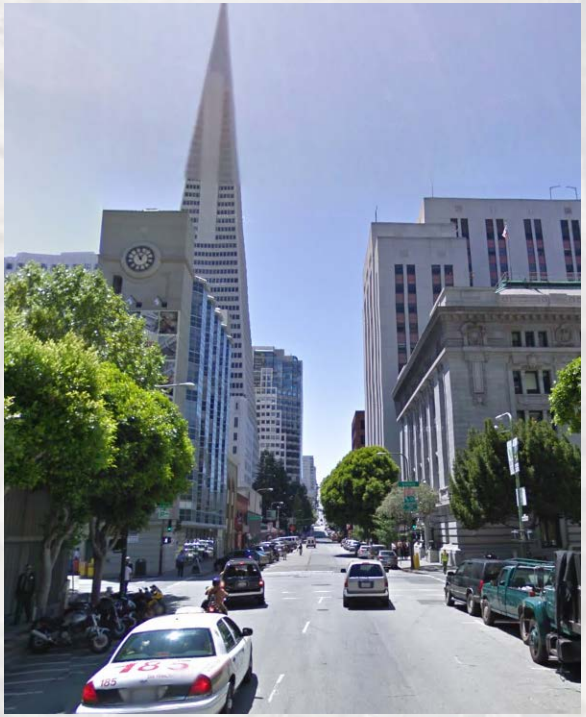
California is leading the way

- **Cool pavement legislation (AB 296)**
  - Guidance for CA local governments evaluating cool pavement strategies
- **California Green Building Standards**
  - CALGreen
- **Climate action/adaptation plans**
  - San Luis Obispo, Novato, Napa
  - Chula Vista: Pilot project to evaluate cool pavement strategies; inform city implementation into municipal/private projects
- **Air Quality Management Districts**
  - Included in Clean Air Plans – regulatory and educational approaches

National progress

- **Leadership in Energy and Environmental Design (LEED)**
  - Includes credit for high-albedo materials (SRI ≥ 29) for 30% of hardscape
- **GreenRoads**
  - Includes credit for high-albedo materials (SR ≥ 0.30) for 50% of project
- **Life-cycle assessment (LCA) tools**
  - Emphasize life-cycle benefits and costs that help cool pavements compete with conventional pavement materials

Urban geometry



Financial District, San Francisco, CA

Northern Park, San Francisco, CA

Image source: Google Maps