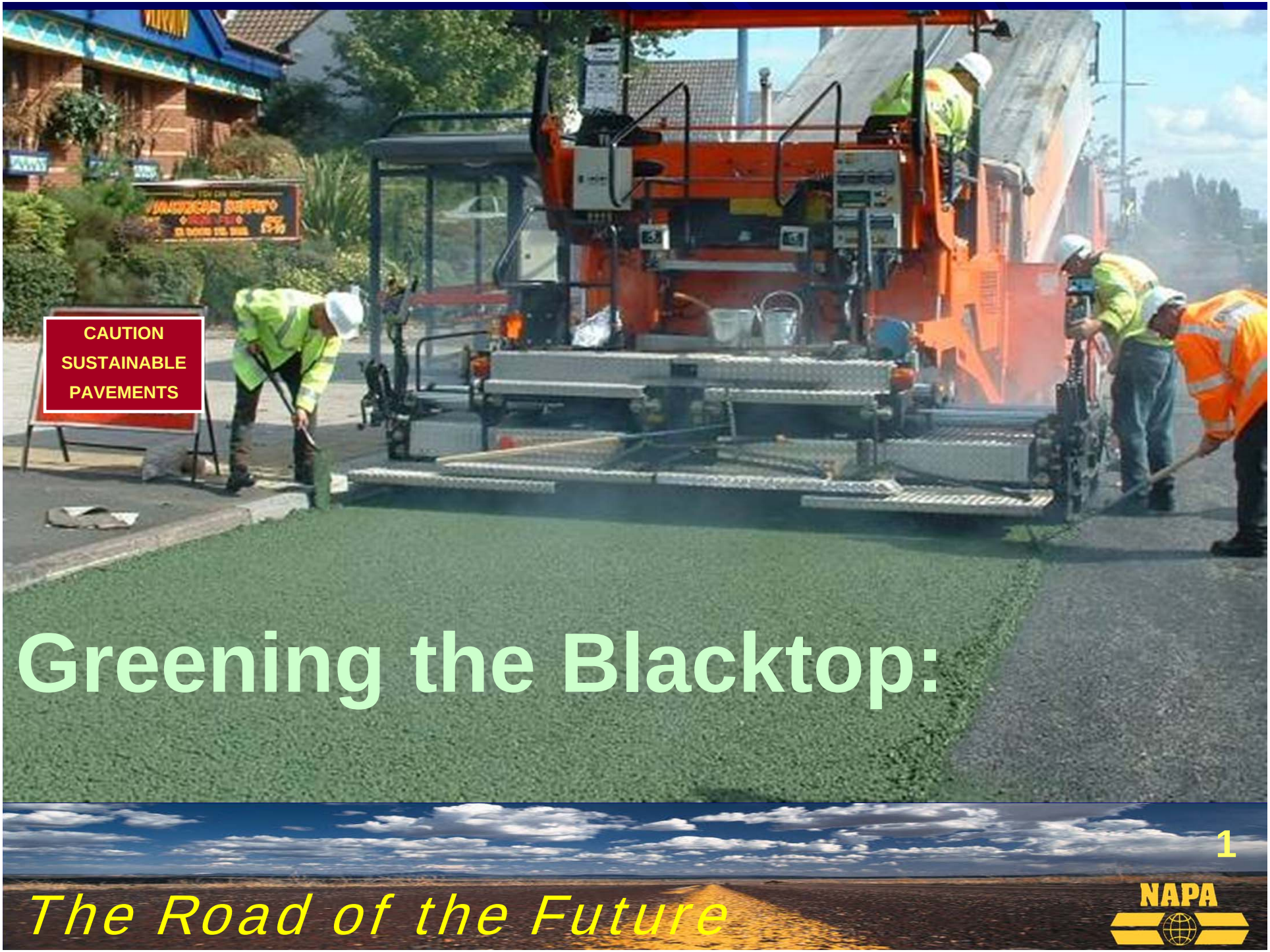
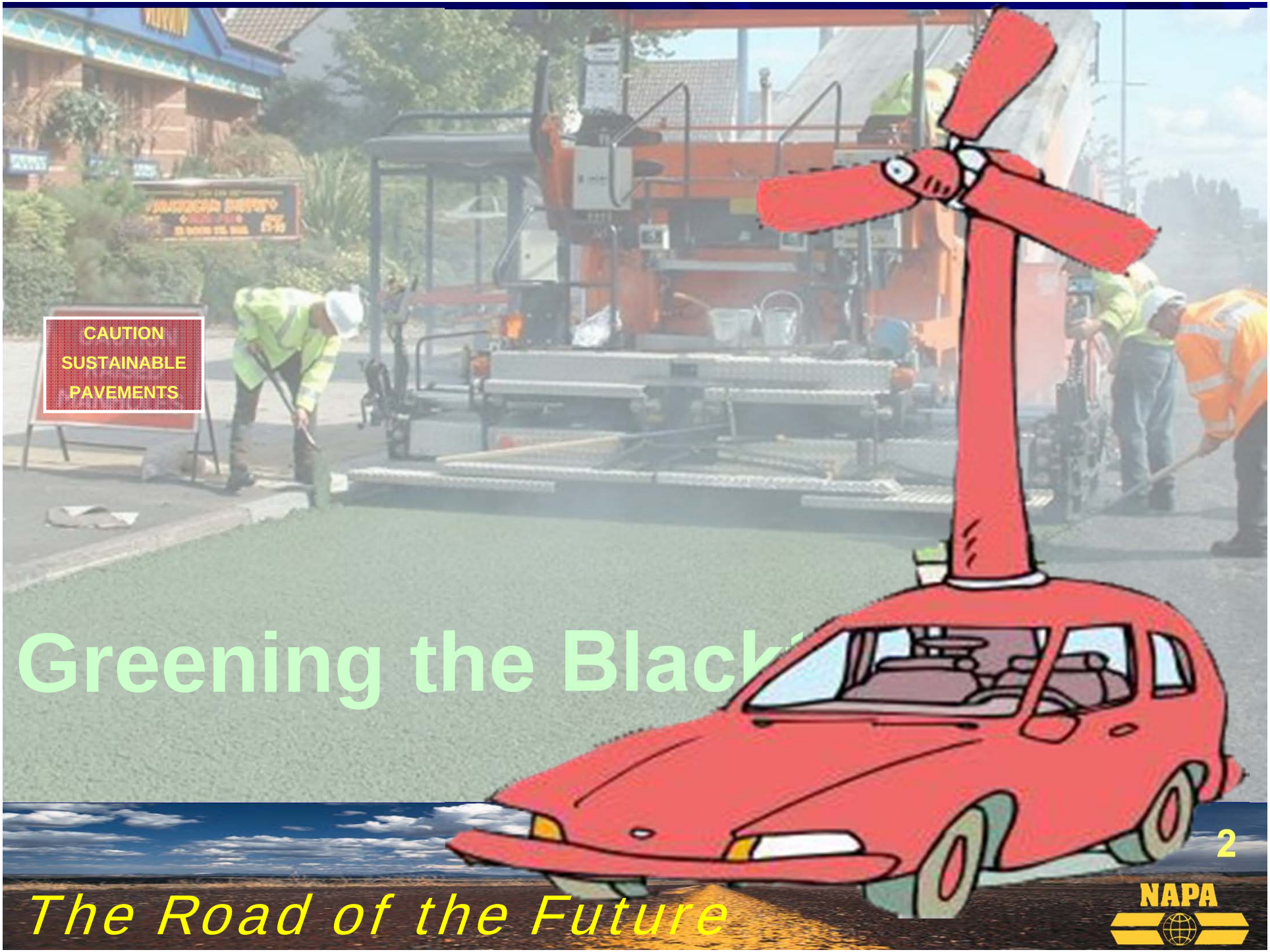


Greening the Blacktop:

The Road of the Future

NAPA



Greening the Black

The Road of the Future

NAPA

- Understanding what is driving America green
- Porous Pavement
- Re-USE with RAP
- Urban Heat Island: not Black-and-White
- Warm Mix
- Carbon Footprints
- Smoothness MATTERS !!
- Green metrics

- **Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.**

(environmental) sustainability

NAPA

- Reduce the Demand on Non-Renewable Natural Resources
- Reduce energy consumption
- Reduce Carbon Footprint of Pavements
- Improved water quality with porous pvmts
- Longer-Lasting Pavements

sustainability goals

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s of life in America. Want
ink about the fact that 94
f the paved roads in
are surfaced with asphalt.
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Jobs in asphalt - new white paper
Lanham, MD – The Asphalt Pavement Alliance announces the release of a new white paper, Jobs in ...
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New APA paper examines greenhouse gas production of asphalt and concrete pavements. Guess who wins? http://ht.ly/2Kphd
APA paper 'Role of Asphalt in Livable Communities' on versatility of asphalt & sustainable qualities

BLACK AND GREEN

Sustainable Asphalt, Now and Tomorrow

NAPA
NATIONAL ASPHALT
PAVEMENT ASSOCIATION

Paving Greener with ASPHALT

November 17 - 18, 2010 • Crowne Plaza Denver Airport • Denver, CO

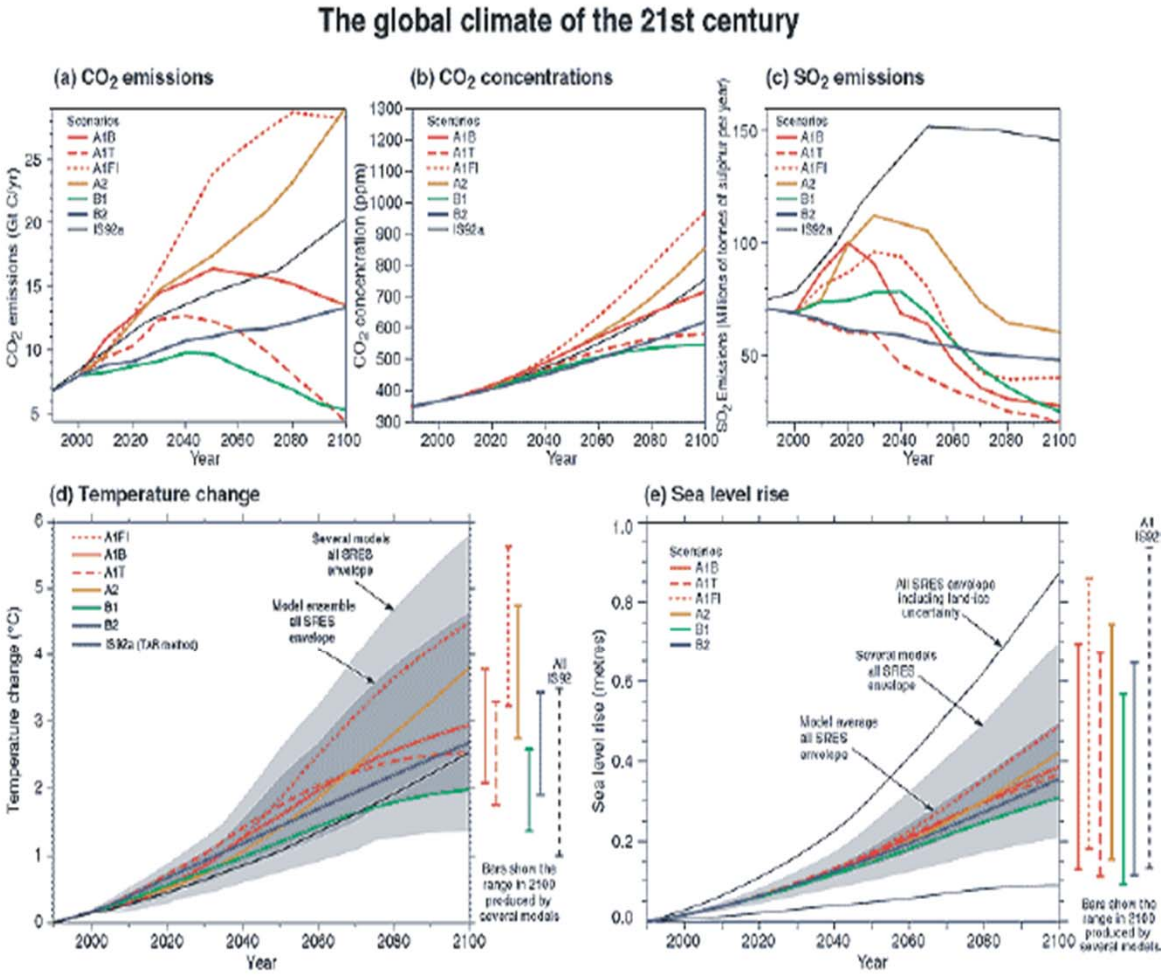
auto exhaust – driving green

NAPA

PROJECTIONS OF FUTURE GLOBAL CLIMATE

Intergovernmental Panel
e Change (IPCC) assess-
ects that global surface air
re could increase by 2.5 to
global sea level could rise
s between 1990 and 2100.

of projected climate change
lace to place around the world.
te will depend on both natural
l the response of the climate
man choices about emissions.



Future climate depends on natural changes and human activities.

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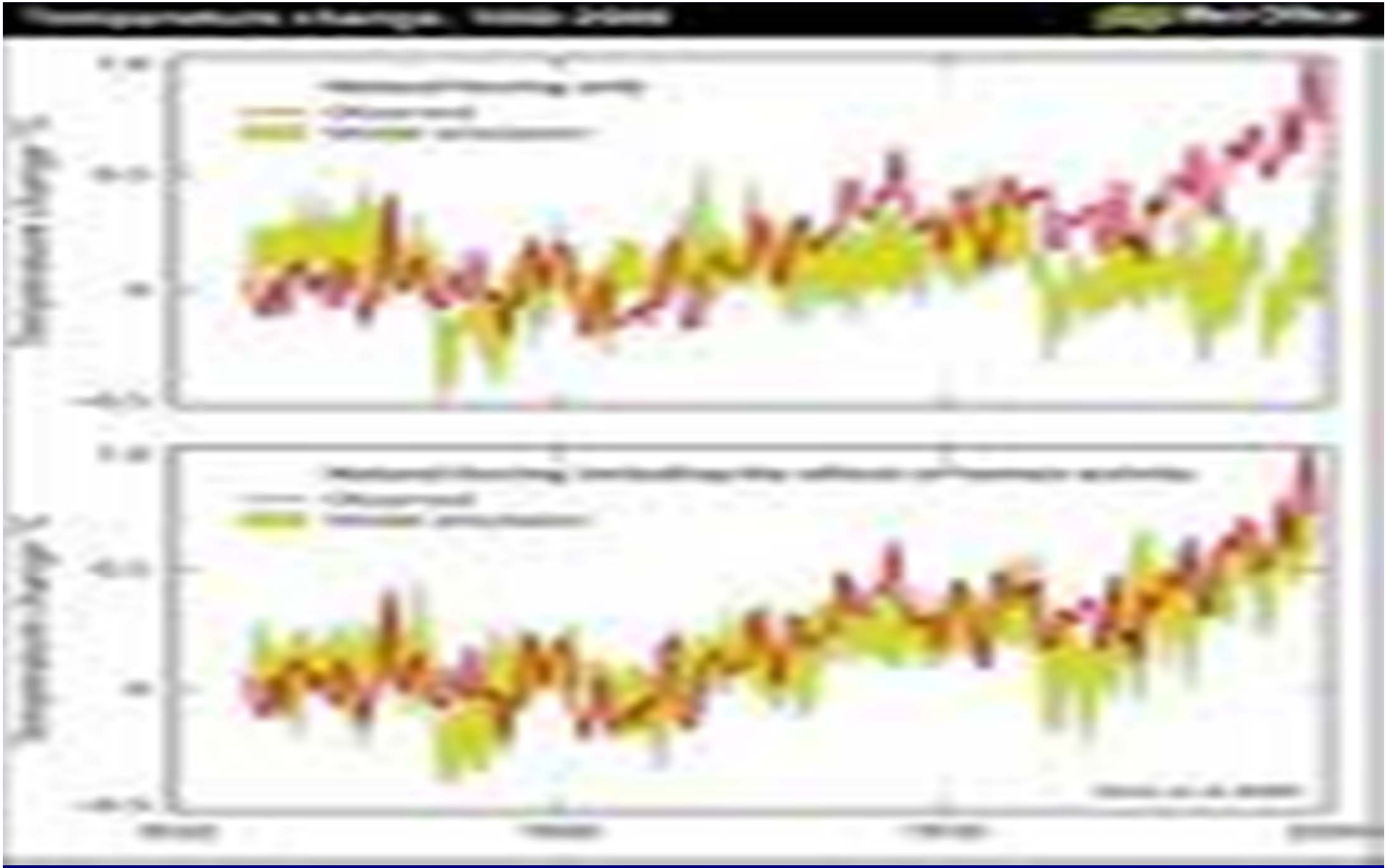

climate change – driving green

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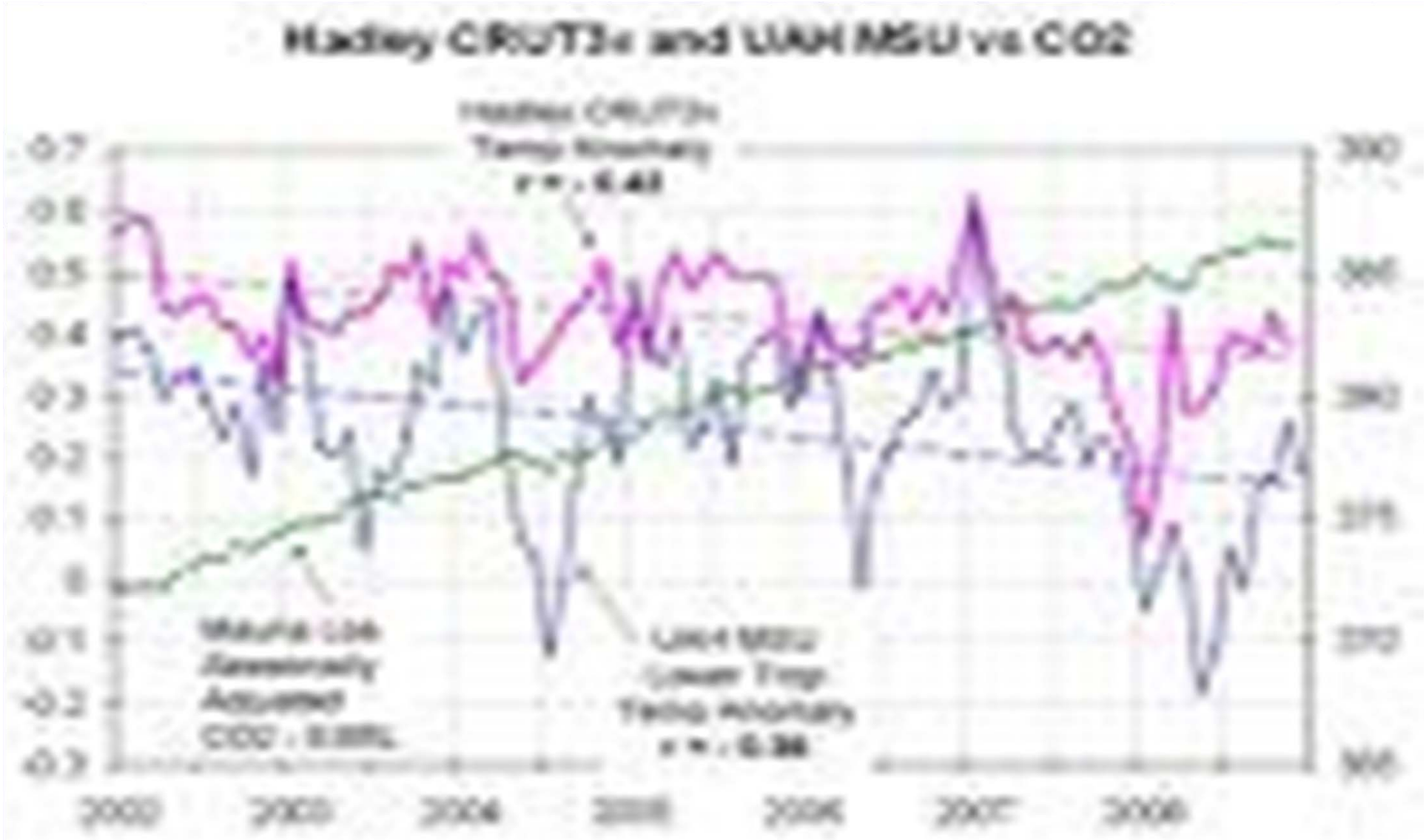

climate change – driving green

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proof of global warming

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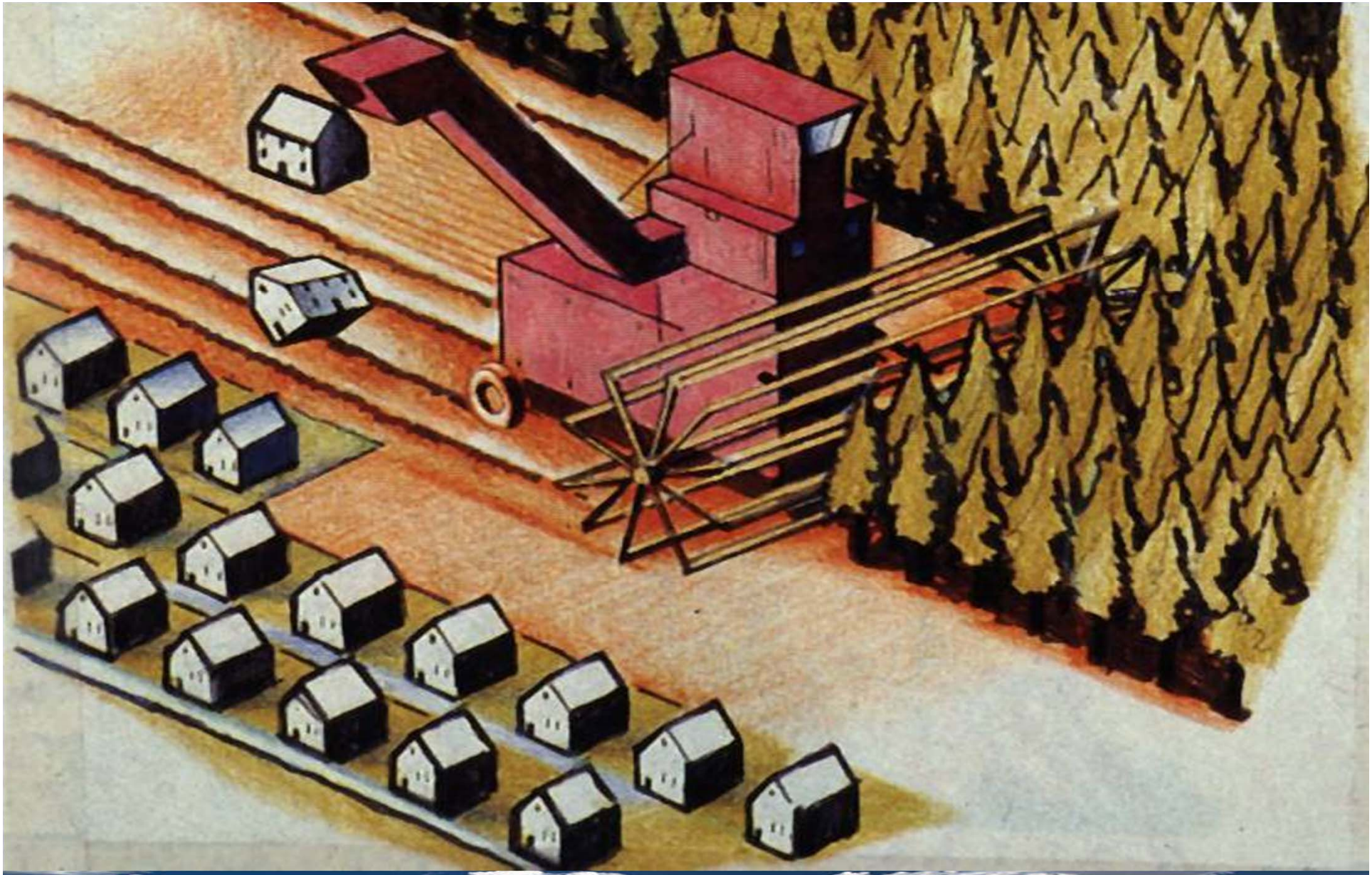
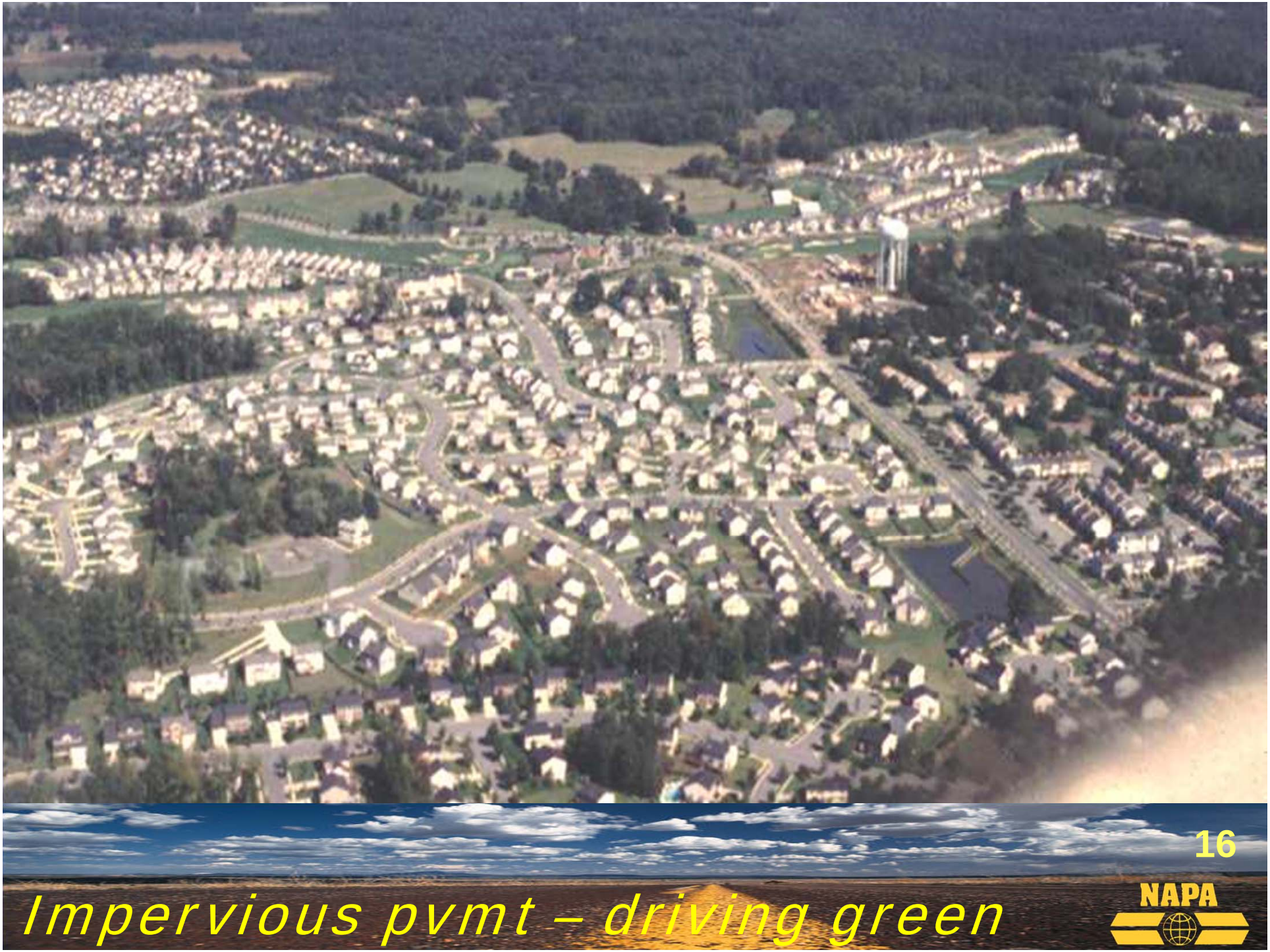
America's current Leadership



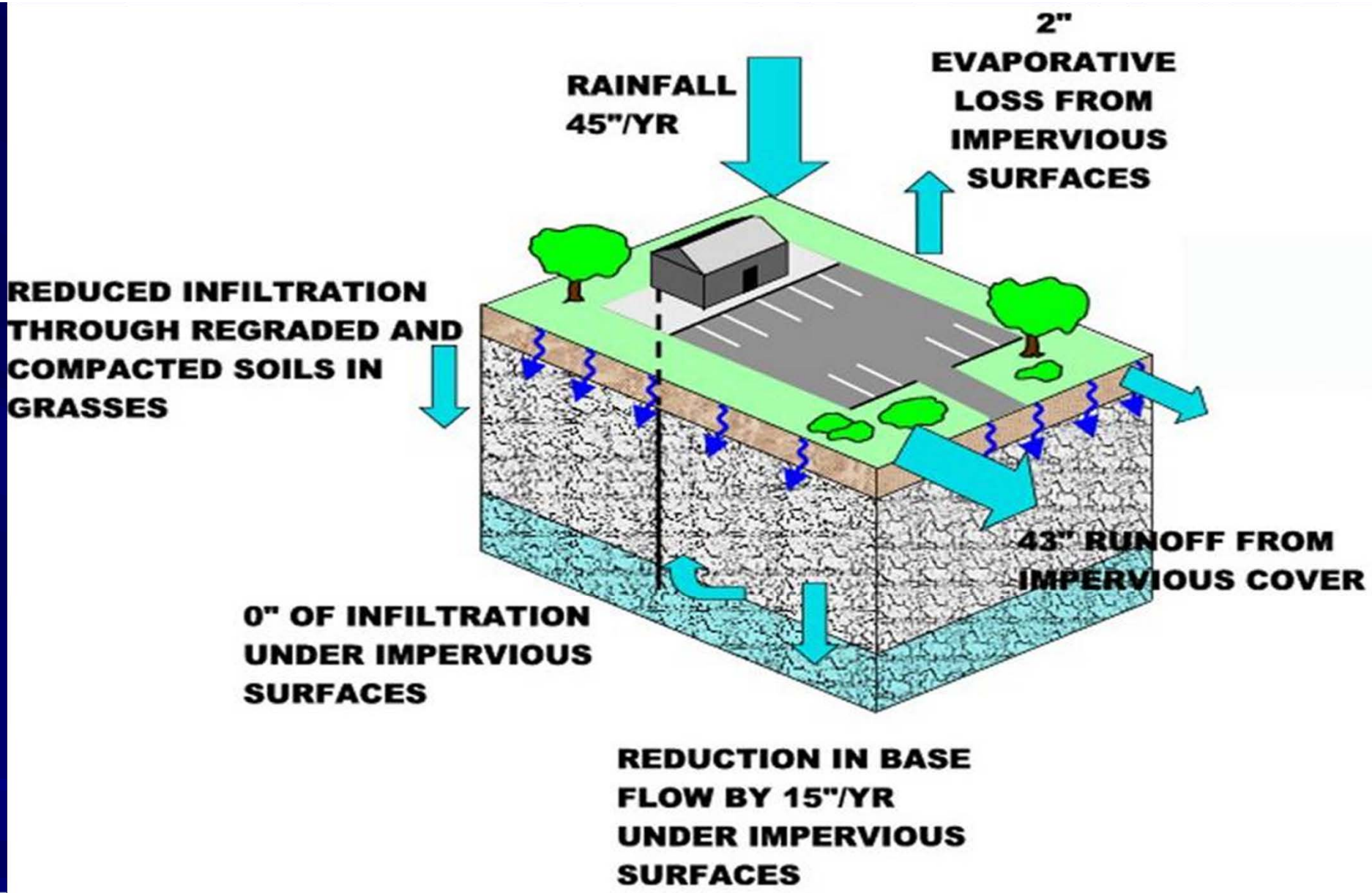
urban development – driving green



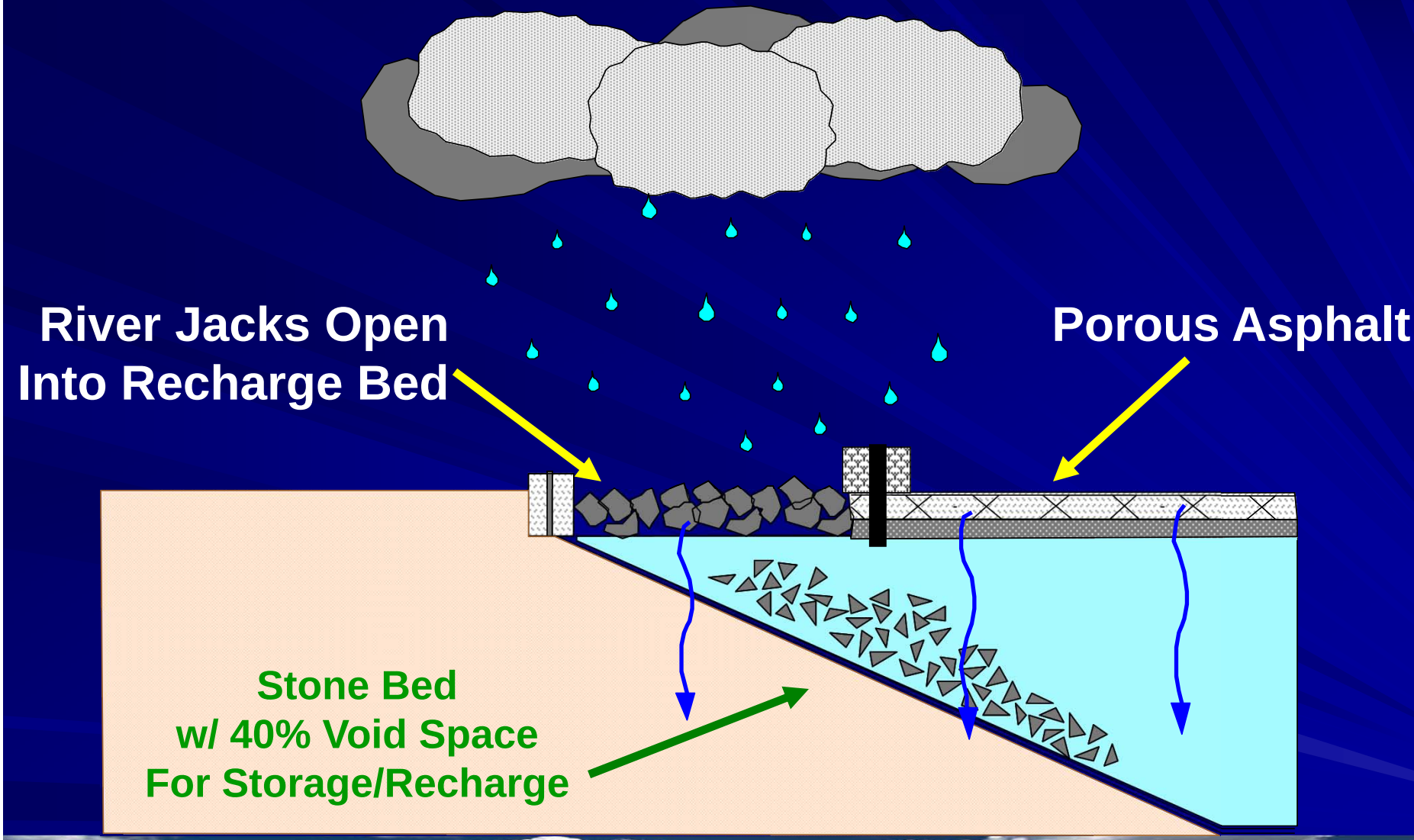
Impervious pvmt – driving green

stormwater management

NAPA


RAINFALL
45"/YR
2"
EVAPORATIVE
LOSS FROM
IMPERVIOUS
SURFACES
REDUCED INFILTRATION
THROUGH REGRADED AND
COMPACTED SOILS IN
GRASSES
43" RUNOFF FROM
IMPERVIOUS COVER
0" OF INFILTRATION
UNDER IMPERVIOUS
SURFACES
REDUCTION IN BASE
FLOW BY 15"/YR
UNDER IMPERVIOUS
SURFACES

Porous Pavement with Recharge Bed



Univ. NC: add'l parking lot constructed ca. 2002

Pringle Creek COMMUNITY

LET'S BUILD A PLACE...

OVERVIEW | PRINCIPLES | COMMUNITY | LOCATION | RESOURCES | CONTACT

WHAT IS A GREEN STREET?

The streets at Pringle Creek Community are part of an integrated water infiltration system that captures, absorbs and filters stormwater instead of sending it downstream in pipes. If the first one inch of every rainfall is captured and absorbed, 90% of rainwater is prevented from entering stormwater pipes.

Read More >

View Street Diagram >

Taxes on impervious residential surfaces – your state . . . and more states to come

porous streets !!

NAPA

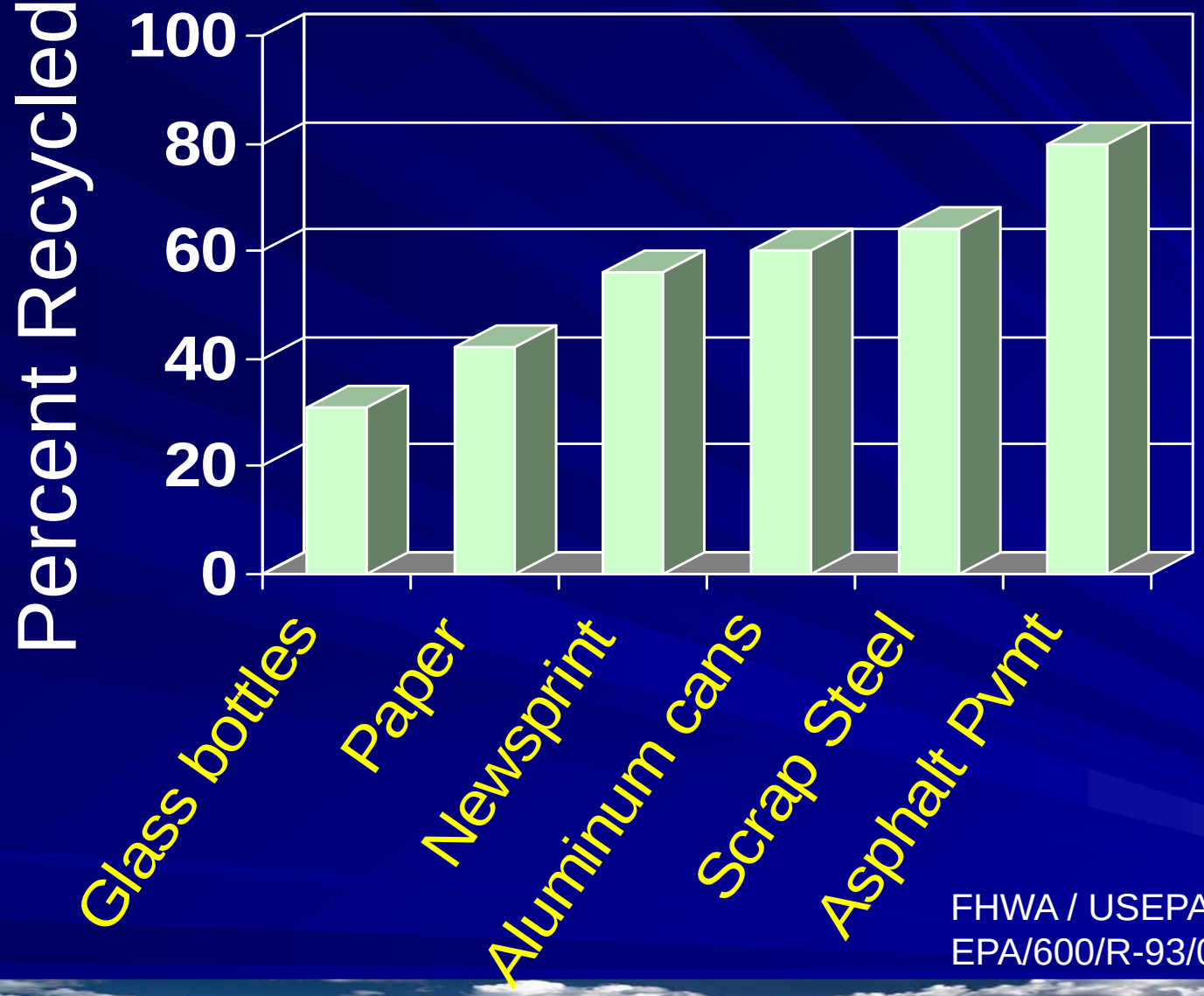
- Porous Friction Course (PFC or OGFC) have proven advantages:
  - Safety
  - Smoothness
  - Reduced road noise
  - Stormwater Runoff Quality
  - Recycled tire rubber (some)

recycled content: "RAP"

NAPA

Reclaimed Asphalt Pavement "RAP"

- Removed and/or reprocessed pavement materials containing asphalt and aggregates
- Over 80 percent of the asphalt pavement, removed each year for widening and resurfacing, is re-used
- Represents close to 100 million tons / year
- RAP is the Nation's No. 1 recycled material in both total amount and percentage recycled



FHWA / USEPA Report to Congress, EPA/600/R-93/095.

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- Recycle = processing a used material into a new raw material or product
- "Reused" for the same purpose is the key
  - Much greater "value"
- Asphalt can be reactivated / reused
- RAP is "reused" back into pavement
  - Cement / concrete – aggregate only

Common Recycled Materials in Asphalt Pavements

- Shingles
- Crumb / Tire Rubber
- Glass
- Slag
- Foundry sand
- All are in different stages of utilization / evaluation

recycled asphalt shingles (RAS)

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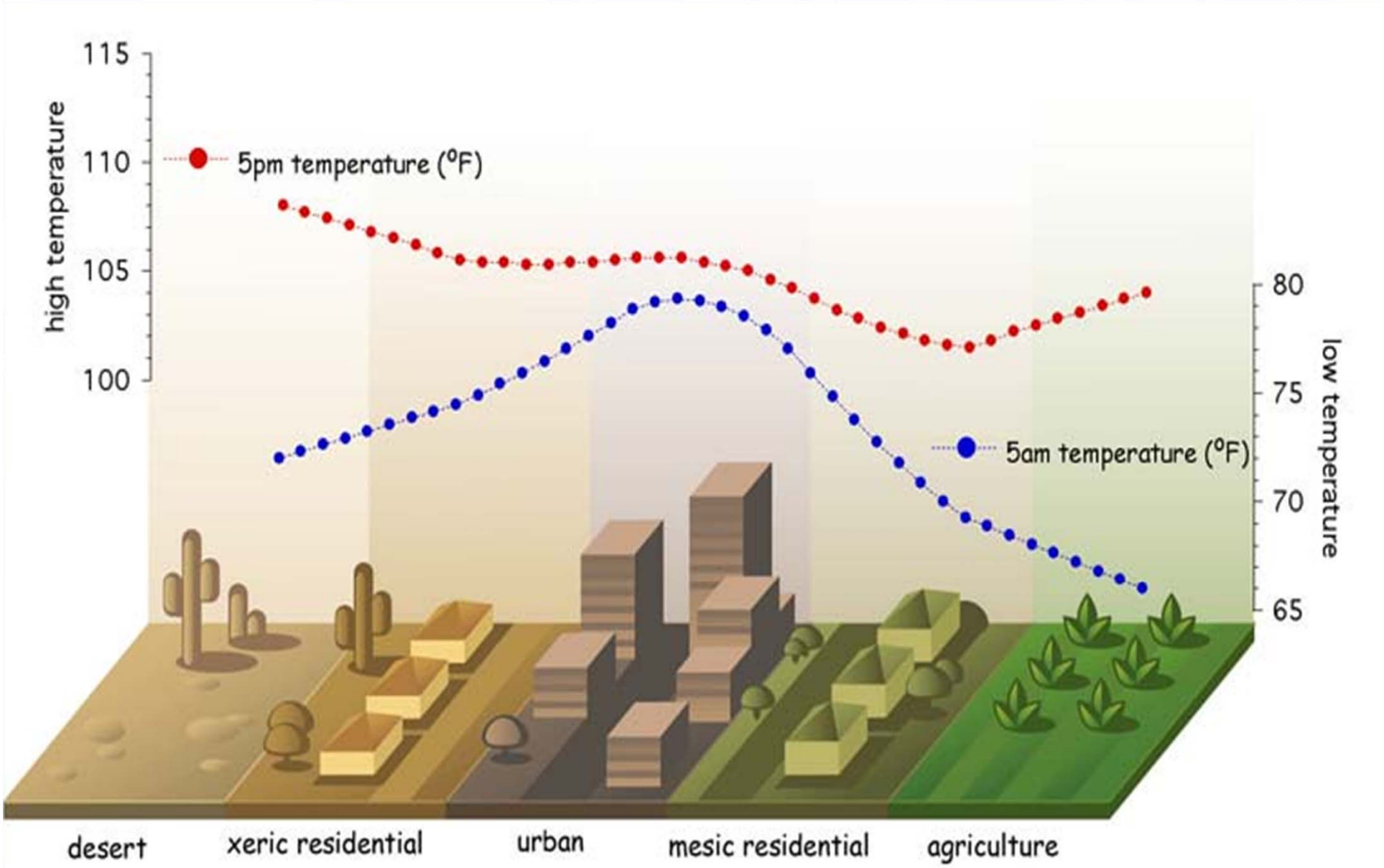


Urban Heat Islands: misperception

NAPA

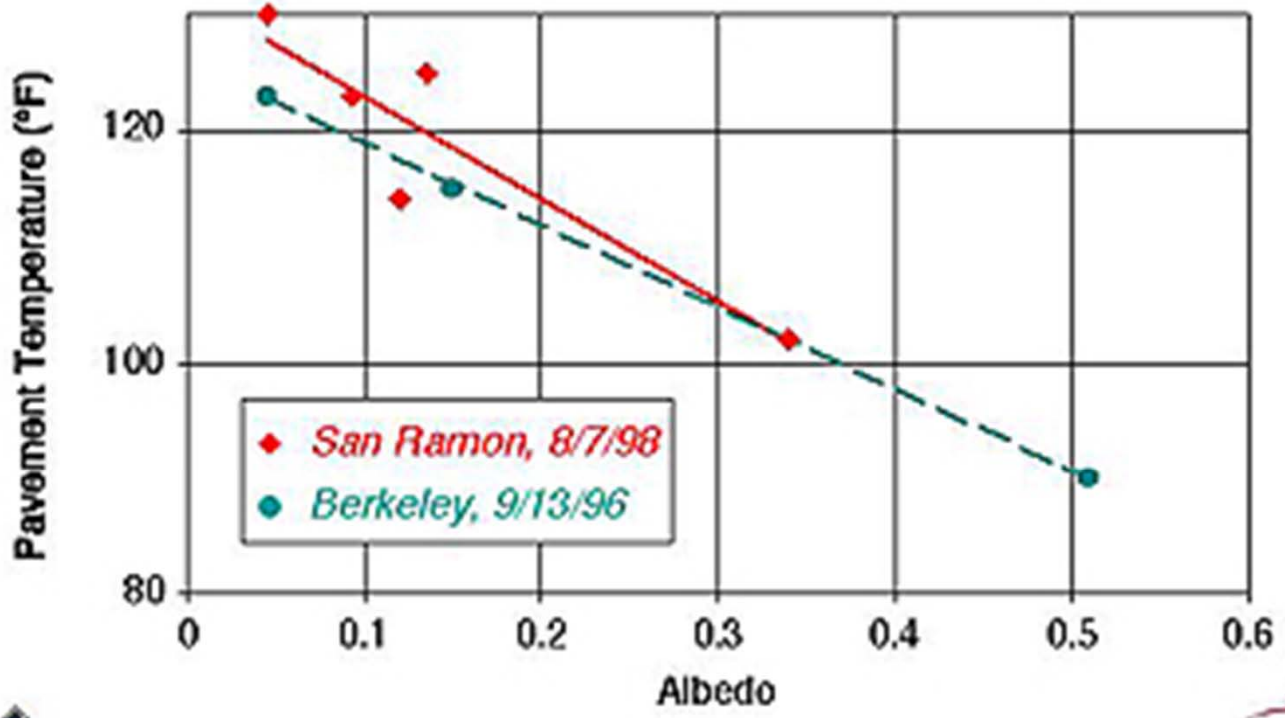
Myth

- Asphalt pavements contribute to UHI
- Reflective pavements are cooler than asphalt

Fact

- The “built” environment contributes to UHI
- OGFC pavements are cooler than concrete
- The hottest location in Phoenix is the airport
  - 23 inches of PCC
- UHI does NOT cause Global Warming – Sci. Am.

Pavement Temperatures *vs.* Albedos



myth or reality ?

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Location: University Dr., Tempe, AZ
Time: 2:30pm, May 15, 2007

Albedo = .192
Surf. Temp = 131, 131.5, 130 (°F)
Age = >5 years
Traffic = light foot, cart and bicycle traffic

Albedo = .090
Surf. Temp = 129.9, 130.2, 128.4 (°F)
Age = >5 years
Traffic = constant traffic

Albedo = .036
Surf. Temp = 146.8, 143.3, 147.4 (°F)
Age = 3 days
Traffic = no traffic

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SMART INNOVATIONS FOR URBAN CLIMATE AND ENERGY
ARIZONA STATE UNIVERSITY

reflectivity & temperatures

NAPA

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???

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reflectivity & temperatures

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Cooler Pavements → Cooler Air

Los Angeles: Simulate change of all pavement albedos (in < 20 years of normal maintenance)

- ***Input:***

  Albedo change = **0.25**
  Pavement area = 1,250 km²
  Urban area = 10,000 km²

  Normal LA weather

- ***Result:***

  –Decrease in air temperature ≅ 0.6°C (1°F)

= $$ Billions in reduced cooling costs

. . . and now CO2 reductions

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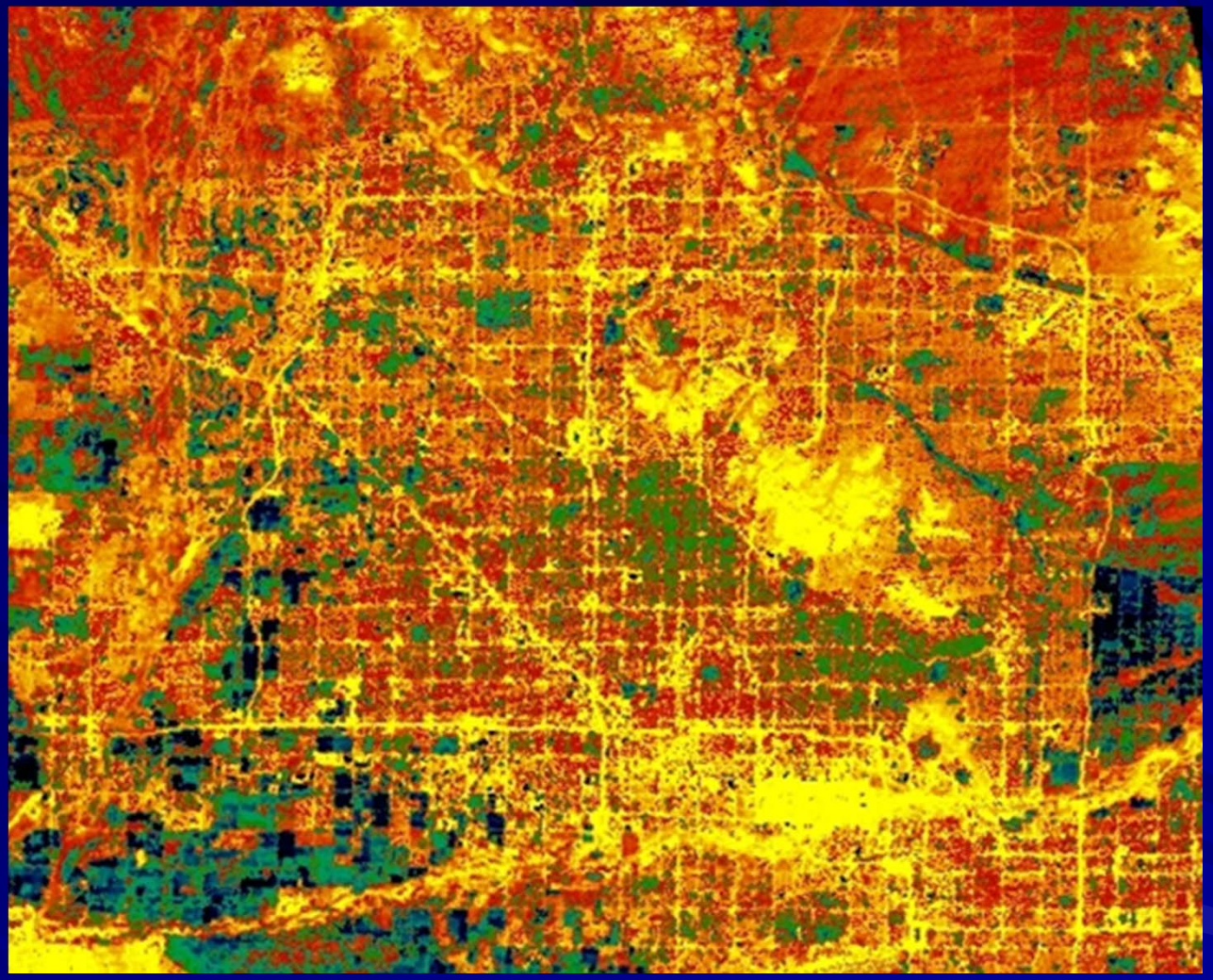
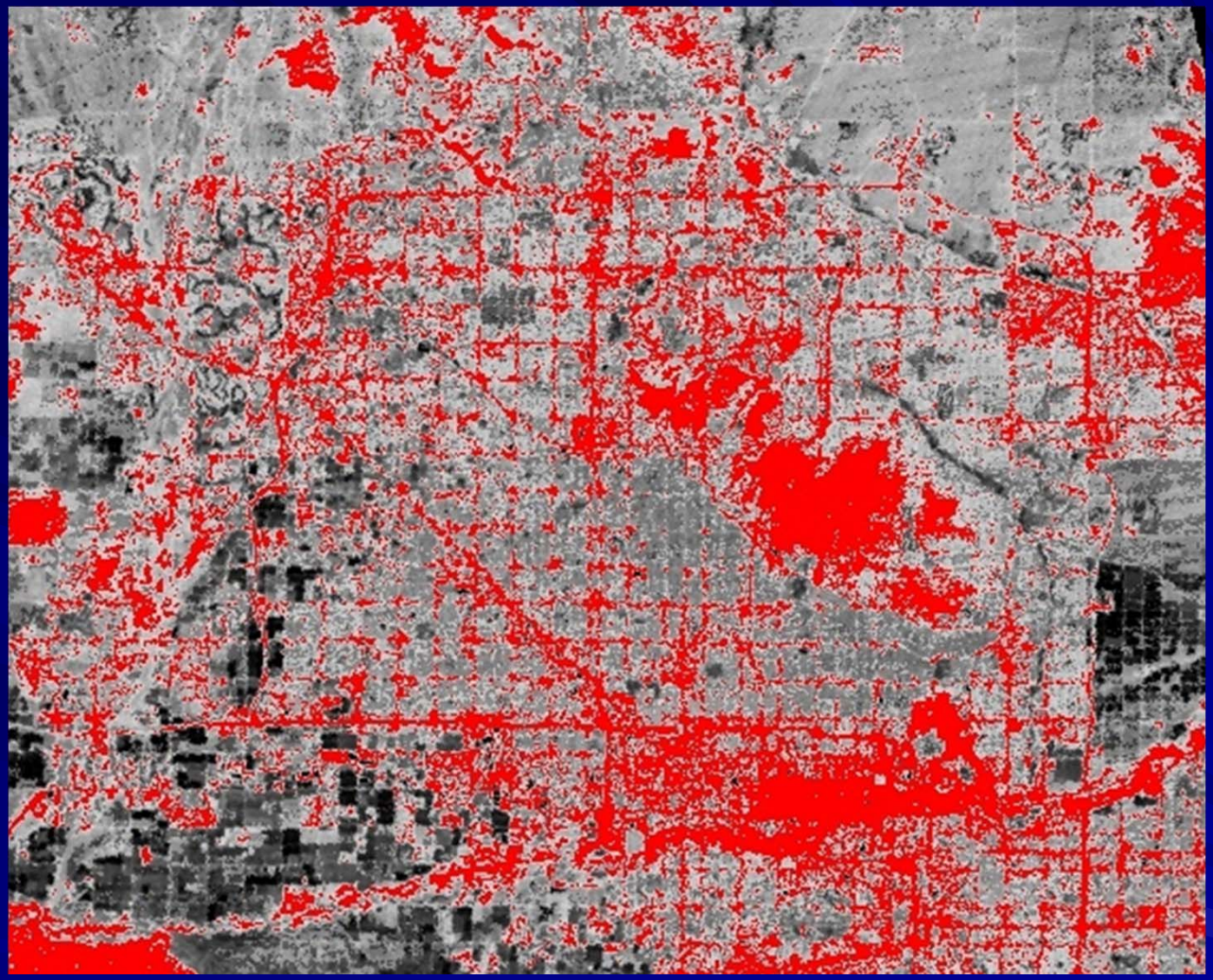
- Calif (proposed) legislative bill
  - Would require CalTrans to specify reflective pavements for all new roadway construction
  - Asphalt would need surface treatment
- Reliance on LEED for “green” decisions
  - Dark pavements penalized
- Dept of Energy and EPA looking at “green” construction practices
  - UHI seen as another “energy” drain

why is this important ?



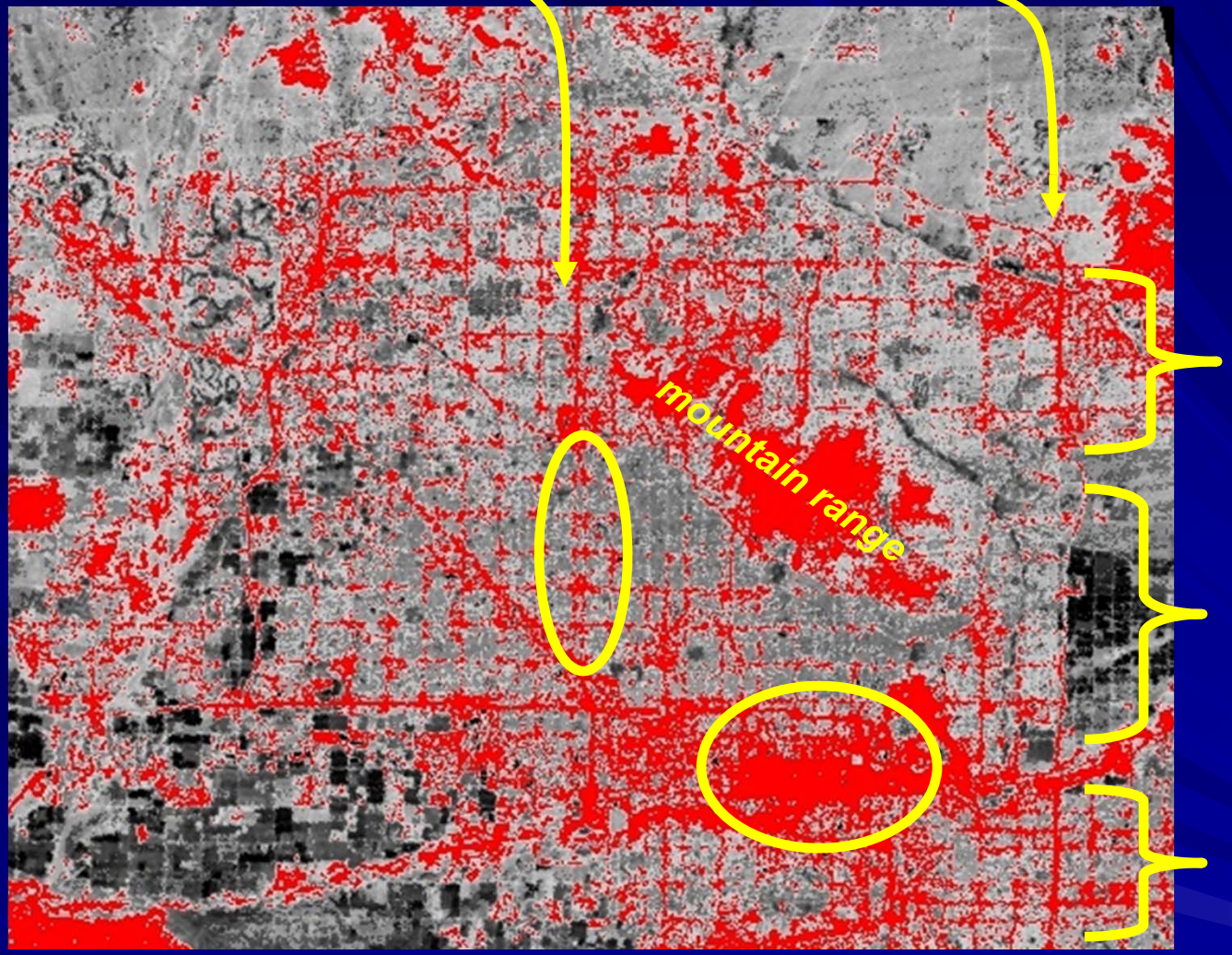
cooler pavements

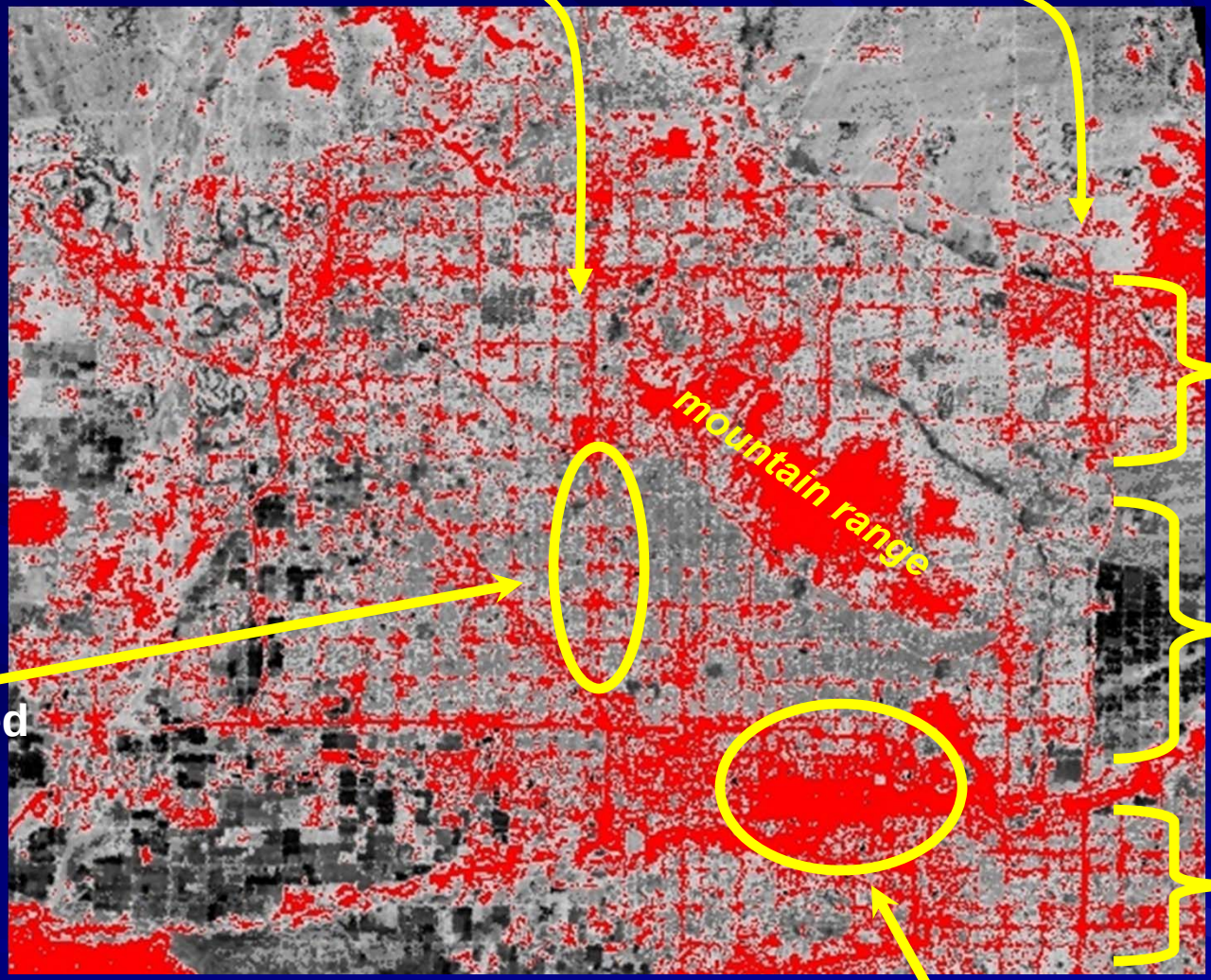
NAPA



cooler pavements

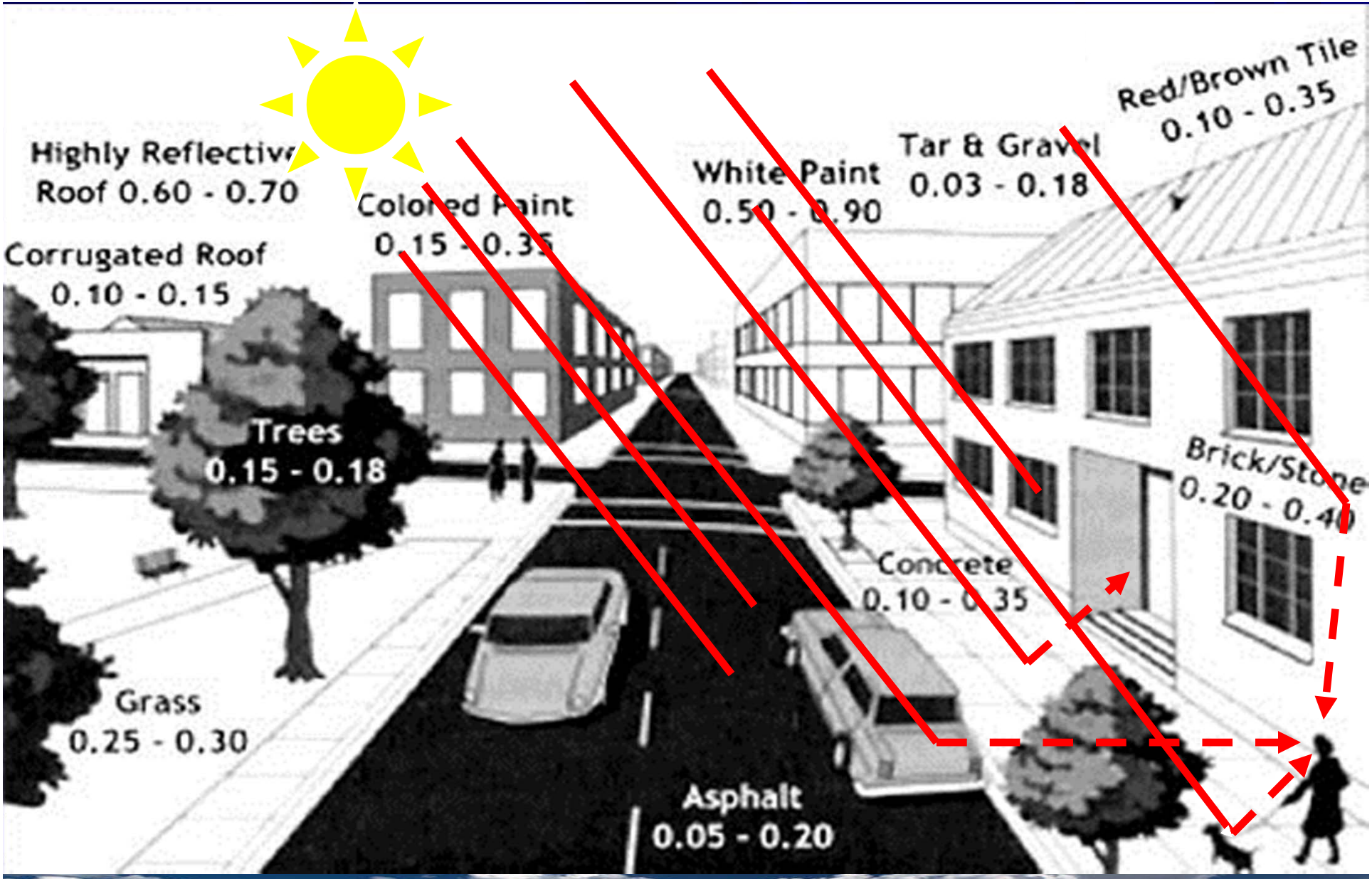
NAPA


Interstate w/ PCC
Highway w/ PCC
mountain range



cooler pavements

NAPA



are reflective pavements better ?

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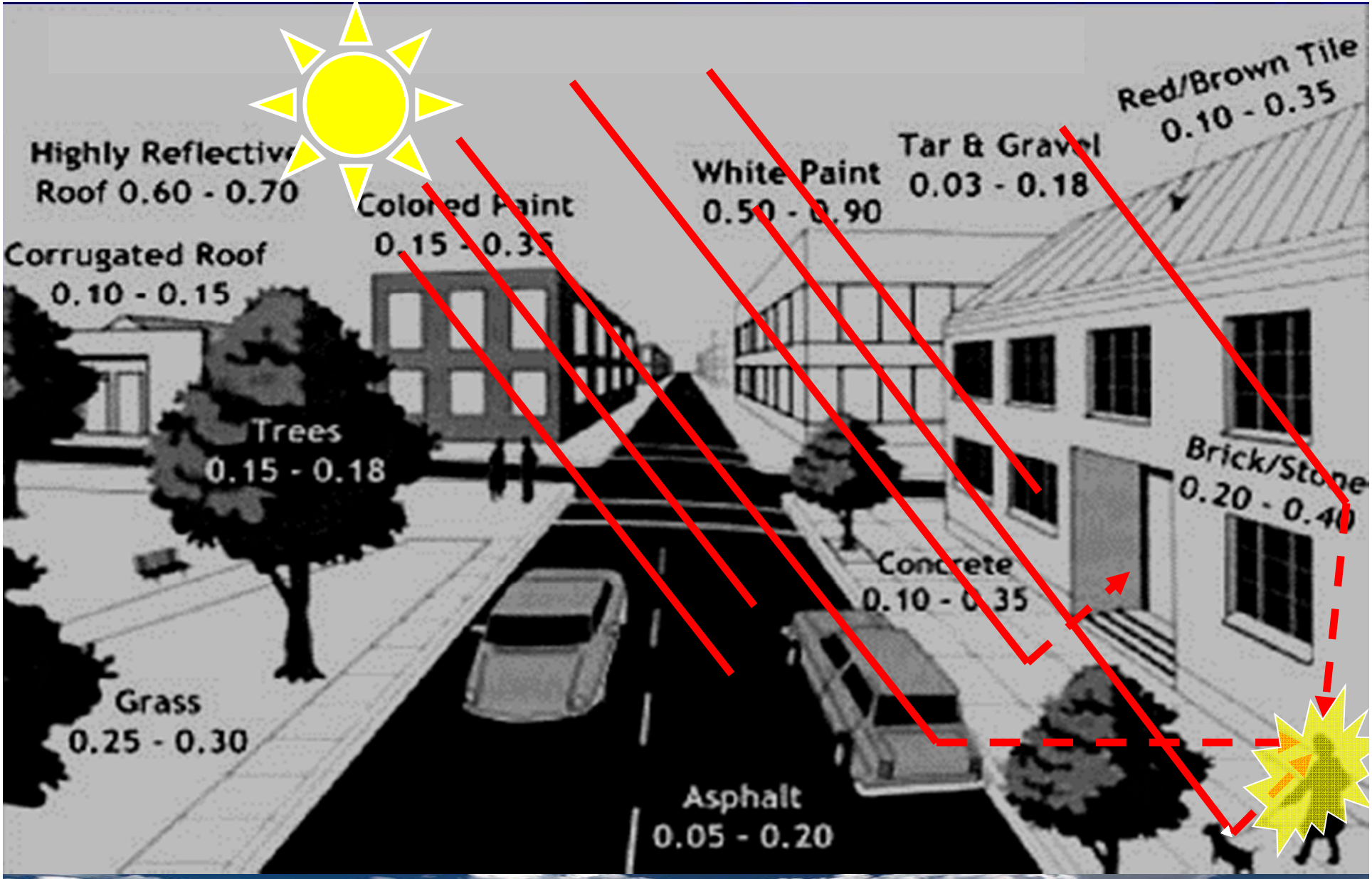

not quite . . .

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Surface Chip Seals and Coatings:
using reflective / light-colored chip / paints

“Gritting”:
reflective chips and aggregate

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Shot-Blasting:
abrading surface binder

Heat Island Effect

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- Heat Island Home
- Basic Information
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  - Green Roofs
  - Trees & Vegetation
  - Cool Pavements
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- Newsroom
- Publications
- Calendar
- Related Links
- Frequent Questions
- Glossary

Cool Pavements

■ - Denotes link to glossary definition

There is no official standard or labeling p
early stage.

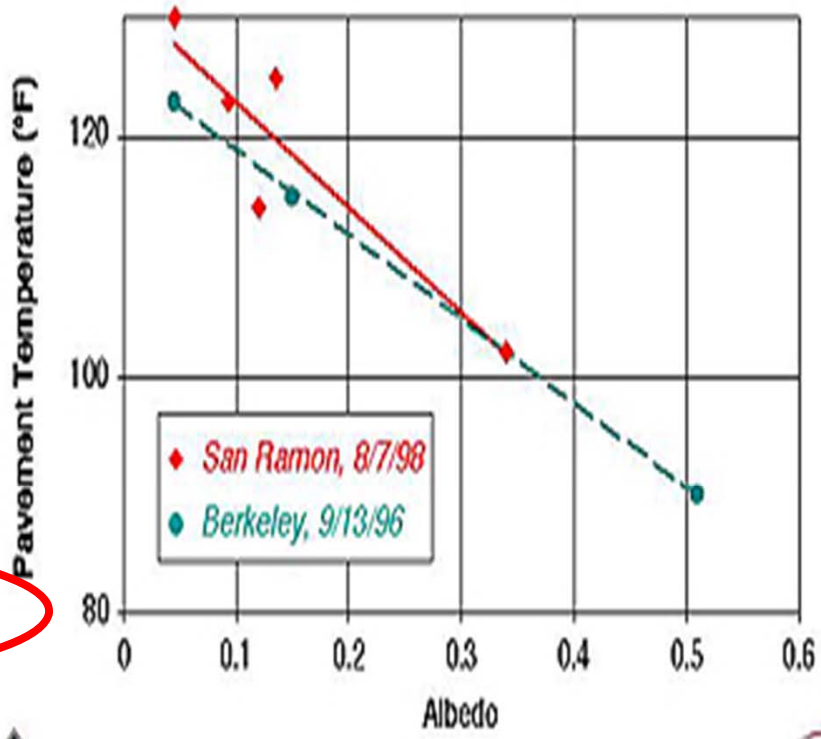
While studies show that pavements can a
several factors. These include the impact
time; and the absorption by buildings of s

There are situations, however, where cor
that lower surface temperature and achie
roadways with large expanses of paved s

Investigations of cool paving materials ha
Pavements with higher solar reflectance
pavements benefit from the cooling effec
construction are essential in applying eith

Other factors affecting performance, cos
the best solutions may occur where multi
help with storm water runoff as well as p

Pavement Temperatures vs. Albedos



It's NOT a black and white issue

- pavement thickness
- material capacities .
- reflected UV radiation / scatter
- pavement air voids (OGFC) cooler
- UHI does NOT cause Global Warming
- pavement impact on overall UHI is minimal

not black and white

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- **WMA is asphalt mix produced with special technologies at temperatures 50 to 100°F lower than typical HMA**
- **Over 20 WMA technologies are available in the U.S.**
- **Foam, additives, waxes**

WMA Temperature at Paver Screed

Comparison of Emissions of HMA and WMA

- Less energy to produce asphalt mixes
- Fewer emissions from asphalt plants
- Less fumes and odors
- Better workability at lower temperatures
- Extended paving season
- Longer haul distances


what's a carbon footprint ??
49
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“The total amount of greenhouse gas emissions caused directly and indirectly by a . . . product [or material].” Usually expressed in carbon dioxide “equivalents” (CO_2e).

- "carbon footprint" = total set of GHG emissions caused directly / indirectly by . . . product / process
- Raw materials extraction and processing
- Pavement manufacturing
- Pavement placement / transportation
- Pavement maintenance
- Numerous studies look at different components
  - Generally, values embedded as LCA inputs
- A number of entities have attempted to calculate pavement's carbon footprint – why?
  - mass of materials; potential GHG emissions
  - Municipalities "going green"

Building and Fire Research Laboratory

Office of Applied Economics

NIST National Institute of Standards and Technology

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BEES® 4.0

Home

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BEES Please

The BEES (**B**uilding for **E**nvironmental and **E**conomic **S**ustainability) software brings to your fingertips a powerful technique for selecting cost-effective, environmentally-preferable building products. Developed by the NIST (National Institute of Standards and Technology) Building and Fire Research Laboratory the tool is based on consensus standards and designed to be practical, flexible, and transparent. Version 4.0 of the Windows-based decision support software, aimed at designers, builders, and product manufacturers, includes actual environmental and economic performance data for 230 building products.

BEES: econ. & env. impacts

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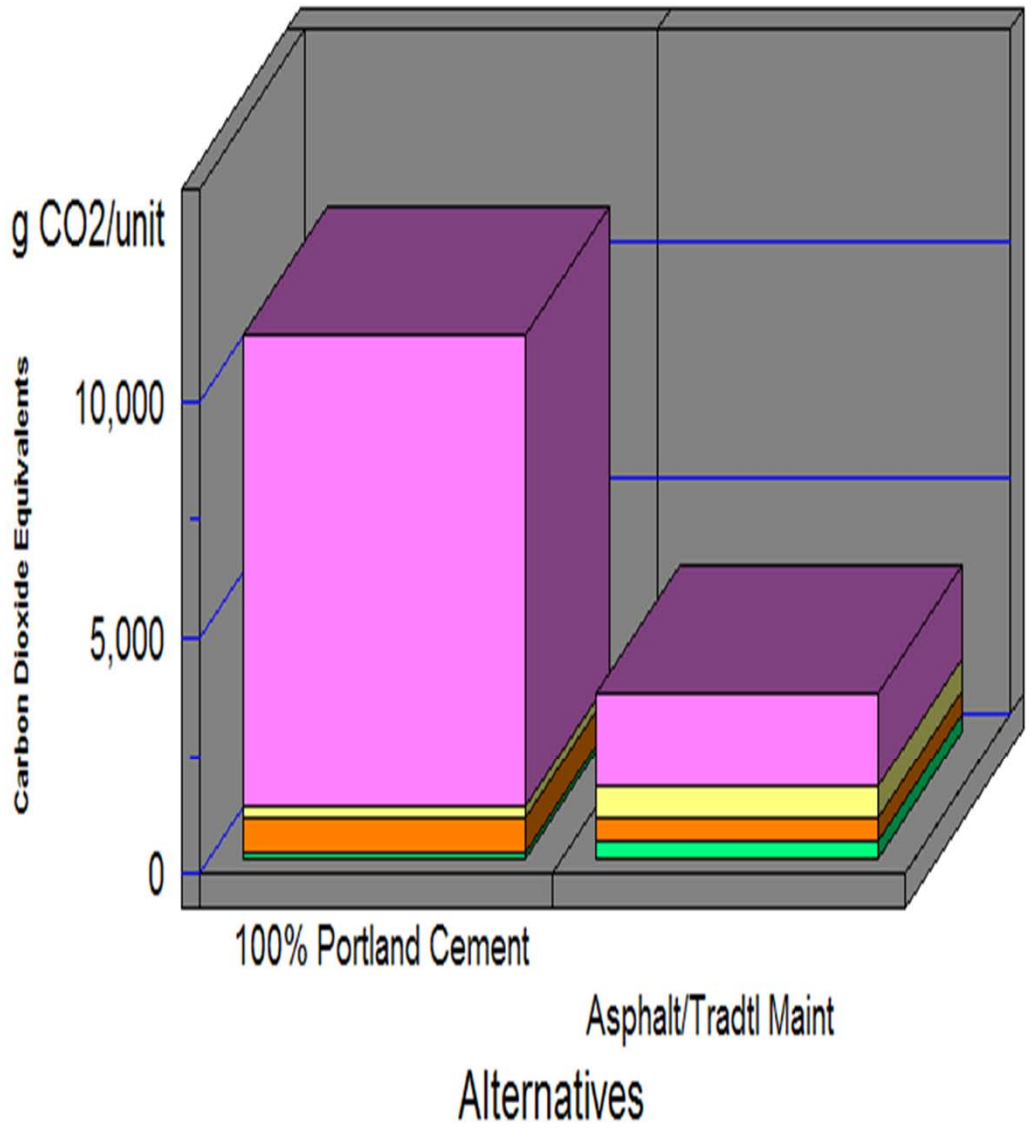
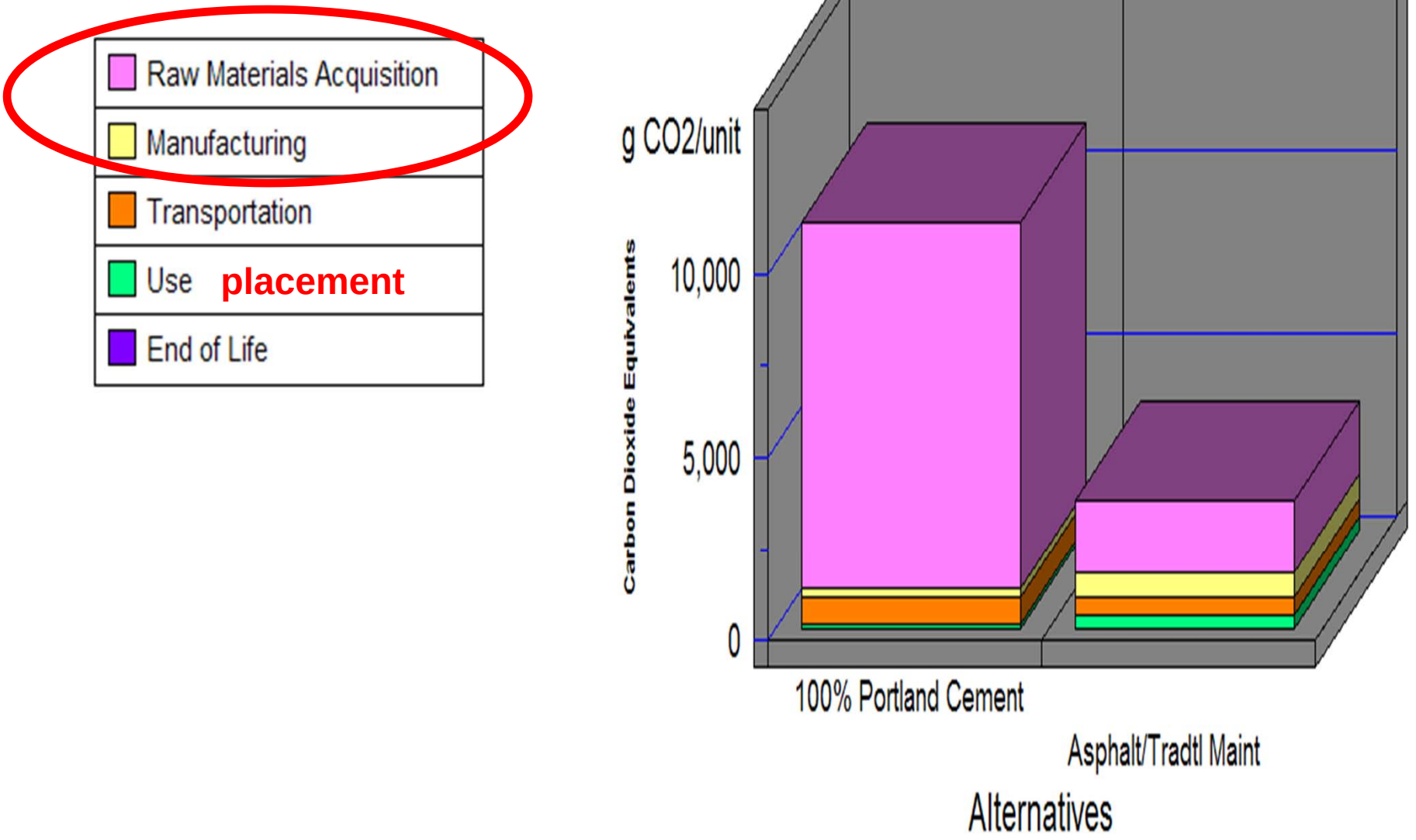
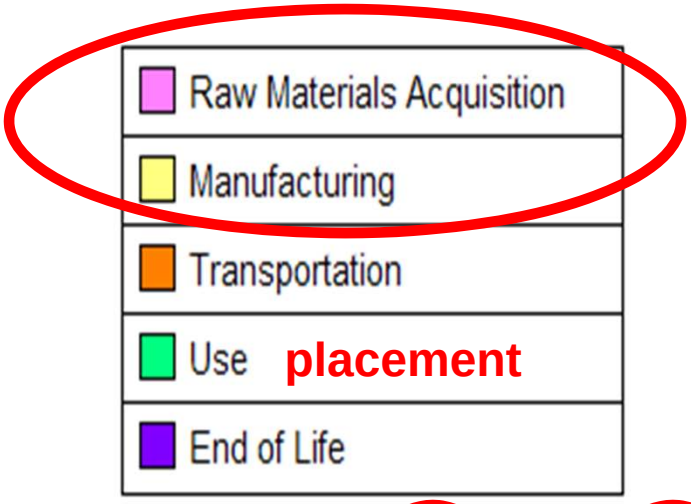


BEES: GWP by Life-Cycle Stage

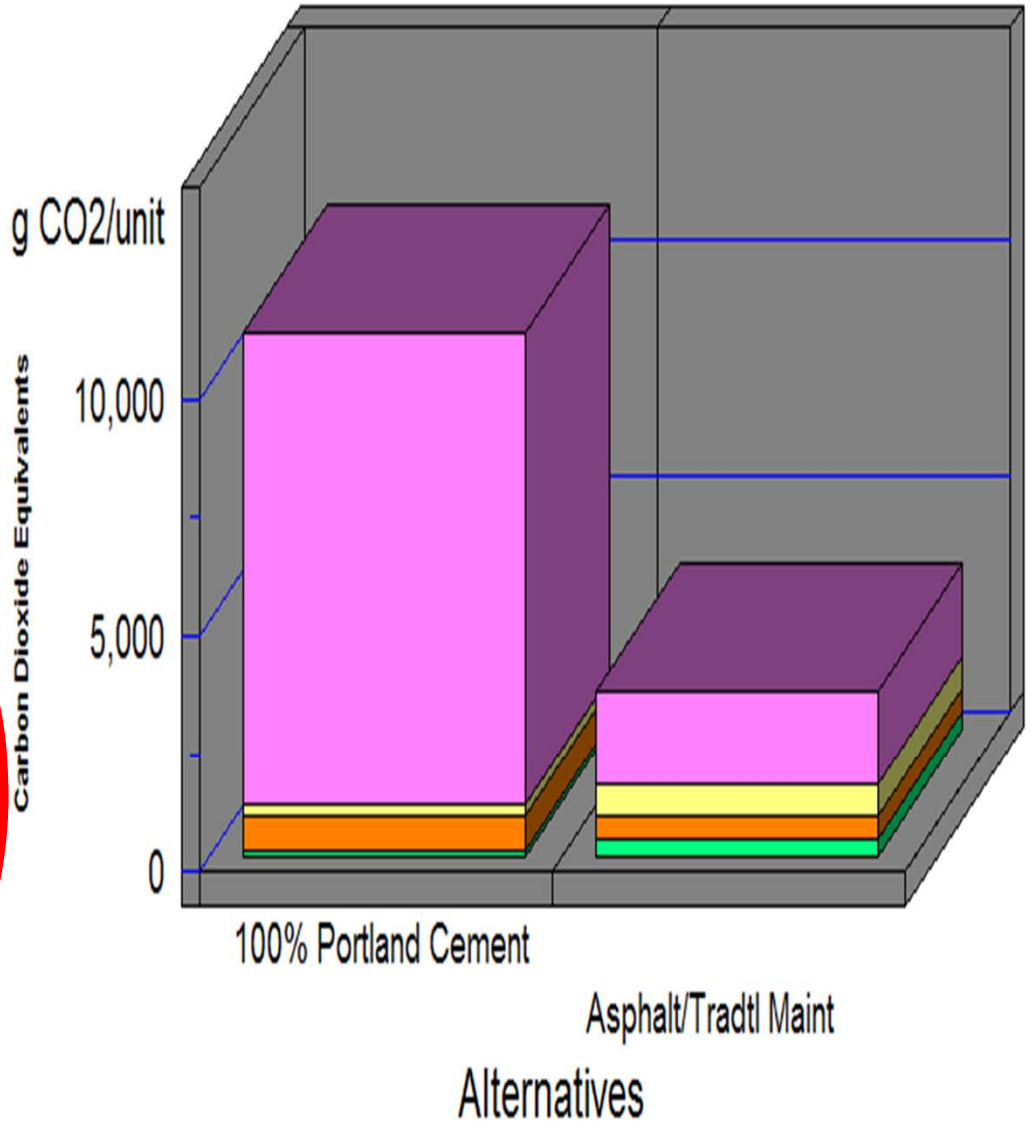


BEES: GWP by Life-Cycle Stage

NAPA

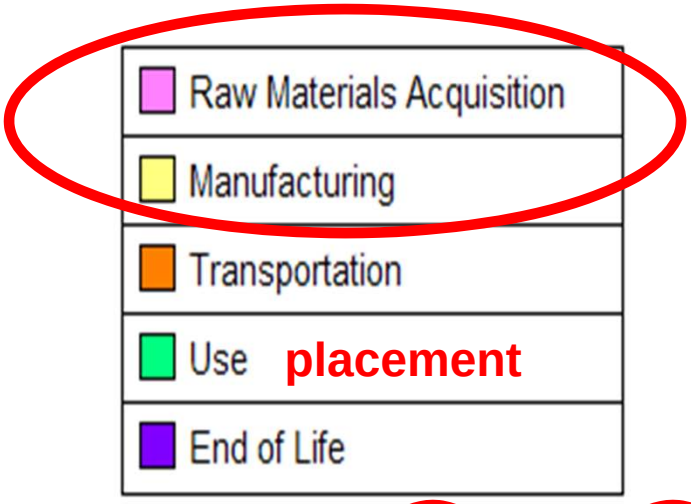


Category	100% OPC	Asph/Trad
1. Raw Materials	9949	1975
2. Manufacturing	282	680
3. Transportation	742	524
placement. Use	138	373
5. End of Life	0	0
Sum	11111	3552



BEES: GWP by Life-Cycle Stage

NAPA



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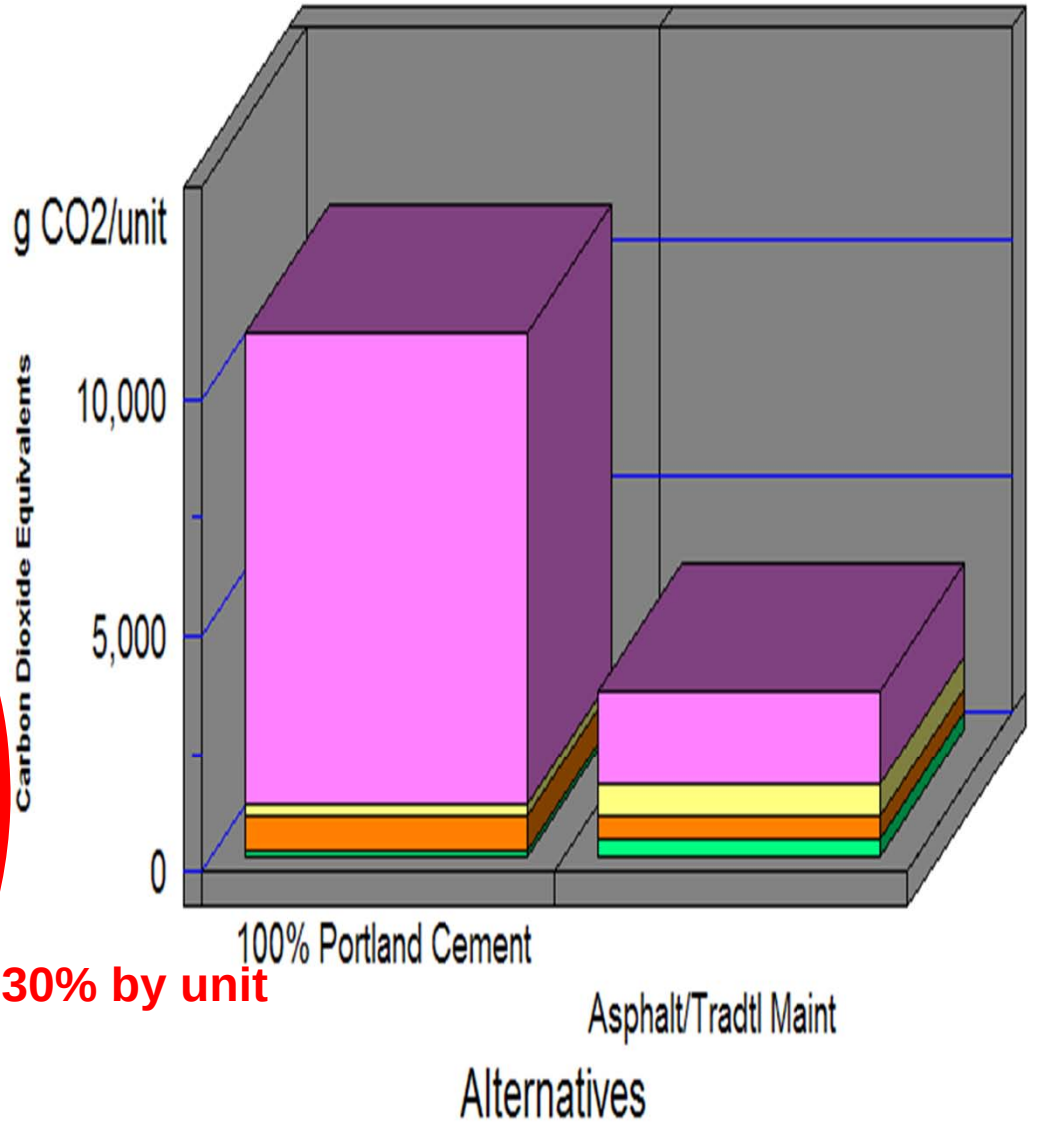
placement

~ 30% by unit



BEES: GWP by Life-Cycle Stage

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Kg CO_2e/tonne

HMA

WMA

HMA w/ 30% RAP

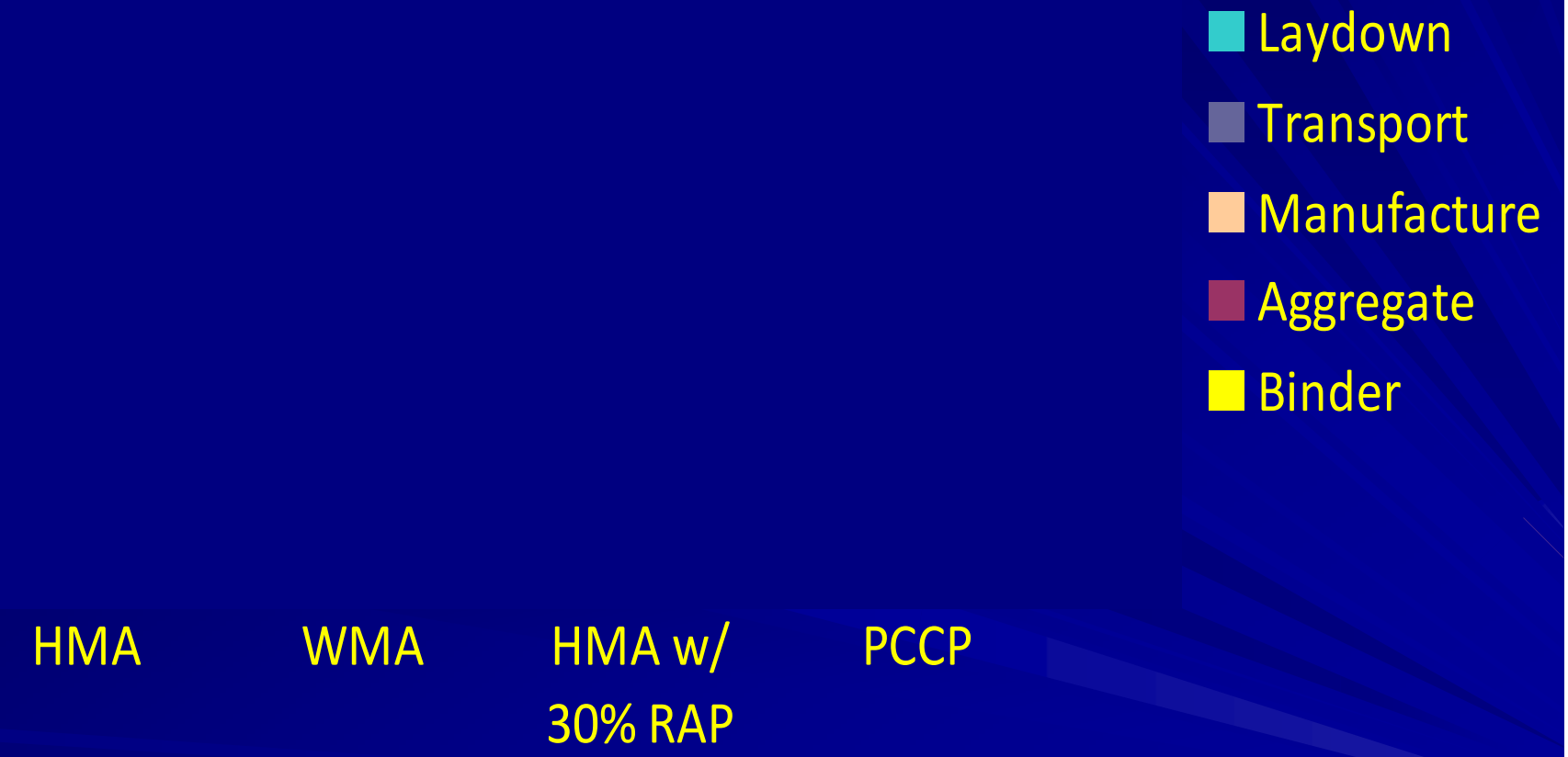
PCCP

Source: The Environmental Road of the Future, Life Cycle Cost Analysis, Chappat and Bilal, Colas Group 2003

technology impact: carbon footprint

NAPA

Kg CO2e/tonne



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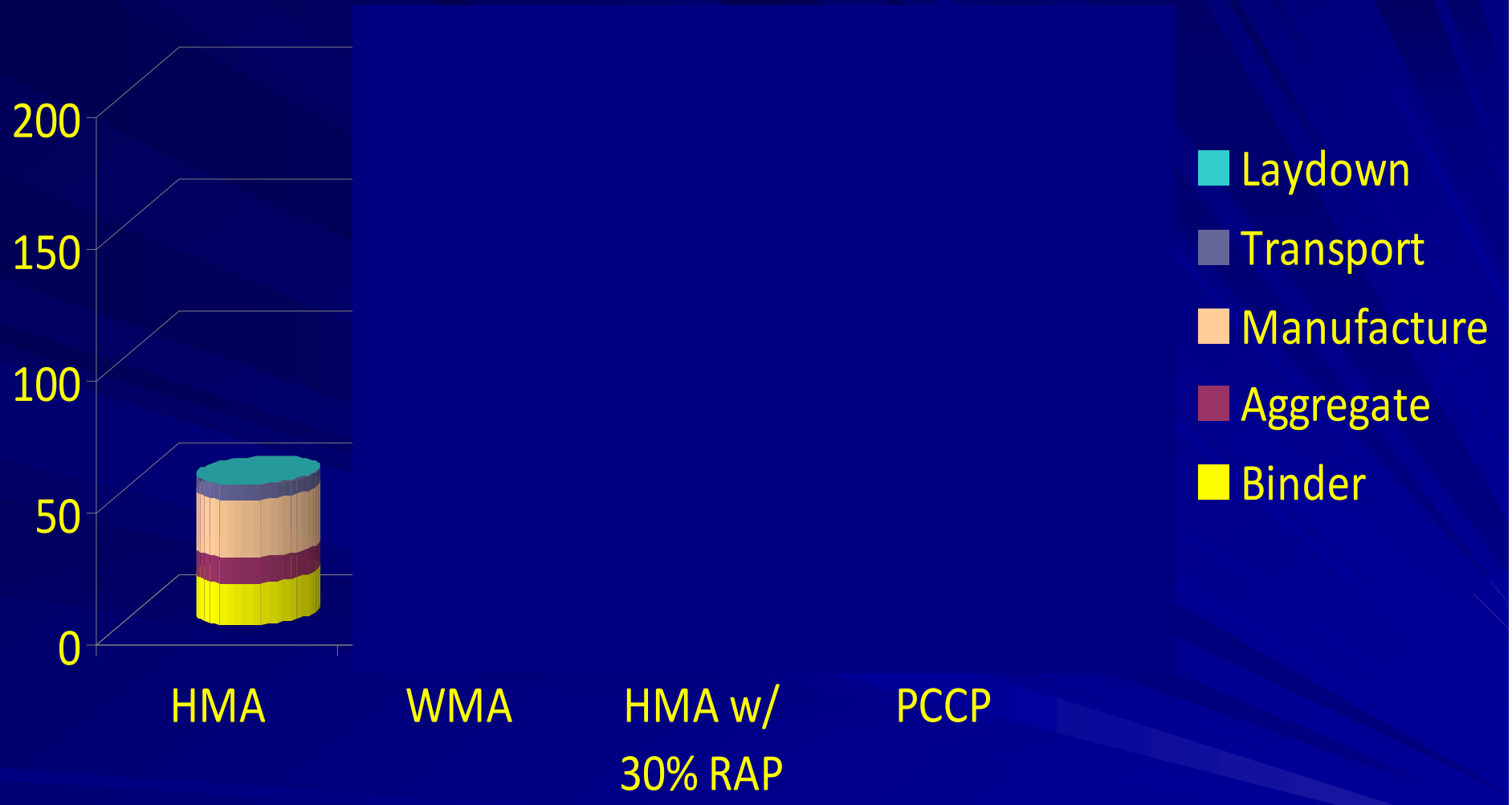
technology impact: carbon footprint



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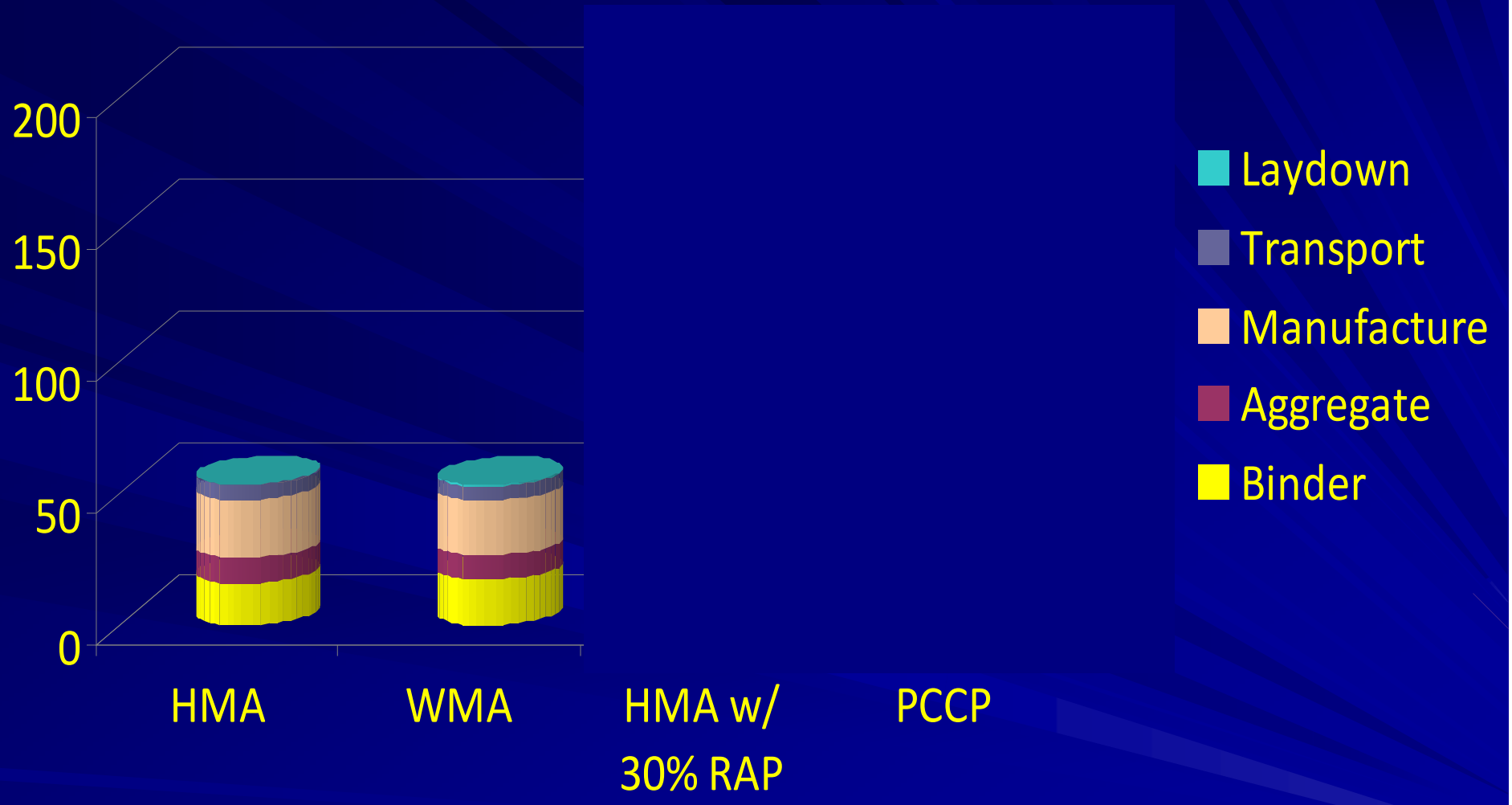
technology impact: carbon footprint



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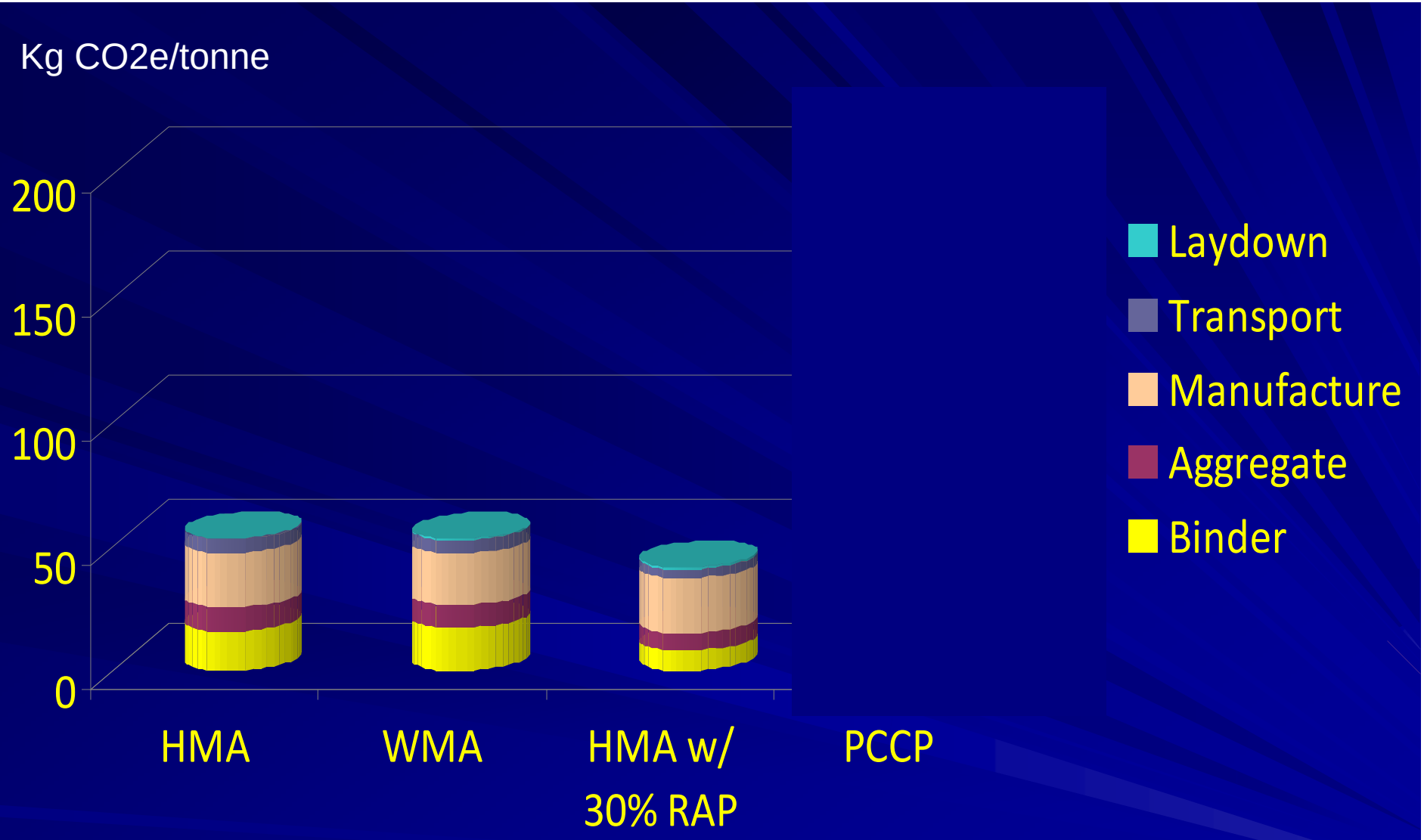
technology impact: carbon footprint



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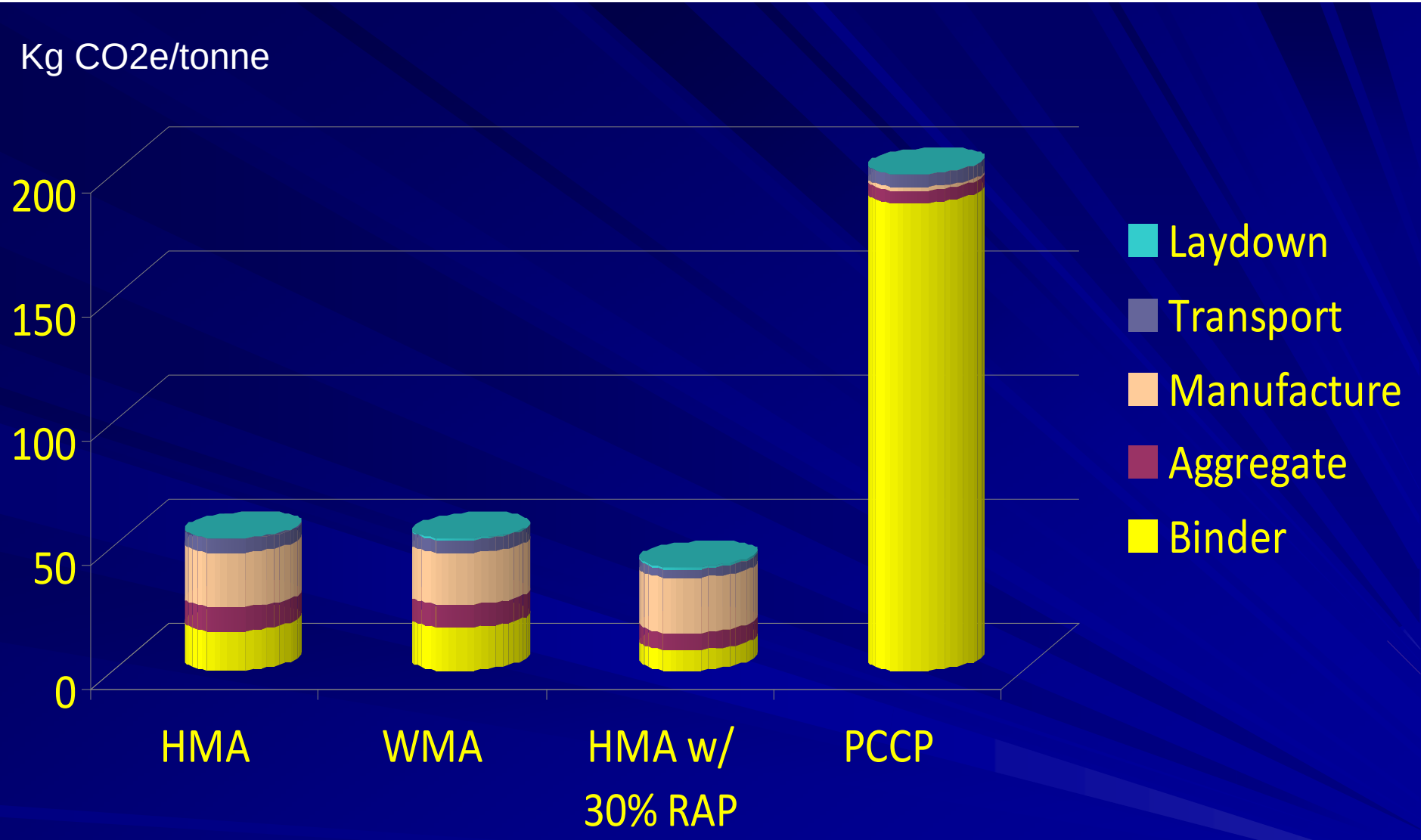
technology impact: carbon footprint



Source: The Environmental Road of the Future, Life Cycle Cost Analysis, Chappat and Bilal, Colas Group 2003

technology impact: carbon footprint

- "Carbon footprint" – consistent way to compare global GHG emissions associated with a product's life cycle
- energy footprint ≠ carbon footprint -- BTU vs CO2
  - Carbon footprint includes "process" GHG emissions
  - Carbon footprint does NOT include "feedstock" energy
  - Be aware of conflicting terms
- Bottom line: asphalt pavement has a much lower carbon footprint vs concrete; between ~ 15% - 45% depending . . .
- Warm Mix reduces energy requirements & CO2
- RAP reduces acquisition of virgin raw materials
- RAP / WMA combination can offsets CO2 equivalent to ~ 1 MM cars annually

carbon footprint conclusions

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AMERICA RIDES ON US Asphalt.

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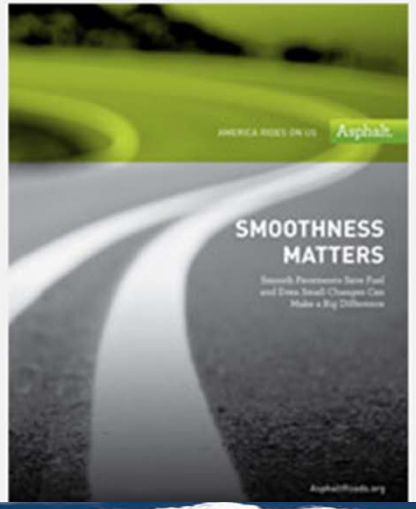
SEARCH... »

Why Asphalt

- Economics
- Environment »
  - Clean Air and Cool Cities
  - LEED and Green Construction
  - Performance Means Sustainability
  - Quiet Pavement
  - Carbon Footprint
  - Recycling and Energy
  - • Smoothness Matters
  - Water Quality
  - Additional Resources
- Engineering

Smoothness Matters

Smooth Pavements Save Fuel, And Even Small Changes Can Make a Big Difference



Experts say that vehicles consume less fuel when traveling on smoother pavements. This makes sense intuitively. And, lower consumption of fuel conserves natural resources for a healthier environment.

Our country has 2.5 million miles of paved roads. Since Americans drive many miles per year, just a slight change in fuel economy per vehicle would result in dramatic fuel savings conserving our natural resources and benefiting the traveling public.

Sign Up for Our Newsletter

Sign up today to receive the latest news.

Email Address GO

About Asphalt

Asphalt is one of the indispensable materials of life in America. Want proof? Think about the fact that 94 percent of the paved roads in America are surfaced with asphalt.

smoothness matters

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Myth

- **Flexible asphalt pavements cause deflection allowing energy to be absorbed and increasing fuel consumption**
- **Concrete pavement reduces fuel consumption by up to 7% saving the trucking industry over $6.3 Billion annually and reducing CO2 emissions by 15 million tons**

Asphalt deflection causes energy to be absorbed … and more fuel to be used.

Concrete pavement's rigid surface allows negligible deflection … no wasted energy means no wasted fuel.

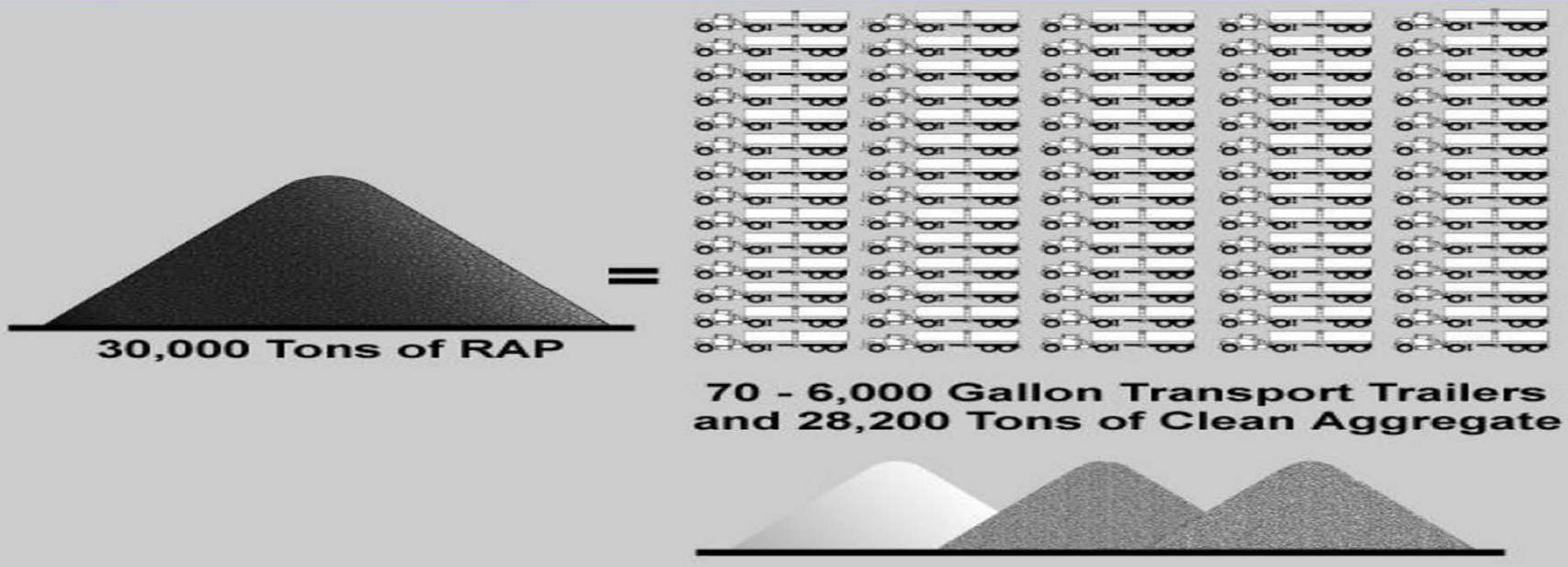
Facts

- Mis-perception continues and is being used in some concrete marketing campaigns
- Potential to be a "big-ticket" item; large impact
- Bottom line: smoothness, NOT pavement type, is determinant for pavement fuel consumption
- Very complicated to compare 2 different pavement sections
  - Cal-Trans recently compared same sections + / - diamond grinding → smoothness
  - Easy to bias results; difficult to dis-prove
- See asphaltroads website; more info to come

- Rough roads increase vehicle fuel consumption and vehicle wear & tear
- Studies show that increasing smoothness by 25% can increase vehicle fuel economy 5 - 10%
- Smoothness and pavement texture play a role
  - Pavement type is insignificant
- Potentially huge values for fuel savings
- Cost of maintenance vs fuel / CO2 offsets
  - No current mechanism for offsets
  - NAPA working w/ stakeholders (eg, DOE, EPA)

- Initiated with USGBC LEED
  - Way to “measure” sustainability / “greeness”
- Started with buildings; now changing
  - DOTs looking to ensure sustainable pvmt
- A number of systems used for pavement
  - Carbon footprints and offsets
- States and universities looking / FHWA as well
- All have pros and cons; define the boundary

The entire annual CO2 / greenhouse gas emissions / carbon footprint from a typical hot-mix plant (~ 2,500 tons) could be totally offset by using ~ +/- 30% RAP in pavement mix designs -- accomplished by minimizing acquisition of energy intensive (natural) raw materials such as aggregate and petroleum asphalt.



RAP: sustainable & carbon neutral

NAPA

ASPHALT:
the environmentally sustainable pavement

- Porous pavements manage stormwater
- OGFCs are safe, quiet, and better water quality
- Reflective / OGFC / Porous can mitigate UHI
- Asphalt pvmts accept recycled / #1 recycled RAP
- HMA pavements are environmentally preferred
  - Lower carbon footprint, speed of construction
- Warm Mix lowers energy consumption / emissions
- RAP can offset entire annual HMA GHG emissions
- Keeping pavements smooth saves fuel

RAP, porous, WMA, smoother pvmts

- Understanding what is driving America green
- Porous Pavement
- Re-USE with RAP
- Urban Heat Island: not Black-and-White
- Warm Mix
- Carbon Footprints
- Smoothness MATTERS !!
- Green metrics

www.asphaltroads.org

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Questions ??
"it ain't easy being green!"
74
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