



information

ENVIRONMENTAL
COUNCIL of CONCRETE
ORGANIZATIONS

5420 Old Orchard Road
Skokie, Illinois
60077-1083
800 994-ECCO (3226)
FAX (847) 966-8389

Shining a Light on "Cool Communities"

"Cool Communities" are having their day in the sun.

Modern-day planners and architects are learning what Mediterranean and Native American builders have known for millennia: Major scale residential and commercial structures can be planned and built to beat the heat and moderate the "heat island" urban effect which raises the average temperatures of America's cities and suburbs.

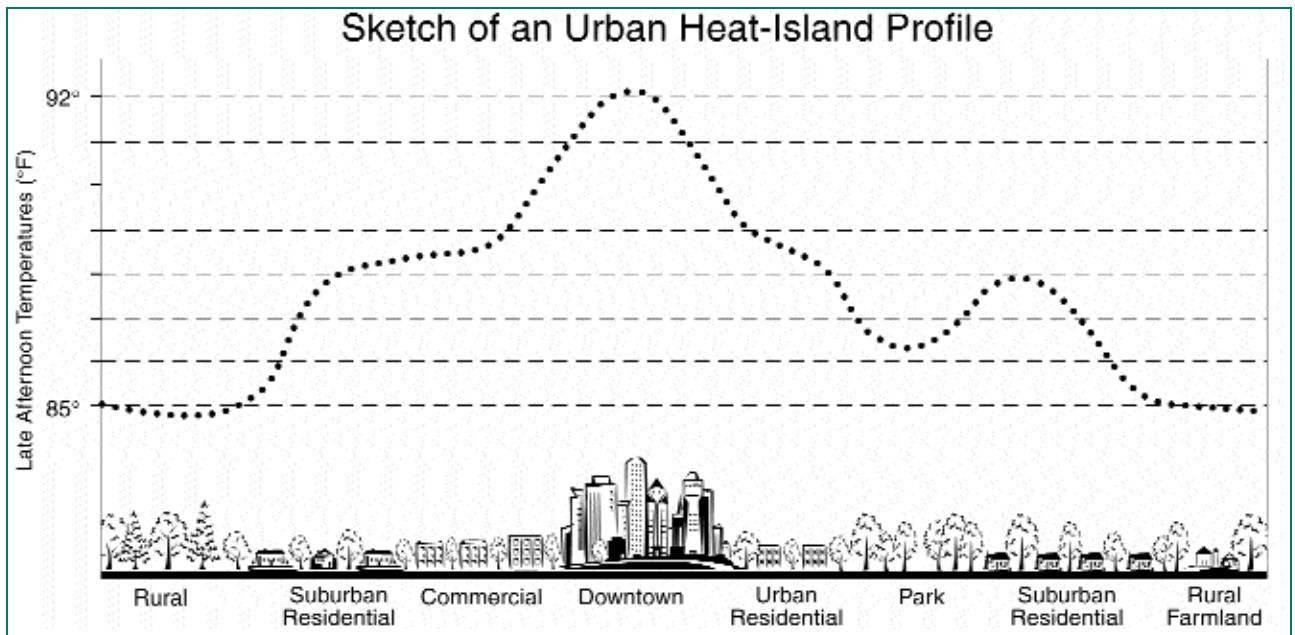
Consistent use of portland cement-based building materials for structures and pavements—along with strategic landscaping—is a prime element of the "Cool Communities" concept.

The *Cool Communities Partnership* is a program of the U.S. Department of Energy, other

federal agencies, American Forests, and private industry, under DOE's *Energy Partnerships for a Strong Economy* effort.

The Partnership applies the research products of the *Urban Heat Island Research* project of Lawrence B. Livermore National Laboratory (LBL) at Berkeley, Calif. A project goal is to develop practical use of reflective surfaces and vegetation in cities as a means of improving energy use in buildings, reducing atmospheric concentrations of greenhouse gases, lowering air and water pollution, and enhancing sustainable development.

Much of the scientific research and development of materials for cooling our nation's cities is being done by the Heat Islands project. In early 1998 there were 13 designated



Summer daytime temperature profiles rise significantly in urban areas.
Source: Lawrence B. Livermore National Laboratory, Berkeley, Calif.



“Cool Communities” in which demonstration projects were taking place.

This research is showing that use of light- and heat-reflective concrete-based materials, along with careful planting of trees, could lower the average summer afternoon temperature in some cities by as much as 5°F, cutting the need for air conditioning by 18 percent and even reducing air pollution. And high-reflectivity pavements and structural materials enhance night illumination with concurrent energy savings, observes the National Ready Mixed Concrete Association.

Master-planned communities in the Sunbelt are being constructed with “Cool Communities” concepts in mind. But structures with “Cool Communities” design elements are lowering energy costs in the Northern tier of states as well, because energy consumption in concrete buildings is lower due to concrete’s thermal mass.

Thermal mass may be used in the exterior building envelope to delay and reduce heat losses and gains, reports the National Concrete Masonry Association. Interior thermal mass may be used to increase thermal comfort and shift heating and cooling loads to off-peak hours. (See also ECCO’s *Thermal Mass—The Energy Saver in Concrete and Masonry Buildings*, EV12.) Interior thermal mass is a crucial factor for achieving the desired performance of passive solar buildings, NCMA states.

Energy efficiency the main event

Urban heat islands are not inevitable, but are the product of dark roofs, black pave-

ment, and loss of vegetation. “Cool Communities” planning lowers air-conditioning and electricity use and can reduce urban haze or smog.

But why bother in an era of cheap energy? Through a combination of abundant supplies, more efficient consumption and deregulation of prices, the United States has enjoyed low energy prices in recent years. And restructuring of the nation’s electricity generation, transmission and distribution industry—now in various stages of implementation—is anticipated to lower prices even more for most customers well beyond the turn of the century.

But in an era of low energy prices, energy efficiency still makes sense. More efficient energy consumption keeps supplies abundant. Furthermore, low energy prices may not stay low indefinitely if carbon taxes are instituted by the U.S. government to meet greenhouse gas emission reductions required by the United Nations Kyoto climate change treaty (December 1997).

And since all energy, from air-conditioning to lights, uses fuel, Cool Communities can help forestall global climate change by reducing energy consumption and related greenhouse gas emissions.

The public is becoming aware of the impact of their decisions on this issue. More than 25 percent of buyers say that it’s important to buy a home constructed with green methods, such as less wood, reports *Professional Builder Magazine*. Better energy efficiency is important to 22 percent of home buyers, the magazine said.

Summers in the city

Global warming aside, there’s no doubt that summers in the city are hot, and getting hotter. Historical data show an increase in inner cities’ temperatures since buildings and pavement began replacing agriculture near urban areas. One report indicates average U.S. urban temperatures have risen an average of 2° to 4°F in the last 40 years.

Of the methods for reducing cooling loads, use of trees and high-albedo (high-reflectivity) surfaces are paramount. High-albedo surfaces (usually light-colored) contain building materials that are more reflective of the sun’s energy and can greatly reduce a building’s cooling load. And this high reflectivity provides even another benefit in the form of energy saved on lighting streets at night.

Albedo is measured on a scale of 0 to 1.0. A surface with a relatively high albedo of 0.75

Landscaping to reduce energy use

While light-colored, high-thermal mass concrete construction is essential to “Cool Communities” design, careful landscape architecture design and tree planting programs are just as necessary.

Within 10 to 15 years—the time it takes a tree to grow to a useful size—properly placed trees can reduce heating and cooling costs by an average of 10 to 20 percent. Over their lives, trees can be much less expensive than air conditioners and the energy needed to run them.

Maximum benefits will be derived from deciduous trees shading the south and west sides of a building, to block the summer sun. For a home monitored in Sacramento, Lawrence B. Livermore National Laboratory *Mitigation of Heat Islands* project researchers found that this reduced cooling energy use by as much as 30 percent.

“Trees, bushes or vines should also shade your air conditioner, which works more efficiently when kept cool. Also, evergreen trees and bushes to the northwest can protect buildings from cold winter winds,” they said.

reflects most of the incoming energy while one with a low albedo will absorb most of it. Geometry and surface texture can impact albedo. Structures and pavements utilizing concrete provide high albedo ratings.

Under the direction of researcher Hashem Akbari, LBL's *Heat Islands* project monitored buildings in Sacramento with lightly colored, higher-reflectivity roofs. They found that these buildings used up to 40 percent less energy for cooling than those with darker roofs. A similar study by the Florida Solar Energy Center also showed up to 40 percent cooling energy savings.

Switch to concrete pavements

Blacktopping of faded asphalt pavements in urban heat islands should be discontinued, write Arthur H. Rosenfeld and Joseph J. Romm, U.S. Department of Energy; Alan C. Lloyd, Energy and Environmental Engineering Center at the Desert Research Institute, Reno; and Akbari in the February/March 1997 issue of MIT's *Technology Review*

"Better yet would be to switch the binder from asphalt to lighter-colored portland cement," they write. "Although its first cost is higher than asphalt, cement is stronger and lasts longer, so its life-cycle cost is lower. Iowa already requires [concrete] roads as a long-term cost-savings policy."

And longer life-cycles translate to fewer wasted resources and energy. These considerations are borne out in quantitative research by T. Asaeda, et. al., Saitama University, Japan (1996). And the American



Headquarters of precast concrete producer Trenwa, Inc., Fort Mitchell, Ky., features "Cool Community" concepts such as southwestern-exposed massive concrete wall near glass exterior wall and white aggregate reflecting yard. Photo courtesy of *Concrete Products* magazine.

Concrete Pavement Association is actively promoting concrete roadways and "whitening" of asphalt pavements on that basis.

Also, tests have shown "cool" terra-cotta roof tiles can run 6°F cooler than "white" asphalt-fiberglass shingles. And an analysis of Frederick, Md., has estimated potential savings of \$3.4 million annually from strategic tree planting around existing buildings.

Encouraging 'Cool Communities'

The U.S. Department of Energy's *Cool Communities* Program is an ongoing part of a national effort to enhance energy efficiency. Besides the Cool Communities demonstration projects, efforts to encourage cool communi-

Pumice concrete in Santa Fe replaces adobe

Ironstone Gardens is an innovative commercial redevelopment in the heart of Santa Fe, N.M.'s warehouse district. Features include passive solar design, low energy consumption, heavy insulation (R40 in roofs; R24 in walls), and low timber use.

One building (5,200 square feet) is constructed with a material dubbed "pumice-crete", its first commercial use in Santa Fe. Because timber is an expensive commodity in the Southwest and is reducing old-growth forest reserves elsewhere, pumice-crete not only produces cost savings while minimizing the impact on the environment, but also provides a stronger, more durable product for construction than other alternative materials.

At Ironstone Gardens, the pumice/cement mix replaces adobe. The mix is a lightweight, cast-concrete material that uses pumice nodules bound by a light coating of cement and water. Only 2-1/2 sacks of cement per cubic yard are mixed with the pumice to produce a material superior to adobe in compressive strength and durability, with a natural insulating R value of 1-1/2 per inch, (versus an R value of 0.3 for adobe or 1 for wood).

This indicates—in the case of this building—an insulating value of R 24 for the pumice concrete, without additional insulation. In addition to its insulating value, pumice-crete has a compressive strength of 600-700 psi compared to adobe, which is around 200 psi. In terms of overall cost comparison, pumice-crete is approximately 25 percent less expensive than adobe.



Computer simulation indicates cooler L.A.

Computer models indicate that a “Cool Communities” strategy can have a lucrative benefit/cost ratio for major cities, researchers say.

Los Angeles could enjoy cooler summers if cooler-colored building materials and pavements were used, and shade trees planted, write Arthur H. Rosenfeld and Joseph J. Romm, U.S. Department of Energy; Alan C. Lloyd, Energy and Environmental Engineering Center at the Desert Research Institute, Reno; and Hashem Akbari, of the Heat Island project at DOE’s Lawrence B. Livermore National Laboratory, in the February/March 1997 issue of MIT’s *Technology Review*

“In our own simulation, we raise the city albedo—the reflected fraction of incident solar heat—by a modest 7.5 percent and cover 5 percent of its area with 10 million trees,” they write. “The use of white roofs and shade trees in Los Angeles would lower the need for air conditioning by 18 percent, or 1.04 billion kilowatt-hours, for the buildings directly affected by the roofs and shaded by the trees.” They estimate peak period electricity savings at about \$100 million per year. Reduction in air conditioner noise pollution is an added benefit.

If an entire community drops a degree or so in temperature due to “Cool Communities” concepts, everyone else’s air conditioning load will go down as well, even for structures not incorporating “Cool Communities” design, they write. This indirect annual savings would total an additional 12 percent, or \$70 million.

“Implementing these cool community measures would lower the need for peak electrical generating capacity by about 1,500 megawatts, equivalent to two or three large power plants,” they write. Because heat causes smog to form and ozone concentrations to rise, the overall-cooler temperature would moderate those conditions as well.

ties are continuing on other fronts.

In the late 1990s, in its next revision, the National Energy Performance Standards for Buildings (of the American Society of Heating, Refrigeration and Air-Conditioning Engineers) may give energy-conservation credits for cool roofs and shade trees.

Similar credits were to be offered in the California Title 24 building standard. The South Coast Air Quality Management District in California has accepted “Cool Communities” strategies as the most cost-effective single measure in the reduction of smog.

And American Society for Testing and Materials Subcommittee E06.21.16 continues to work to standardize procedures for rating roofs and pavements for reflectivity. In 1998 a new Cool Roof Rating Council—with rep-

resentatives from roofing manufacturers, electric utilities and code bodies—was being formed to tackle these issues.

Also, new federal regulations revised Jan. 1, 1997, require energy efficient design that favor “Cool Communities” concepts (Code of Federal Regulations, Title 10, Volume 3, Parts 200 to 499, Part 435: *Energy Conservation Voluntary Performance Standards for New Buildings; Mandatory for Federal Buildings*). These regulations would favor concrete’s high albedo and high thermal mass in structural applications.

Without doubt, and for many reasons — its low embodied energy, high-reflectivity and thermal mass, and ease of recyclability — concrete is the building material of choice for structures and pavements in environmentally friendly “Cool Communities.”

© 1998 by the Environmental Council of Concrete Organizations

The Environmental Council of Concrete Organizations is a coalition dedicated to promoting the environmental benefits of concrete and its role in safe and sustainable construction.

ECCO members are companies, organizations, and individuals affiliated with the concrete industry. Together, they are committed to developing and disseminating information on the environmental benefits of concrete and concrete products.
