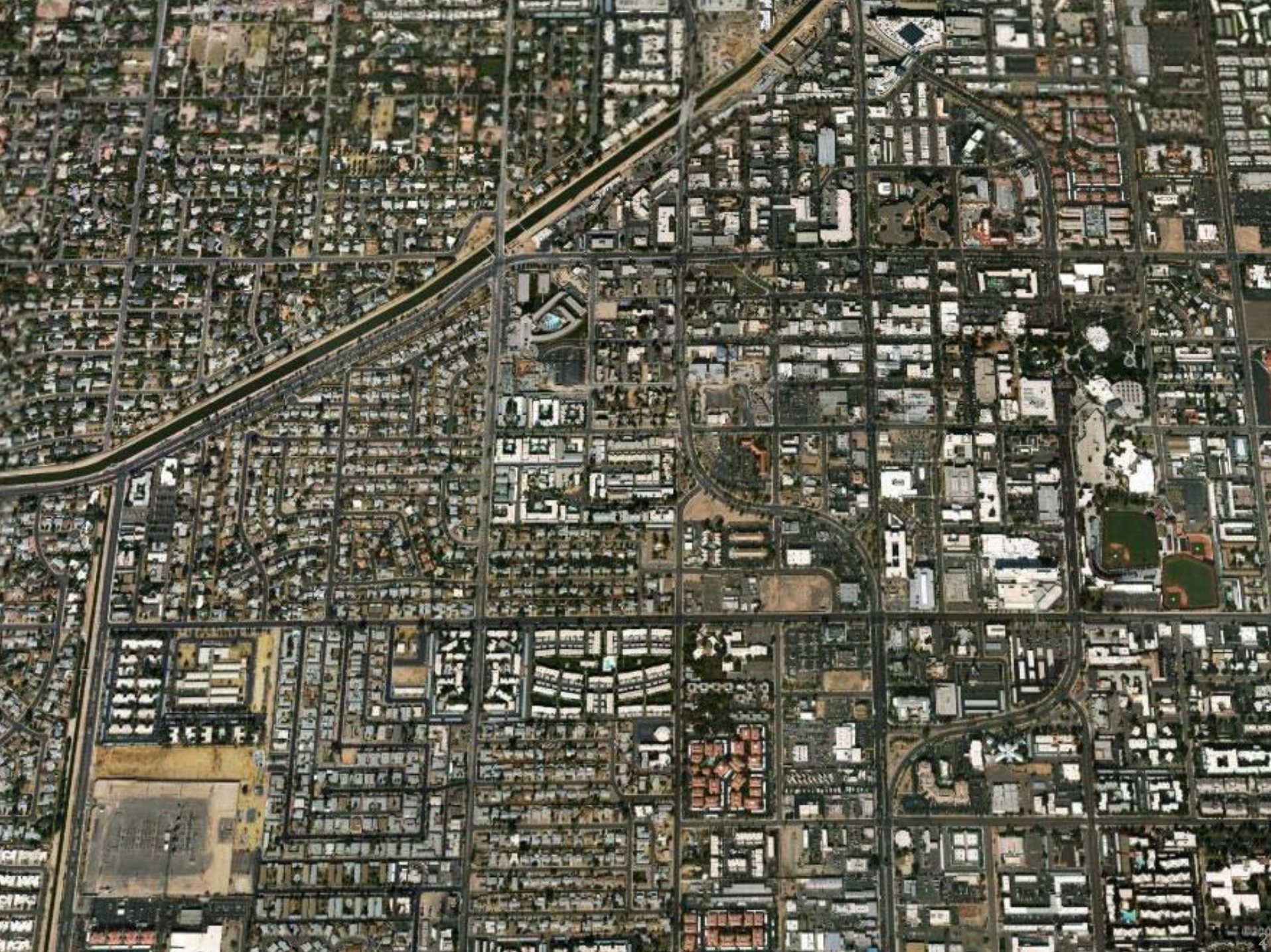




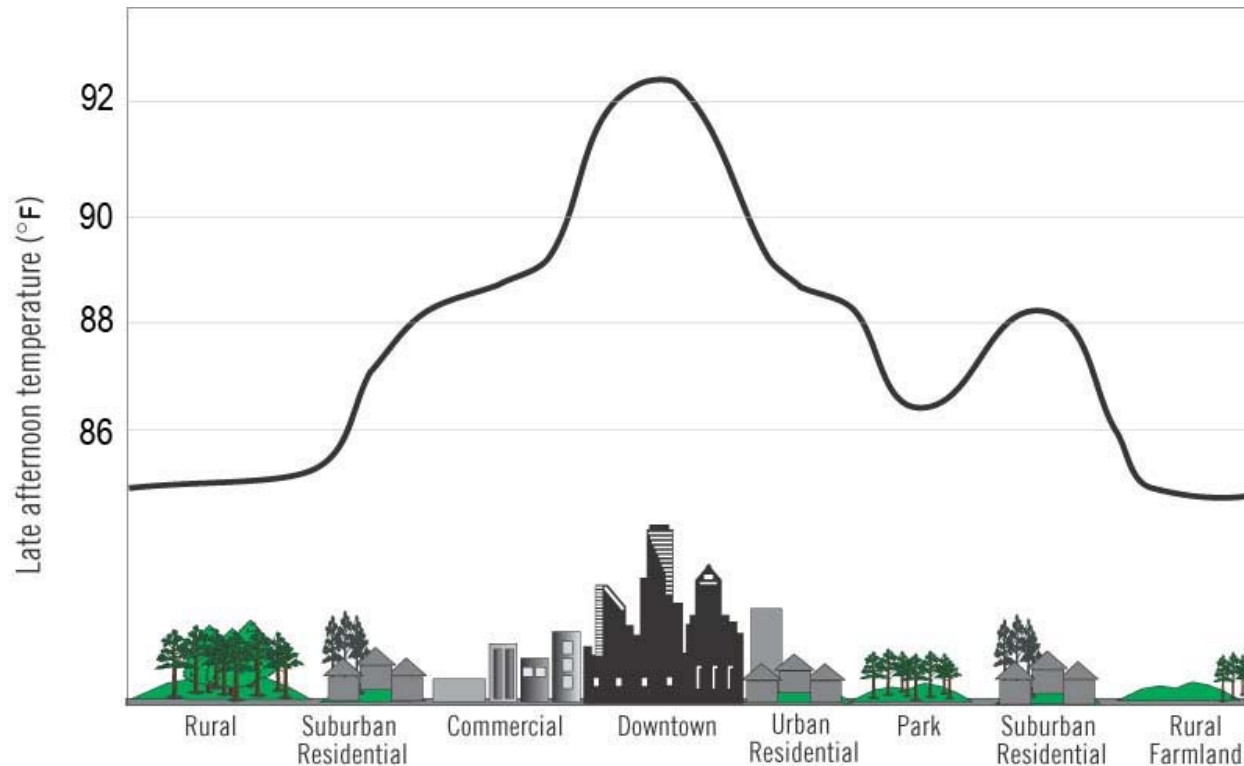
# GREEN DESIGN AT ANY SIZE URBAN HEAT ISLAND EFFECT & TOD

Kevin Gardiner and Amitai Heller  
Kevin Gardiner & Associates, San Francisco

**Rail ~volution 2008**

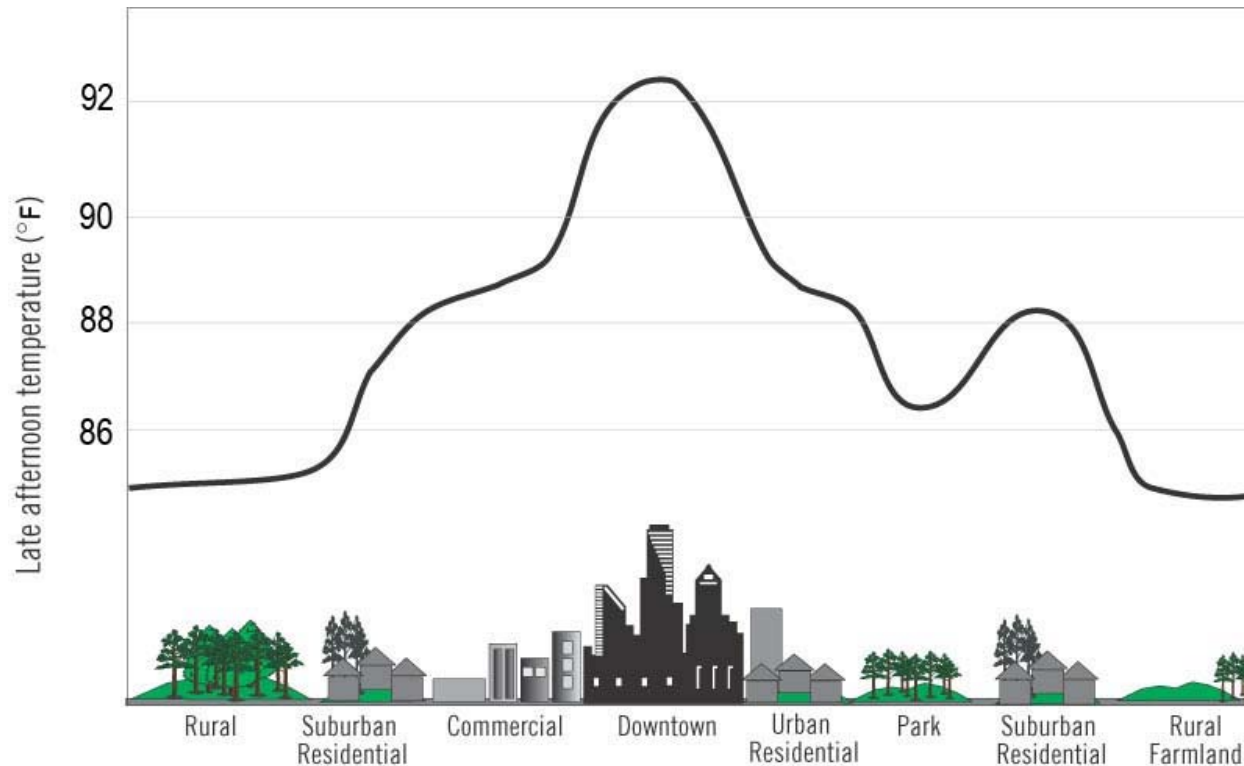


# What is an Urban Heat Island?



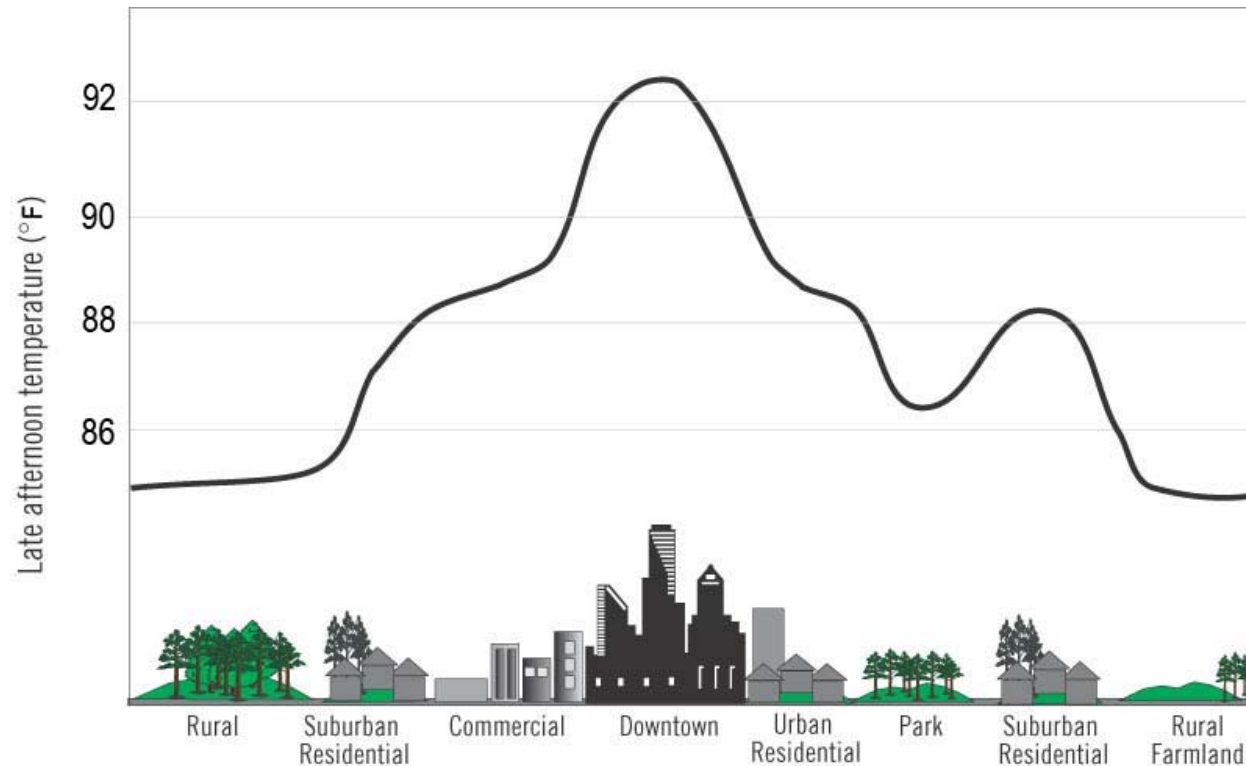
- An **urban heat island (UHI)** is a metropolitan area which is significantly warmer than its surrounding rural areas.

# What is an Urban Heat Island?



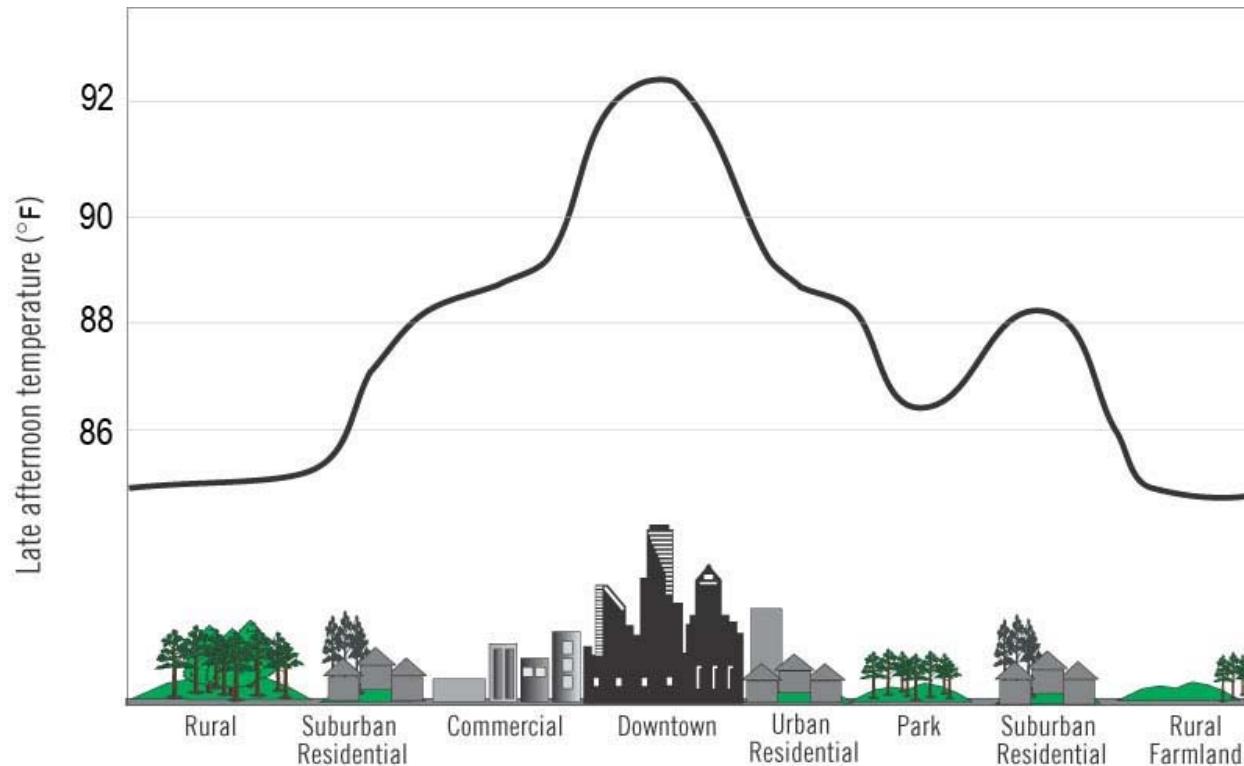
- In denser cities, UHI's can get up to 8 degrees warmer during the day time and 12 degrees warmer at night then their surrounding areas.

# What is an Urban Heat Island?



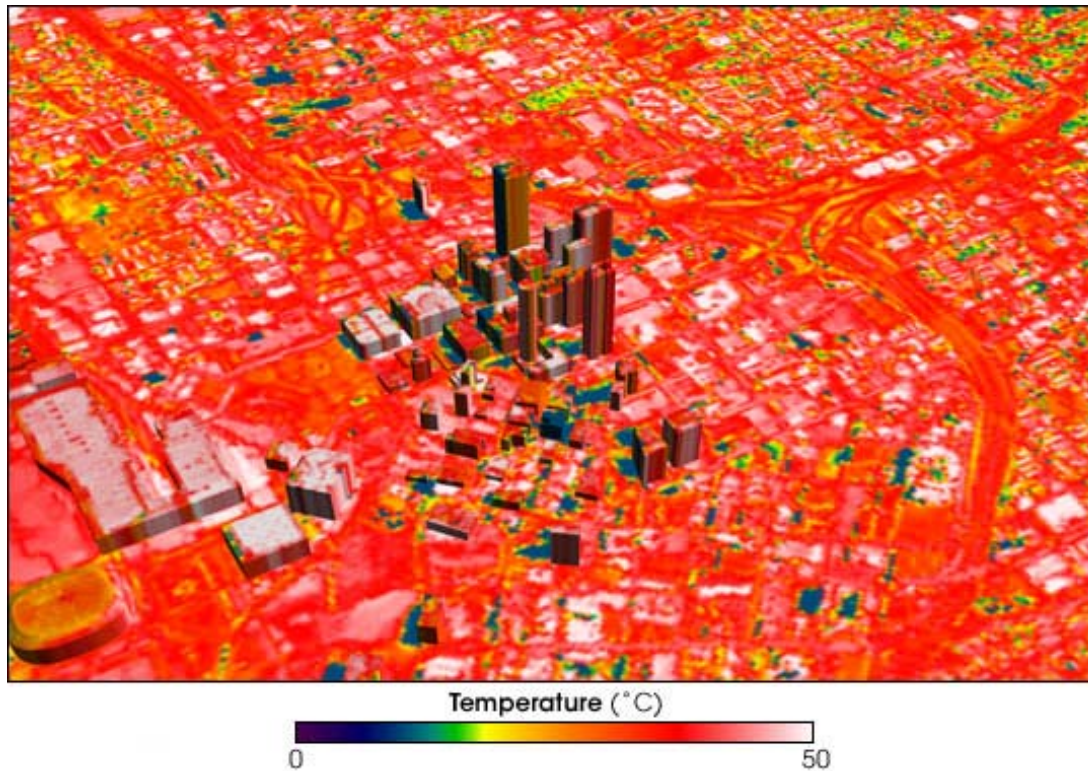
- The Urban Heat Island Effect (UHIE) is more prominent at night than the daytime.

# What is an Urban Heat Island?



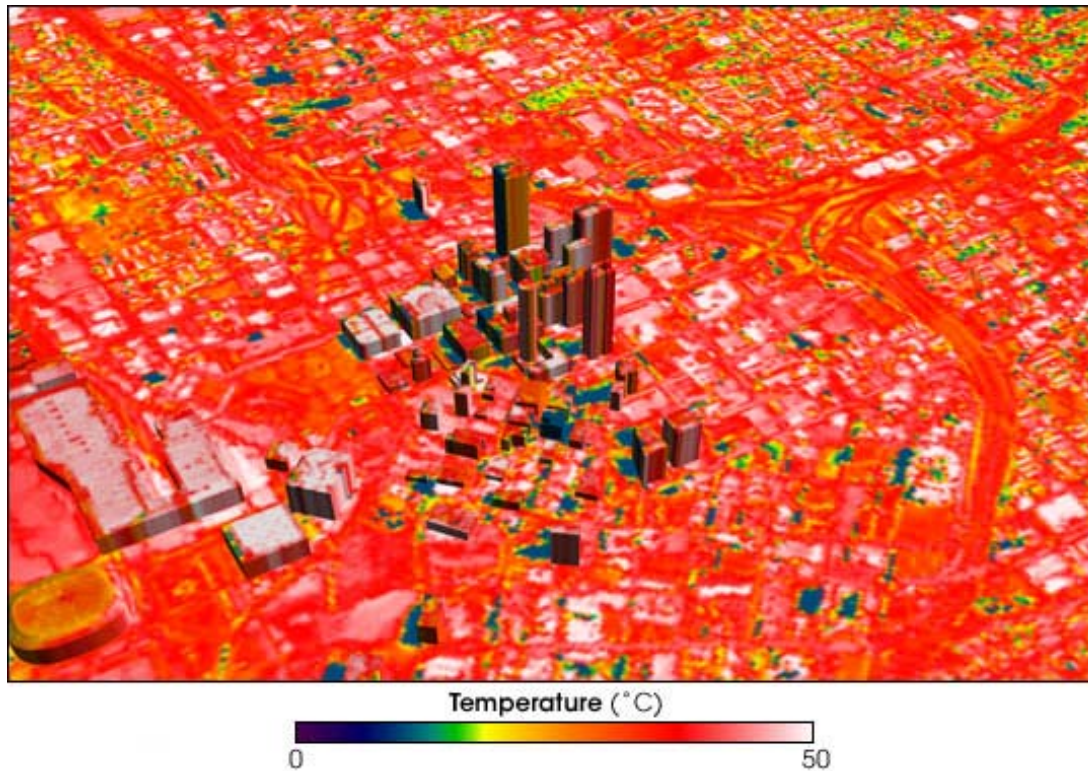
- It has long been recognized that the excessive heat and smog in many cities in the Summer is partly due to the Urban Heat Island and choices of building materials, vegetation and urban design.

# Elements that contribute to the Urban Heat Island Effect (UHIE)



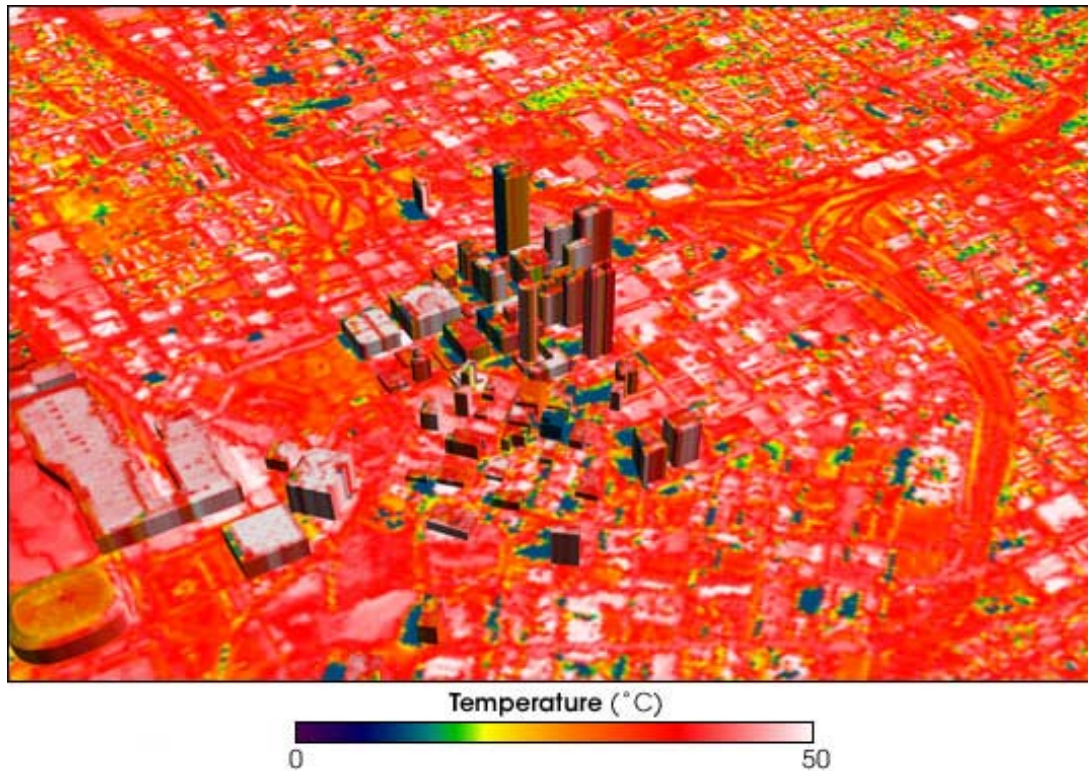
- Buildings block the view to the cool sky - air is not circulated
- Lack of Vegetation = loss of **evapotranspiration**

# Elements that contribute to the Urban Heat Island Effect (UHIE)



- Thermal properties of building materials such as roads, concrete, etc. (dark and dense mater absorb rather than reflect)

# Elements that contribute to the Urban Heat Island Effect (UHIE)



- Increases in density and amount of building materials
- Automobiles and other machines ejecting heat

## Energy Use

- The rise in heat creates higher demand for air conditioning
- Demand for electric power rises nearly 2% for every degree Fahrenheit the daily maximum temperature rises.
- It is estimated that in Los Angeles, UHIE accounts for increased city AC costs of 100 million dollars.
- Increases in temperature = decrease pedestrian and bicycle-riding = increase in car usage = increase in pollutants, mechanical heat emissions, and a need for more roads.



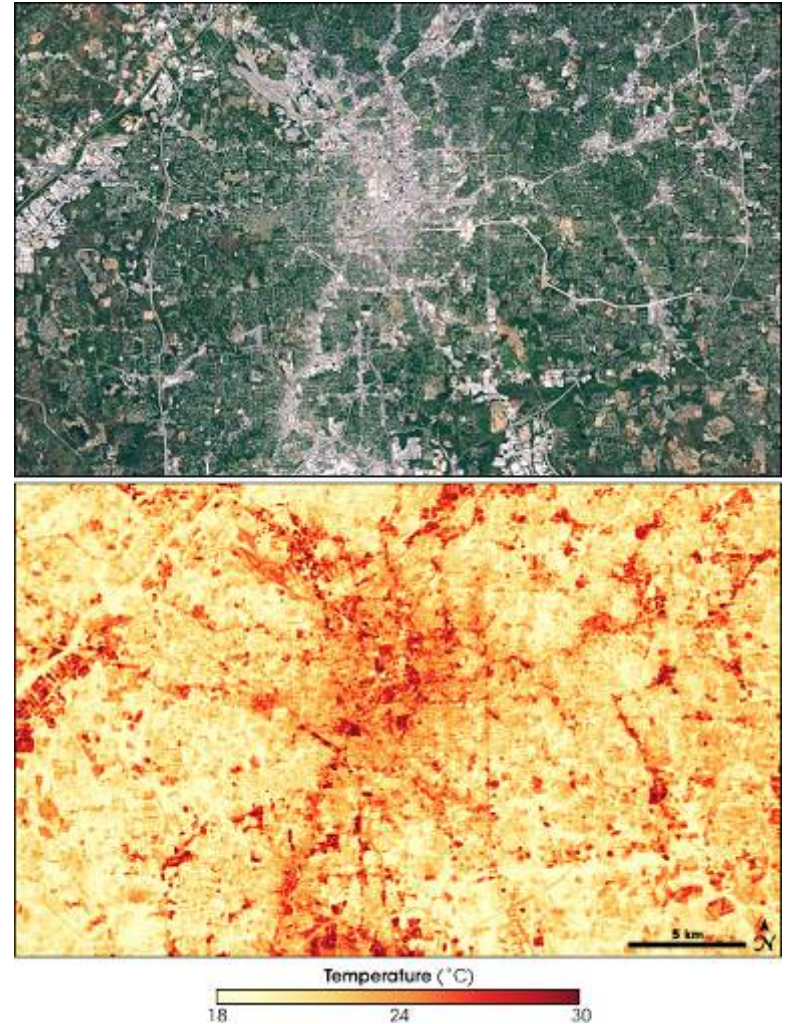
## Air Quality

- The formation of smog is highly sensitive to temperatures; the higher the temperature, the higher the formation.
- The probability of smog increases by 5% for every 0.5°F rise in daily maximum temperature above 70°F.



## UHI misconceptions

- UHIE has been adopted by some global warming critics.
- The claims: In the most simplistic terms, the world is not growing warmer; rather, weather measuring stations, generally located closer to cities, are picking up the increased heat of the UHI as opposed to actual global warming. These claims have proven largely fallacious.
- UHIE has also been used as a way for suburban sprawl advocates to justify less density.



# The Density Paradox



- UHI is caused by increased density; even though density is now generally considered the most environmentally responsible form of urbanization

# The Density Paradox



- Should increased density be a more important consideration than UHI? Yes and No.

# The Density Paradox



- Density alleviates many other environmental impacts.
- Transit Oriented Development seems the most sensible model with which to begin.

# Transit Oriented Development and and UHI



- Transit Oriented Development *does* create density but reduces the proportion of land devoted to roads and parking lots.
- TOD suggests all important city functions should be within 1/4-1/2 mile of transit; this requires a lot of density.

# Transit Oriented Development and and UHI



- Reduced parking ratios in TOD allow for increased opportunities for UHI mitigation.
- **The integration of UHI mitigation in TOD planning is essential for its effectiveness.**

## Mitigation Techniques: Albedo Mitigation

- The albedo of an object is the extent to which it diffusely reflects light from the sun.
- Way to improve reduce high urban albedo rates: Cool Rooftops.
- Up to 80% of the solar heat reflected by cool roofs passes back through the atmosphere and out into space, leaving the city unaffected.
- 90% of roofs in USA are black. Lighter colors are more reflective.



## Mitigation Techniques: Cool Roofing Options

- White vinyl
- Cool Coating: Paint with higher glass quantity
- Green Roofing: Rooftop Gardens



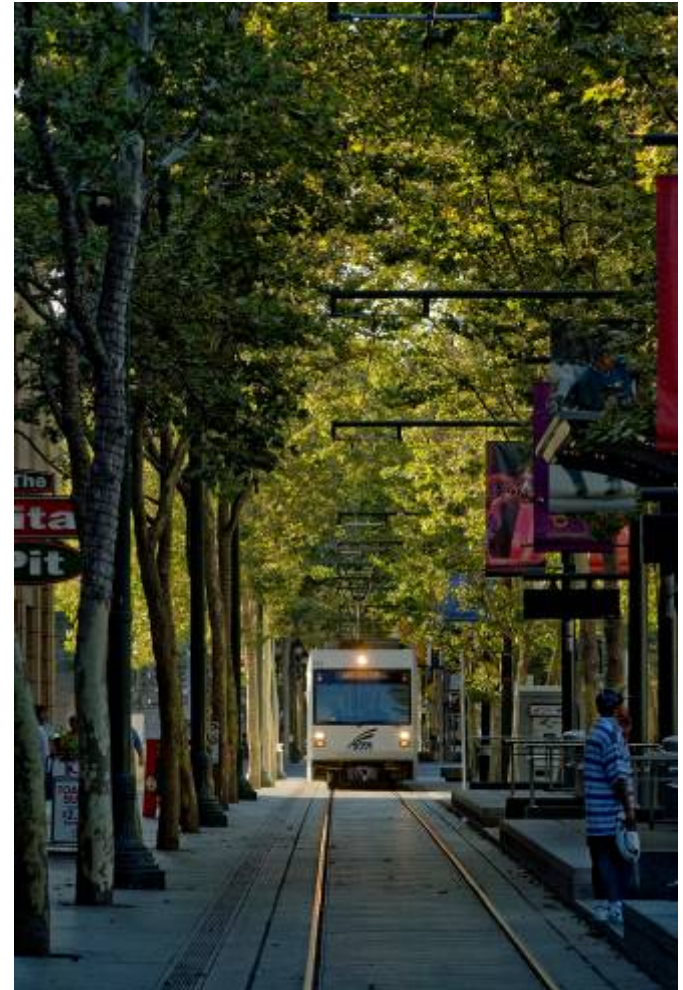
## Other benefits of green roofing

- In San Francisco, the large rooftop on the California Academy of Sciences is being used as a habitat for the threatened bay checkerspot butterfly.
- Environment Canada found a 26% reduction in summer cooling needs and a 26% reduction in winter heat losses when a green roof is used.

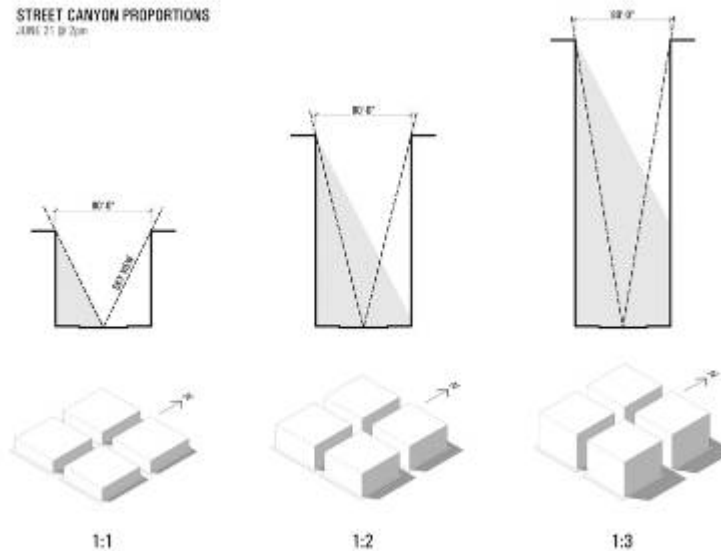


## Mitigation Techniques: Vegetative Mitigation

- Any increase in urban vegetation, trees, rooftop gardens, public parks, will have a cooling effect through evapotranspiration.
- Trees should be planted strategically, to east and west of buildings. Optimally they would shade AC condenser units, windows, and roofing.
- Trees are the preferred shading method for pedestrians as they don't trap hot air, allowing for increased air circulation.
- Trees may block useful solar energy in the winter particularly on the south side.



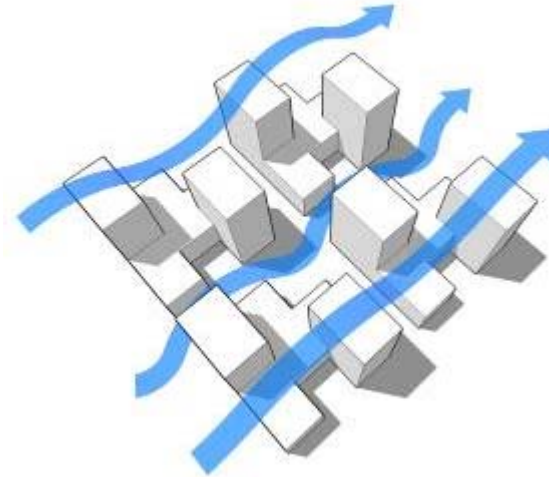
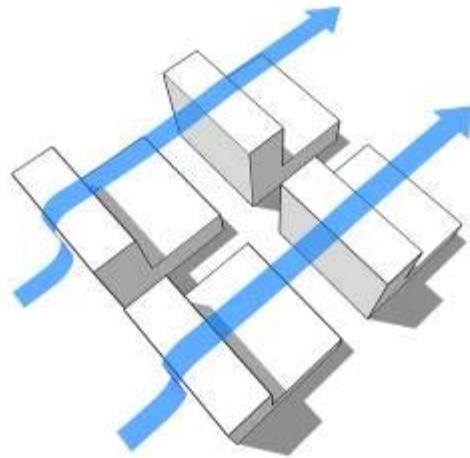
## Mitigation Techniques: Wind Circulation



CITY OF PHOENIX / STUDIO MA

- Increased wind circulation patterns diffuse the UHI.
- Large cities that plan “street canyons” to coincide with the wind patterns will see a drop in UHI.
- While narrow roads may be preferable to increase density, wider street canyons are preferable towards heat reduction.
- Best practice would be checkerboard building mass patterns.

## Mitigation Techniques: Wind Circulation

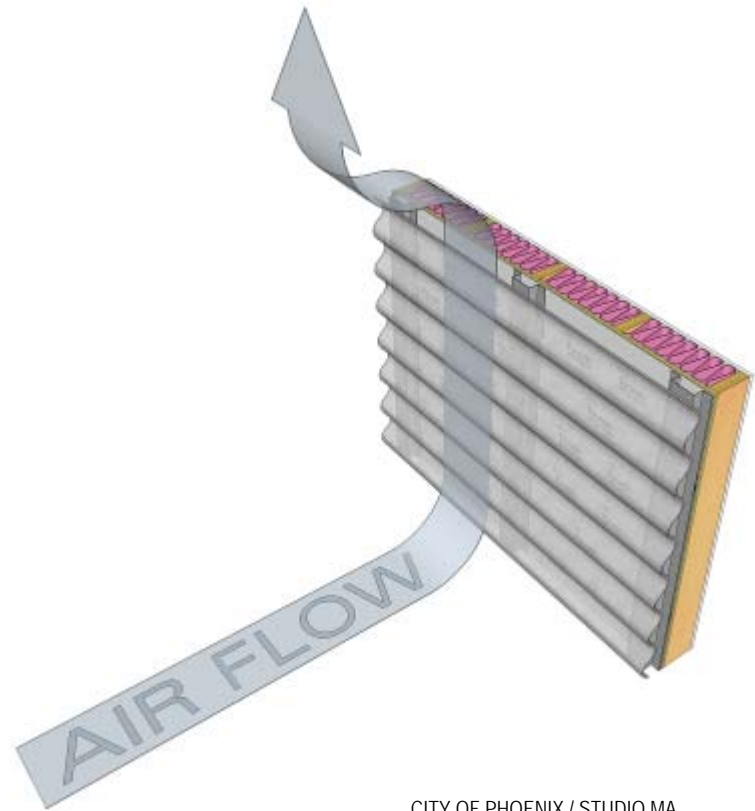


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## Mitigation Techniques: Opaque Vented Walls

- An opaque ventilated wall is a special façade case where the outer face consists of a detached layer that forms a naturally ventilated cavity.
- Construction of walls that can ventilate air is an essential technique in mitigating heat inside buildings and helps the circulation of surface air.



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# TOD Best Practices

- Good TOD can mitigate UHIE while remaining functional and aesthetic.
- Mixture of shading methods both vegetative and man-made at differing heights. Too *much* shading will be bad for winter months.
- Open air, multifunctional water systems.

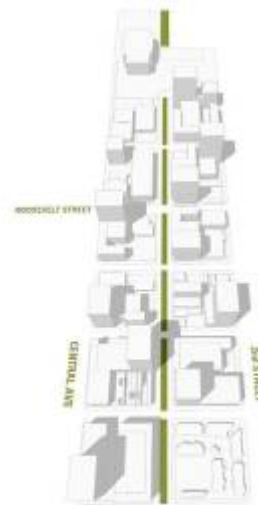


# TOD Best Practices

- “Cool corridors” allowing increased levels of pedestrianism in hot climates.
- Color schemes that promote cooling effects.



*A Downtown resident would walk along the sidewalk, shaded on one side by trees, and on the other side by building awnings.*

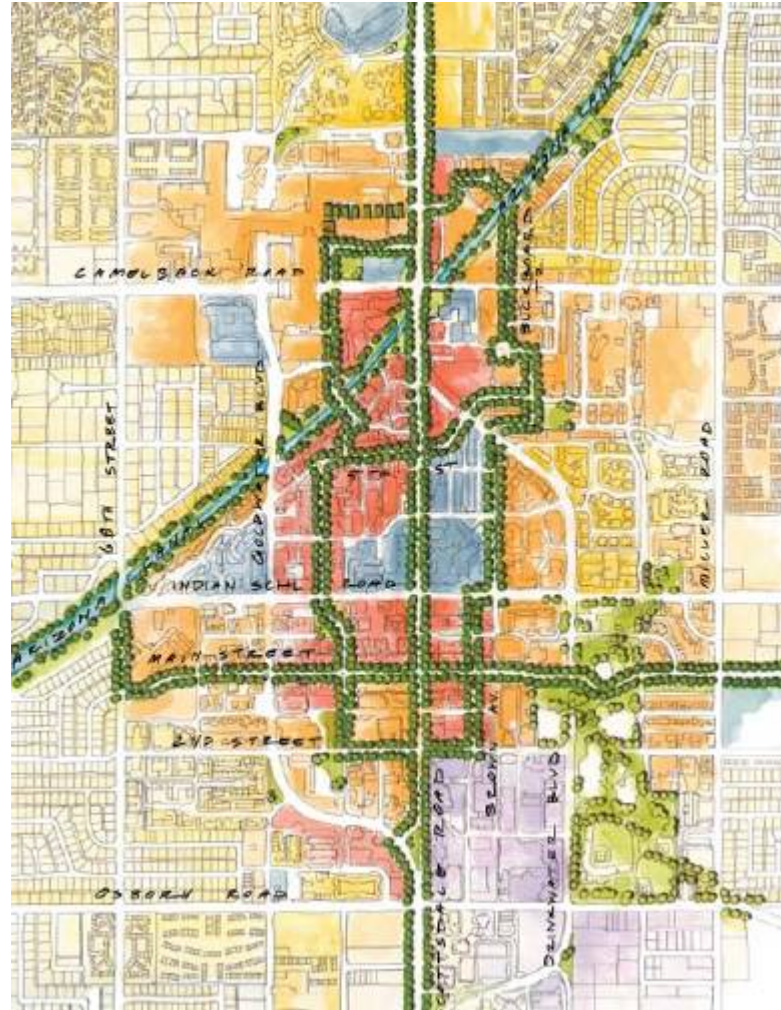


*The resident would then turn the corner and discover the 1st Street linear park, and enjoy the view of trees and public art, or maybe even walk their dog in the park itself.*

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# What other Cities are doing to mitigate UHIE

- Phoenix and Scottsdale, AZ plans call for providing “cool corridors” for pedestrians through the provision of shade, landscaping, street furniture and other elements of human scale and comfort to extend perceived walking distance and make travel safe and enjoyable.
- Policies and standards requiring buildings, streets, and public spaces to be designed with materials and forms that create comfortable temperatures for pedestrians and minimize the Urban Heat island Effect.



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## What other Cities are doing to mitigate UHIE

- Seattle Policy Statement:  
Strive to increase the amount of permeable surface and vegetative cover in the city in order to mitigate the heat island effect of developed areas, control storm water flows and reduce pollution.
- City of Houston has a policy of reflective roofing for all new buildings and reroofings.



## What other Cities are doing to mitigate UHIE: Green Roofs

- Portland and Chicago have zoning incentives for the installation of rooftop gardens by allowing developers to build additional square footage on the same building site.
- In Washington DC: adding more water-retaining surfaces including green roofs will lower a building owner's city fees.
- Some cities in Europe (mostly in Switzerland) require green roofing.



# What other Cities are doing to mitigate UHIE: Parking Lot Tree Planting Policies

- Trees in parking lots not only mitigate UHIE but also help clean carbon dioxide emissions.
- Sacramento has one of the more aggressive ordinances requiring new parking lots to have enough shade for 50% of the lot after 15 years.
- Orlando's ordinance requires tree coverage specified as 1 "tree point" per 100 square feet. Tree points are earned according to tree size.

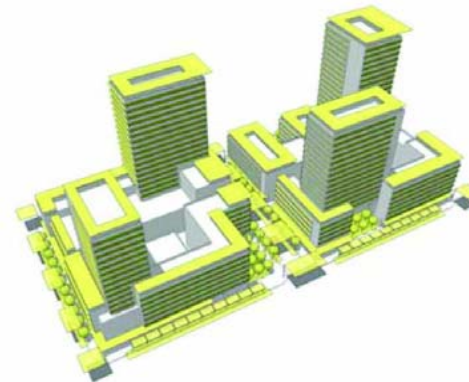


## What other Cities are doing to mitigate UHIE: Transit Oriented Development + UHIE Mitigation

- ✓ TOD/Smart Growth Strategies
- ✓ Green Design/Green Building to minimize environmental impacts and mitigate climate change
- ✓ Urban Heat Island Effect design strategies to mitigate effects of higher density and ensure human comfort



*Downtown Phoenix as envisioned with a network of comfortable and walkable Green Streets.*



*Typical shading diagram for upcoming Form-based Code.*

## More Information

- **Lawrence Berkeley Labs Heat Island Group:**  
<http://heatisland.lbl.gov/>
- **Arizona State University National Center for Excellence (ASU Smart):** <http://asusmart.com>
- **U.S. EPA Website:**  
<http://www.epa.gov/hiri/index.htm>
- **Wikipedia:**  
[http://en.wikipedia.org/wiki/Urban\\_heat\\_island](http://en.wikipedia.org/wiki/Urban_heat_island)
- **Phoenix Urban Form Project:**  
<http://phoenix.gov/urbanformproject/>

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