



Strategy and Operations Plan

Global Cool Cities Alliance



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Executive Summary



Former Vice President Al Gore and New York City Mayor Michael Bloomberg kick off New York City's NYC CoolRoofs initiative which has a goal of installing 1 million square feet of cool roofs in 2010. © NYC.gov, photo by Edward Reed

The planet is warming.

Increased concentrations of greenhouse gases in our atmosphere are in the process of raising the average global temperature anywhere from 2–7 degrees Celsius, or possibly farther, by 2100.¹ This rapid change in temperature is stressing our planet's ecosystems. It is also increasing health risks to human populations in cities around the world, with massive heat waves growing in frequency.

While we must do everything feasible to slow and ultimately reverse rising average global temperature, society must also start to deal with some of the inevitable effects. Increasing the solar reflectance, or "albedo," of our buildings and roads is one of the single most effective tools we have to help cool things down. Specifically, because white and other highly reflective surfaces reflect sunlight and thus stay cooler than dark surfaces, using reflective materials in our roofs and pavements can help:

- Reduce the energy consumption of individual buildings by lowering air-conditioning demand and keeping un-air-conditioned buildings cooler and more comfortable.
- Decrease the outside air temperature in cities by removing easily heated dark surfaces, thereby countering the "heat island" effect and helping to improve air quality.
- Reduce the overall effects of climate change by reflecting more sunlight back into space. It is estimated that a campaign to use highly reflective roofs and pavements globally could have a cooling effect equivalent to "offsetting" or "cancelling" 44 gigatonnes (Gt) CO₂, or over a year's worth of world CO₂ emissions.

The world is rapidly awakening to the benefits of cool roofs, with the concept gaining momentum at a rapid clip in recent months. On June 1, 2010, US Secretary of Energy Steven Chu announced several steps to

implement cool roofs at the US Department of Energy (DOE) and beyond. Specifically, he directed all DOE facilities to install cool roofs whenever they are cost effective over the lifetime of the roof, issued a letter to the heads of other US federal agencies encouraging them to take similar steps at their facilities and published "Guidelines for Selecting Cool Roofs" which provides technical assistance on selecting cool roofs.

Several cities and states in the US are also incorporating cool roofs into their regulations and climate plans. In 2005, California revised its "Title 24" Building Energy Efficiency Standards to prescribe white roofs for commercial buildings with low-sloped roofs. In 2008, California went on to prescribe cool surfaces for some residential buildings. In May 2010, Philadelphia mandated vegetative or highly reflective roofs on all new low-sloped buildings, and is partnering with The Dow Chemical Company to retrofit a whole city block with cool roofs as part of its RetroFIT PHILLY "Coolest Block" contest.² New York City surpassed its goal of installing one million square feet of cool roofs in 2010. In 2007, India enacted a voluntary national building code that includes cool roofs. And city governments in Athens, Delhi, São Paulo, and Taipei, have all expressed interest in launching cool roof programs.

Global Cool Cities Alliance (GCCA), a non-profit launched in 2010 by leading cool roofs scientists, is designed to capitalize on current momentum and promote the implementation of cool surfaces around the world.

Global Cool Cities Alliance is dedicated to advancing policies and actions that increase the solar reflectance of our buildings and pavements as a low- or no-cost way to promote cool buildings, cool cities, and, most importantly, to mitigate the effects of climate change through global cooling.

Implementing cool roofs and cool pavements across the world's cities would have the equivalent cooling effect of stopping the emissions of 44 billion tons of CO₂, or over one year's worth of humanity's CO₂ emissions.

GCCA's primary focus is to build and support a global network of city governments that are committed to the widespread installation of cool surfaces as a primary tactic in combating climate change and protecting citizens from rising temperatures. GCCA believes strongly that individual cities must take the initiative, driving action on the ground. At the same time, GCCA will inform and guide policies, regulations, and other mechanisms that will open up the market for cool roofs. Specifically, GCCA will focus on federal and state building codes, financing mechanisms, and government research budgets. GCCA will work in close partnership with the leading cool surfaces researchers (e.g. Concordia University and Lawrence Berkeley National Laboratory) and research funders (e.g. US Department of Energy) to ensure that the latest science on cool surfaces is integrated into the marketplace efficiently.

GCCA launched in 2010 in San Francisco, CA, under the aegis of the Energy Foundation, and in collaboration with Lawrence Berkeley National Laboratory and Concordia University. GCCA's long term headquarters will be in North America, either in Washington, DC or in San Francisco, CA, in close proximity to the Energy

Foundation, Lawrence Berkeley National Laboratory, and ClimateWorks, another potential partner. As it expands its network of global cities, the Alliance's operations and organizational structure will evolve to reflect its international mission. GCCA intends to partner with technical institutions in target countries to deliver its services, and will expand its board of directors to include representatives from major international markets. As it grows, GCCA will continue to marshal resources from its technical partners as needed and act as a central repository of best practices and research to help scale and streamline implementation of cool surfaces. This approach will allow GCCA to operate with a modest staff and budget. GCCA anticipates growing to six full-time employees and an annual budget of approximately \$4.2 million by 2014.

Over the next several months GCCA will focus on building out its staff and operational capacity, developing services for its network of major global cities, recruiting additional cities to its network, providing technical input into building code development in the US, and identifying opportunities for national action in other target countries.

Left: In India, whitewashed roofs have been used for generations to help keep buildings cool. ©Paul Goyette. Right: RetroFIT Philly program. ©Nigel Maynard.



Introduction



In Greece, whitewashed buildings are commonplace, both because they are aesthetically pleasing, and because they help cool things down.

It has long been known that white roofs reflect sunlight, helping keep buildings cool during warm seasons. The traditions of white buildings on the Greek Islands and white washed roofs in parts of India point to a popular understanding of this phenomenon. In recent times, California and other US states have aggressively promoted white roofs as a way of reducing electricity use in air-conditioned buildings.

In addition to the building-specific benefits, scientists and some local governments have come to understand that white and other reflective surfaces can combat the summer “urban heat island” effect. In summer months and hot climate zones, dark pavements, dark roofs, and a lack of vegetation can make the outside air in cities as much as a few degrees Celsius warmer than that in surrounding rural areas. Cool surfaces, such as highly reflective roofs and pavements, can mitigate this effect.

In 2008, *Climatic Change* published a paper by Akbari et. al. of the Heat Island Group at Lawrence Berkeley National Laboratory that calculated the climatic benefits of permanently increasing the albedo of the world’s urban roofs and pavement surfaces. The paper estimated that such a change in the reflectivity of our built surfaces would have a global cooling effect equivalent to a one-time GHG emissions reduction of 44 Gt CO₂, or roughly *one year* of global greenhouse gas emissions. The authors recognized that a campaign to implement highly reflective surfaces would be a simple, low- to no-cost option, effectively buying the planet time to combat climate change.

Despite the recent attention given to cool roofs, including support from US Energy Secretary Steven Chu, municipal action in New York City and Philadelphia, and the inclusion of cool roofs in California’s Energy Efficiency Standard for Residential and Non-residential Buildings (“California Energy

Code” or “Title 24”), the benefits of cool surfaces to buildings, cities, and the planet are still widely undervalued. There is a tremendous need to build on the success of early adopters and move cool roofs into the mainstream in a coordinated manner. Dedicated non-profit action is needed to provide support to interested cities, liaise between cutting edge cool roofs science and the leading market enablers, and help establish cool roofs as a default building practice through building codes.

Global Cool Cities Alliance has been established to do just that.

Global Cool Cities Alliance is dedicated to advancing policies and actions that increase the solar reflectance of our buildings and pavements as a low- or no-cost way to promote cool buildings, cool cities, and, most importantly, to mitigate the effects of climate change through global cooling.

“Cool roofs are one of the quickest and lowest cost ways we can reduce our global carbon emissions and begin the hard work of slowing climate change.”¹⁴

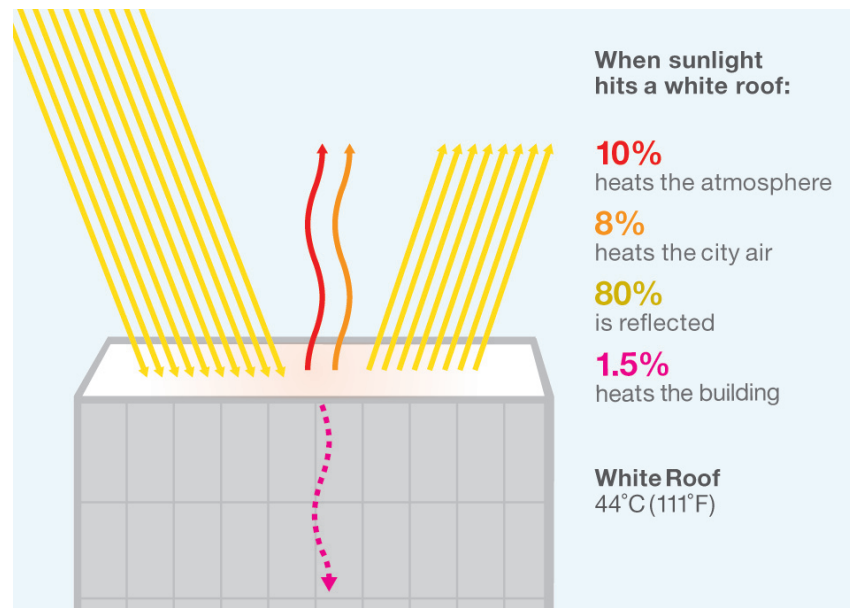
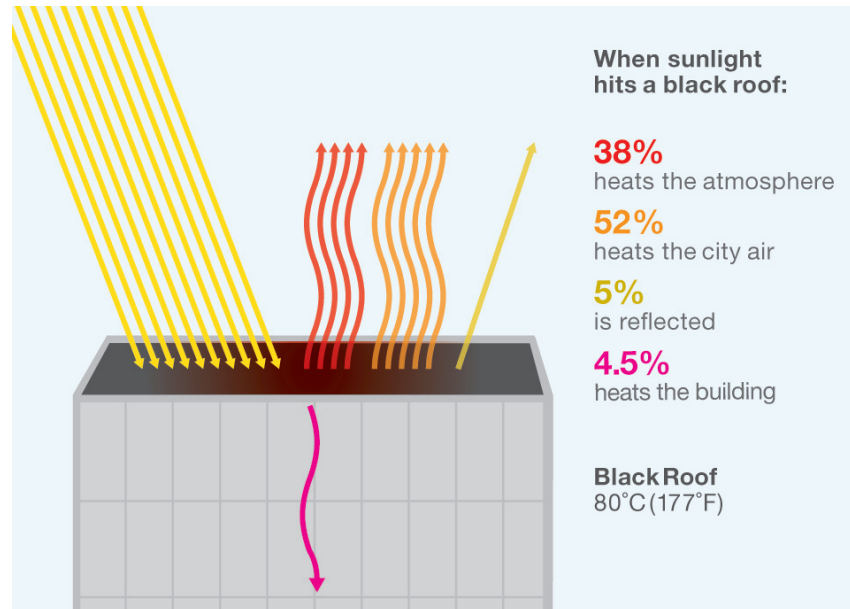
—Steven Chu, US Energy Secretary

Background

The age-old technology of using white surfaces to cool buildings takes advantage of the high solar reflectance, or “albedo” of white surfaces. The higher the albedo, the more a given surface reflects sunlight instead of absorbing it and turning it into heat. The concept is simple: increasing the albedo of our buildings and paved surfaces can substantially reduce the amount of heat trapped under the earth’s atmosphere.

Today, for the first time in human history, over half of the world’s population lives in urban areas. By 2040 that fraction is expected to reach 70%. Pavements and roofs comprise over 60% of urban surfaces (typically roofs account for 20-25% and pavements for about 40%).³ Most roofing and paving materials are dark and typically absorb over 80% of the incoming sunlight, converting it into heat. This built environment of dark urban surfaces in which we live has a larger effect on the climate than most people realize.

Most urban developments are exacerbating the stresses of our warming climate by building with dark, heat-absorptive materials. Instead, these developments could become an effective tool to mitigate the impacts of climate change. By gradually transitioning urban surfaces from highly absorptive materials to highly reflective materials, we can help reduce GHG emissions or cancel their heating effects while alleviating some of the stress caused to human populations by rising global temperatures. Cities around the world are starting to take advantage of this low-cost, no-regrets way to help cool our buildings, cities, and planet.



Top: Without white roof.
Bottom: With white roof.

White roofs reflect sunlight, keeping our buildings and cities cooler. For example, a white roof in temperate or tropical regions absorbs about 70% less sunlight than an ordinary roof. White roofs cool the human environment as well as the atmosphere, and reduce our need for air conditioning.

Cooler Buildings

By reflecting more sunlight back into space, highly reflective roofs can help cool individual buildings, thus lowering their cooling energy use (if air-conditioned) or making them considerably more comfortable (if not).

Many studies have demonstrated building cooling energy savings in excess of 20% upon raising roof albedo from an existing 0.1-0.2 to about 0.6.⁴ Although white roofs may slightly increase heating costs in northern climates, recent studies by Lawrence Berkeley National Laboratory estimate that 80% of commercial building roof area in the US could yield cost savings if retrofitted for cool roofs. In total, installing cool roofs on this 2.58 billion square meters of commercial building roof area would yield net energy cost savings of \$735 million, and offer an annual CO₂ reduction of 6.23 Mt.⁵ A few building codes in the US, such as California's Title 24, now recognize this benefit.

Cool roofs are relatively easy to implement for commercial buildings. The roofs of most commercial buildings are flat or low-sloped, and are generally not visible from the street. As a consequence, there is little resistance or cost to changing the color of these roofs during routine retrofits. In contrast, residential buildings often have steep roofs that can be seen from the ground. In many parts of the world, white is not currently a popular color for residential roofs, and as a result there may be aesthetic concerns about using white materials. To address this, roofing manufacturers have developed "cool" materials in popular roof colors (e.g. red and gray) that strongly reflect the invisible heat component of sunlight and much of the sun's energy away from the building.⁶ However, for a variety of reasons, the cool roofing materials currently

on the market are typically more expensive than traditional asphalt shingles.

Cooler Cities

Cool roofs and cool pavements decrease the ambient air temperature in individual cities, thereby countering the "heat island" effect and helping to improve air quality by reducing smog levels.

Urban heat islands result from the many square miles of dark roofs and pavement in cities. In summer months, urban areas can be a few degrees Celsius hotter than surrounding rural areas due to the heat island effect. Increasing the albedo of urban surfaces (roofs and pavements) can reduce the summertime urban ambient air temperature, making cities more comfortable and also improving air quality (because smog forms more readily on hot days). In the Los Angeles basin, reroofing and repaving with lighter colors, in combination with planting shade trees, could reduce smog levels by about 10%.⁷ Across the US, the potential energy and air quality savings that could result from increasing urban surface albedos is several billion dollars per year.⁸

Cooler Planet

Increasing the solar reflectance, or albedo, of pavements and buildings is an effective tool to alleviate some of the negative impacts caused by rising average global temperatures.

Although the practice of using reflective roofs to cool buildings has been used for generations, it is only recently that we have begun to model the global effects of cool roofs and pavements. Using cool roofs and cool pavements in urban areas can, on average, increase the albedo of urban areas by 0.1. This change would induce a negative radiative forcing⁹ effect equivalent to a one-time reduction of 44 Gt CO₂ emissions. Assuming a plausible annual growth rate of 1.5% in the world's CO₂ emission rate, Akbari, et. al. (2009) estimate that the 44 Gt CO₂ cooling potential for cool roofs and cool pavements would counteract the greenhouse effect attributable to the growth in CO₂ emission rates expected over the next 11 years.

Cool roofs are an important tool for reducing the effects of climate change; buying time for other, more aggressive mitigation actions. Their benefits to the global climate are significant enough to warrant major policies and efforts to implement cool roofs across all major urban centers.



Left: Without white roofs. Right: With white roofs. Pavements and roofs comprise about 60% of city surfaces. White roofs and cool pavements can help reflect away the sweltering temperatures of summer urban heat islands, improving air quality and comfort.

Vision

Installing 1,000 ft² (about 100 m²) of white roof surface would essentially offset the climate warming effect of 10 tonnes of CO₂. This simple reality has excited worldwide interest in implementing “cool cities” to help combat global warming.

The recent convergence of better scientific understanding of the benefits of cool surfaces, increased interest and willingness of city governments to take action to counter climate change, and the explicit US DOE support of cool roofs research, development, and implementation, make this an opportune time to launch Global Cool Cities Alliance.

Cool roofs are certainly starting to gain attention, but the recent wins represent just the tip of the iceberg in terms of actions that are needed to make the widespread use of cool roofs a reality. Throughout the world, this early attention must be used to catalyze voluntary action as well as policy changes in major cities that incorporate cool roofs into building code mandates and create financial incentives and building product ratings to encourage above-code performance. Further scientific research is needed to improve our understanding of the urban heat island and global cooling benefits of cool roofs and pavements. A clearer quantification of the benefits incurred from city level action will strengthen the justification for financial and policy support at all levels of government.

The US may be the most advanced market for cool roofs, but it is not the most important one. Many of the world’s mega-cities are found in the tropics, where temperatures will be pushing into the 40 and even 50°C range with increasing frequency in the next several years and where air-conditioning is often only available to a small percentage of the population.

Cool roofs will be one of the most important tools to keep cities like Guangzhou (China), Manila (Philippines), Mumbai (India), and São Paulo (Brazil) comfortable and safe. Dedicated efforts to support the implementation of cool roofs in major cities around the world are needed. At the same time, national and state level action—through building codes, incentives, and manufacturing guidelines—in critical countries such as China, India, and Brazil, will help accelerate implementation.

A wide spread global cooling effort is needed now. Throughout May and June, 2010, Kuwait, Saudi Arabia, Iraq, Chad, Niger, Pakistan, and Myanmar all set new records for their hottest temperatures of all time. In early July, 2010, the Asian portion of Russia recorded its historic high temperature: 42.3°C (108°F) at Belogorsk, as did Sudan: 49.6°C (121°F) at Dongola. Temperature records were also broken in cities across the eastern coast of the US in June and July, 2010. Meanwhile, in May, 2010, Asia recorded its all-time highest temperature: 53.5°C (128°F) in Pakistan.¹⁰

Global Cool Cities Alliance is well-positioned to be a much-needed global cooling catalyst. It will fill the glaring capacity gap in the existing NGO landscape. Though there are several effective NGOs focused on energy efficiency, and even global cooling, none provides a dedicated, science-based effort to promote cool surfaces worldwide as a solution to climate change. It is time for such a dedicated effort.

Global Cool Cities Alliance will bring exceptional resources to bear, including leadership from top cool roofs scientists, access to the highest levels of US DOE management, and emerging partnerships with several major global cities and with ICLEI, the leading

membership network of municipalities dedicated to climate action. GCCA has already received requests for assistance from cities around the world that are eager to develop or strengthen their cool roof implementation programs. We envision a future world in which our urban environments are dramatically more reflective and thus noticeably cooler than they are at present.



We envision a future world in which our urban environments are dramatically more reflective and thus noticeably cooler than they are at present.

Objectives, Programs and Services

“In response to the sweeping climate change issues, and actions to curb the urban heat island effect, Taipei City is honoured to be part of this cool cities program.”¹⁵

—Lung-Bin Hau, Mayor of Taipei City

Cool roofs could greatly reduce some of the stress caused to human populations from rising global temperatures. In the face of a rapidly changing climate, white and other highly reflective surfaces offer a low cost, “no regrets” strategy that can both help reduce greenhouse gas (GHG) emissions and counter the temperature forcing that results from increased GHG concentrations in the atmosphere.

Although awareness of cool roofs is growing around the world, it will take a concerted effort by national, state, and local governments to accelerate their adoption on a timeline that will benefit our warming planet. Rapid deployment is critical. A global clearinghouse that can promote cool roofs and offer technical assistance, information, and support to interested governments, is needed to ensure that this critical opportunity for widespread global cooling is not missed.

Global Cool Cities Alliance has been launched to be just that.

Global Cool Cities Alliance is dedicated to advancing policies and actions that increase the solar reflectance of our buildings and pavements as a low- or no-cost way to promote cool buildings, cool cities, and, most importantly, to mitigate the effects of climate change through global cooling.

Global Cool Cities Alliance will pursue this mission through the development of four different program areas which together are designed to ensure that a range of mechanisms, from municipal action to advancements in research and development, act in concert to accelerate the adoption of cool roofs. Specifically, GCCA will work towards the following goals:

1. Recruit and obtain commitments from major cities across the globe by 2015, with widespread installation of cool surfaces by 2020.
2. Promote the inclusion, by 2015, of cool surfaces—mainly white roofs—in the building codes and pavement specifications of key US states and foreign countries.
3. Develop financial mechanisms, by 2015, that broadly support the installation of cool surfaces in the US and other key countries.
4. Ensure that information about cool surfaces research, development, and demonstration is broadly disseminated.

GCCA will prioritize geographies based on several key factors including: number of megacities, dominant climate zones in the country, interest of the major cities in working with GCCA, and likelihood of success in enacting national measures. However, GCCA will remain committed to providing its services to any and all cities interested in working with GCCA to implement cool surfaces.

Of the top 100 cities in the world by population, 17 are in China, 12 are in the United States, 10 are in India, 10 are in the Middle East,¹¹ 8 are in the Association of Southeast Asian Nations (ASEAN),¹² 8 are in the European Union, 6 are in Brazil, 3 are in Japan, and 3 are in Mexico. Of the largest ten tropical cities by population, 3 are in China, 2 are in India, 2 are in Brazil, 2 are in ASEAN, and 1 is in Mexico. GCCA will focus near term efforts on the US, China, and India, given the density of high population cities in these countries. The US is a near term priority because the density of high population cities coupled with relatively high political will and capacity for strong regulation could result in early, high-impact wins. China and India are near term priorities because

together they are home to approximately one third of the world's population and over a quarter of the world's largest cities by population. Moreover, most of the cities in both China and India are in hot climates, with above average rates of solar insolation.

Over the next few years, GCCA will actively widen its focus to include a secondary set of regions and countries; targeting Brazil, Mexico, the Middle East and ASEAN/APEC.¹³ GCCA will also continue to keep abreast of opportunities in the European Union, especially Southern Europe, where rates of solar insolation are relatively high and political will and strong regulatory infrastructure may provide relatively easy wins. Although GCCA will be focused on serving countries that have the potential for the biggest impact, its programs and services will be made available to all cities.

“It is quite amazing—the payback on these kinds of [cool roof] investments really are very quick and make an enormous difference.”¹⁶

—New York Mayor, Michael Bloomberg

City-Level Action

Recruit and obtain commitments from major cities across the globe by 2015, with widespread installation of cool surfaces by 2020.

Catalyzing strong action on the part of city governments will be the most effective way to ensure progress on the ground. The primary focus of GCCA will be to support action in the world's major cities through a partnership model. Cities will sign on as partners to Global Cool Cities Alliance and will then gain support from Global Cool Cities Alliance in developing cool roof and cool pavement programs. The organization is currently gaining traction in the marketplace. Five cities—Athens, Chicago, New York, Singapore, and Taipei—have already joined as partner cities. Montreal has announced its intention of joining. And several others, including Delhi, Houston, Hyderabad, São Paulo, and Tokyo have expressed interest in launching cool roof programs with the support of GCCA. Early conversations with mayors' offices in these early adopter cities indicate that city governments are already attracted to the cool roof concept and are eager for the kind of planning and implementation support that GCCA can provide.

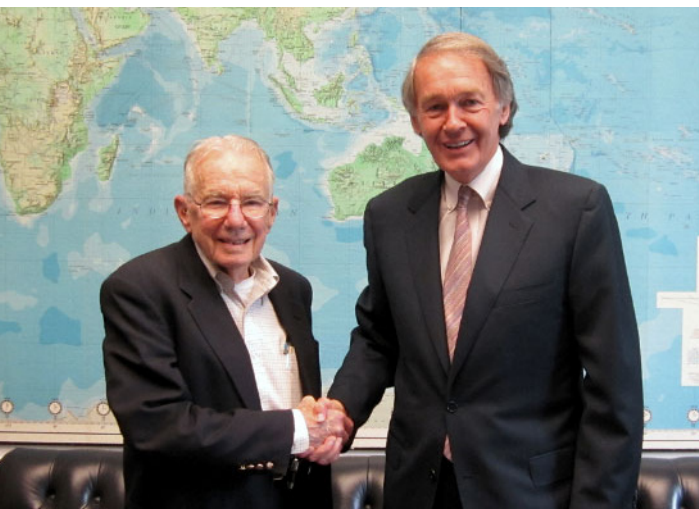
GCCA will create an advisory board in the coming months specifically to help guide GCCA's city members. The advisory board will include significant representation from GCCA partner cities and provide responsiveness to the needs of the city network.

GCCA will focus its near and long-term efforts on developing a suite of services to support city governments that are dedicated to the rapid installation of cool roofs and cool pavements. GCCA will start small, aiming to develop “proof of concept” with a pilot set of four to five cities and then develop its services in an iterative process that responds to the real-time needs of its network.

Over the next several months, Global Cool Cities Alliance will focus on building out the following service offerings:

- **Annual conference** – GCCA plans to host its first annual conference in late 2011, or early 2012. The conference will be a gathering of the Founding Partners of the city network. Representatives from the world's 100 largest tropical and temperate zone cities will also be invited to learn about the latest scientific research and share findings from demonstration projects, success stories, and lessons learned. Subsequent conferences will be hosted by partner cities, with hosting responsibilities rotating throughout the network.
- **Cool city standard** – Over the next couple of years, GCCA will work with its city partners to develop criteria for a cool city certification that cities can achieve. Meeting the cool city criteria will allow cities the use of the cool city brand, which will be a tool for recognition, branding, and marketing, similar to LEED and Energy Star ratings in the US. The cities that join Global Cool Cities Alliance will be expected to work towards this cool city certification.
- **Best practice database** – GCCA will build out a best practice database where partner cities and other relevant parties can share success stories, data from demonstration projects, and technical information with one another.
- **Technical assistance** – Over time, GCCA will build up a stable of technical experts from around the world, serving as employees and partners, who can be deployed to provide direct support to cities as they design, implement and assess their cool roof plans.
- **Access to scientific literature and research** – GCCA website will house (or link to) a library of scientific literature related to cool roofs and cool pavements. This library will be a convenient hub for peer reviewed literature and articles from popular media sources that analyze the performance and benefits of cool roofs to individual buildings, cities, and the planet.

GCCA will develop this suite of services directly and through relationships with NGO partners, such as ICLEI and the Clinton Climate Initiative, who are already working with large networks of cities on climate mitigation and adaptation. GCCA will also participate in municipal government associations, such as the Conference of Mayors, to support their adoption of cool surface initiatives.



Cool roofs advocate, Art Rosenfeld, with Massachusetts Congressman, Edward Markey.

Building Codes and Pavement Specifications

Promote the inclusion, by 2015, of cool surfaces—mainly white roofs—in the building codes and pavement specifications of key US states and foreign countries.

Buildings

In much of the world, the design, construction, and materials used for residential and commercial buildings are guided by building codes. Building codes are an obvious leverage point for promoting cool roofs. The bulk of these codes are dedicated to ensuring the integrity of the building from a health and safety perspective. However, these codes also routinely cover matters relating to energy use, and have, in recent years, become increasingly inclusive of cost competitive energy savings requirements.

Because building codes are generally focused on the energy savings potential of individual buildings, they do not factor in the global climate benefits of cool roofs or the local climate benefits of reducing the heat island effect. As a result, building codes have systematically undervalued cool roofs within the suite of efficiency tools (e.g. insulation). However, the cost-effective nature of cool roofs makes building codes a useful, and in many places, a successful tool. GCCA will be focused on updating codes.

The level of granularity, process for updates, degree of centralization, and level of enforcement of building codes vary greatly by country. For example, in China, there is one national code with three climate zones. In India, there is one national code, but it is voluntary. In the US, building codes are set at the state or local level, but are largely based on national model codes. In the European Union (EU), building codes are decentralized and are determined at the country level.

The US may offer the greatest near-term opportunity for effective promotion of cool roofs through building

codes. In the longer run, China and India's population density, growth in buildings, and tropical climate present significant potential for cool roofs, though the challenge of enforcement will be great. For the next two years, GCCA will focus its building code efforts in the US while also exploring the building code landscape in China, India and other target countries and regions including Brazil, ASEAN, the Middle East and Mexico to identify opportunities and objectives for subsequent work.

GCCA will prioritize providing technical input to model codes that exist in the target countries but will also work in key jurisdictions to secure the adoption of either these model codes or more advanced ones.

GCCA will contribute to building codes development directly through its board members, staff and consultants and by partnering with a host of NGOs already negotiating with the industry groups on building efficiency. A more detailed overview of building codes in the target countries and GCCA's approach to gaining cool roof inclusion in them is covered in Appendix 1.

Pavements

Protocols and specifications for highway design are developed by industry and public agency associations, with jurisdictions varying greatly by country. In the US, the primary standard setting body is the American Association of State Highway and Transportation Officials (AASHTO) whose membership is composed of the Departments of Transportation of each US state. The US Department of Transportation and state Departments of Transportation all have some level of influence and autonomy in their pavement material choices.

GCCA will provide technical input into these associations and will further research opportunities for influencing pavement standards.

Across the US, the potential energy and air quality savings resulting from increasing urban surface albedos exceeds \$1 billion per year.

Financial Mechanisms

Develop financial mechanisms, by 2015, that broadly support the installation of cool surfaces in the US and other key countries.

In air-conditioned buildings, cool roofs pay for themselves. In non-air-conditioned buildings, cool roofs make the building more comfortable at a modest cost. However, there are many scenarios in which building owners lack incentives, or even have counter-incentives, to install cool roofs. The most notable example is sloped roof residential buildings where the roof is visible from the street. Homeowners may not like the aesthetics of a visible white roof. Highly reflective shingles, in a range of colors including grey and rust, are available, but currently are not cost-competitive with standard asphalt shingles. Even when cool roofs are cost-effective over the life of the roof, existing building owners are not always willing to accelerate their maintenance schedule to retrofit the roof.

Financial mechanisms that either create a market for cool surfaces by monetizing their climatic benefit, or simply provide government-backed incentives supporting the implementation of cool roofs and pavements, could dramatically accelerate the adoption of cool surfaces. Expanding financial incentives for energy efficiency and renewable energy projects to include cool roofs is an important, though secondary, initiative of GCCA.

GCCA will support the development of three main categories of financial mechanisms.

- **Adaptation** – Cool surfaces are a low cost, “no regrets” strategy that can help the residents of major global cities cope with the effects of a warming climate. When stacked up next to common adaptation strategies such as building barrier walls to protect against rising sea levels, the costs and benefits of cool surfaces are very appealing. GCCA

will work to ensure that cool surfaces are eligible for any internationally-designed adaptation funds.

- **Financial incentives** – In the US, there are currently a range of financing incentives in development to support the development and adoption of energy efficiency and renewable energy technologies including utility rate payer funded programs and federal tax incentives. GCCA will provide technical input to allow for the inclusion of cool surfaces in the development of these mechanisms.
- **Carbon markets** – Although carbon markets have the potential to be an enormous source of financing for cool roofs, there are currently no albedo-based offsets included in the carbon markets and there are a number of significant challenges to introducing them. Although GCCA does not see immediate opportunities for cool roofs financing through the carbon markets, it will continue to explore options for cool roofs financing through any kind of carbon funding or climate legislation.

GCCA will begin its work on financial mechanisms by reviewing the current set of options for financing cool roofs and cool pavements. GCCA will start by interviewing experts in the range of potential financing mechanisms (e.g. tax incentives, utility rebates, federal grants), then analyze the impact of potential policies that would support the financing of cool roofs and pavements. GCCA will also review any available data, literature or reports on the impact and success of existing or past financing mechanisms. Finally, GCCA will disseminate its findings to its city partners as a way to provide guidance for cities that are evaluating their options for funding cool city programs.

Dissemination of Research and Development

Ensure that information about cool surface research, development, and demonstrations is broadly disseminated.

GCCA is led by several of the top North American scientists studying cool surfaces. The organization is unequivocally positioned to be a thought leader on the latest research with respect to cool surfaces. It will play an important role in disseminating and explaining the current state of the science with all audiences, in advocating for additional research and demonstration projects by government agencies and private foundations, and in accelerating the market adoption of cool surface technologies based on the extensive research currently supported primarily by the US government. The GCCA website, GlobalCoolCities.org, includes a library of the top scientific literature and also provides explanations of complex concepts in laymen's terms.

The US DOE's Office of Building Technology is pursuing a robust research agenda on cool surfaces. Its focus is on developing methodologies for quantifying the global cooling and heat island reduction benefits of cool roofs for individual buildings and cities. Additionally, it is working to develop the necessary infrastructure for market penetration of cool surface technologies, including methodologies for reflectivity ratings for building materials and for accelerating the process of rating "aged" roofs from three years to six months. GCCA has strong existing relationships with the Office of Building Technology at the US DOE and will be able to access and build off of the research

coming out of its programs and act as a conduit between the latest cool surfaces science and the marketplace.

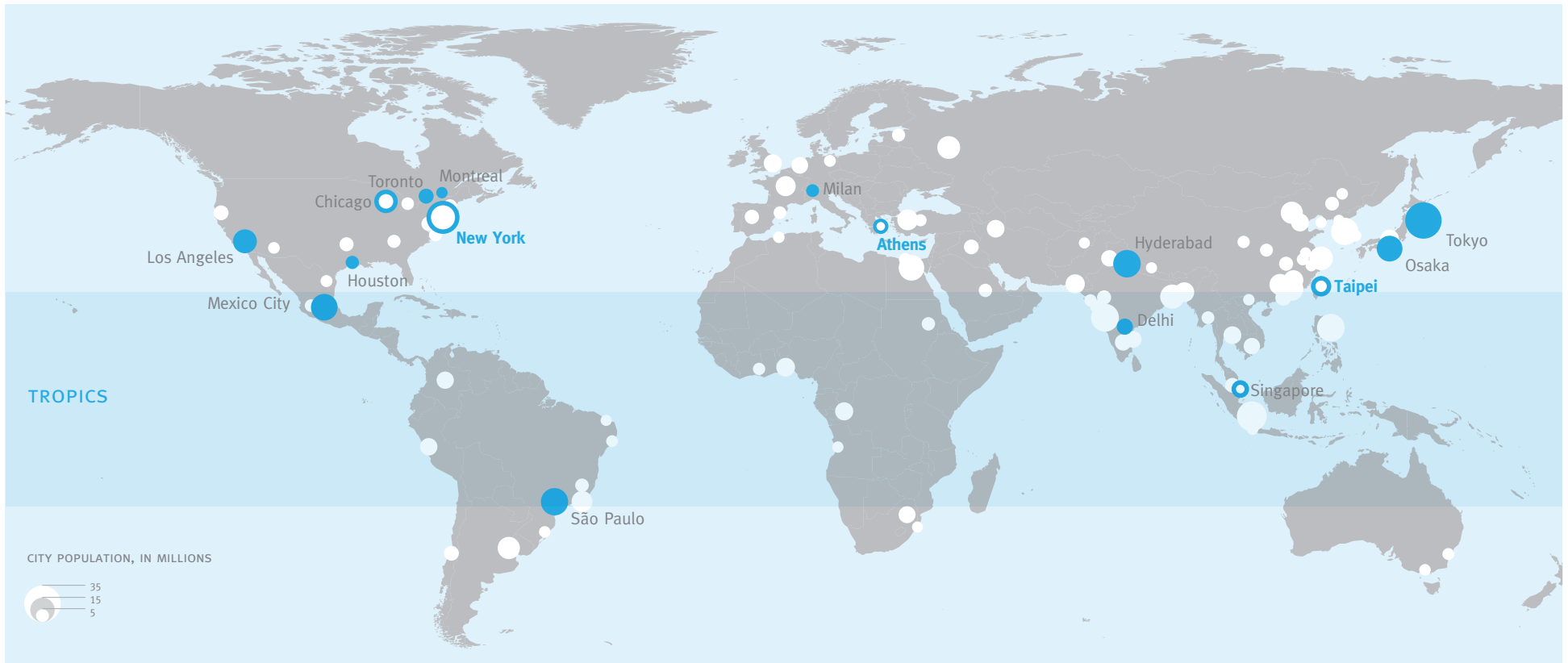
GCCA will also be in a unique position to help reflect the concerns and priorities of the marketplace back to the researchers and funders, and help shape their research agendas going forward. Because GCCA will be on the front lines of implementation with its partner cities, it will quickly understand what the areas of knowledge are limiting adoption. For example, GCCA has already identified several issue areas that require near term attention by the scientific community:

1. The relationship between reflectivity and moisture in roofs.
2. The development of standard monitoring protocols for cities so that they can begin to understand the direct impact of their programs.
3. More comprehensive tools for understanding the costs and payback periods associated with cool roof installation.

Additionally, there are many outstanding research questions surrounding cool pavements, and GCCA will prioritize advancements in pavements research through this program area. GCCA will target relevant industry associations and public agencies that have research budgets, especially the US Department of Transportation and state level departments of transportation, to advocate for accelerated development of cool surfaces, and promote existing cool pavements research.

In 2010, Asia recorded its all-time highest temperature 53.5°C/128°F in Pakistan.

GCCA Cities Network



CITY POPULATION, IN MILLIONS



○ GCCA members

● Cities that have expressed an interest in membership

Largest cities by population

1. Tokyo, Japan	34.6m
2. Jakarta, Indonesia	23.3m
3. New York City, USA	21.3m
4. Mumbai, India	20.4m
5. Manila, Philippines	20.1m
6. Delhi, India	19.8m
7. Seoul, Korea	19.6m
8. São Paulo, Brazil	19.5m
9. Mexico City, Mexico	18.5m
10. Osaka-Kobe-Kyoto, Japan	17.3m

Population of metropolitan area in millions.
Sources: NASA Atmospheric Science Data Center and Demographia, 2009.

Largest tropical cities by population

1. Jakarta, Indonesia	23.3m
2. Mumbai, India	20.4m
3. Manila, Philippines	20.1m
4. São Paulo, Brazil	19.5m
5. Mexico City, Mexico	18.5m
6. Calcutta, India	15.5m
7. Shenzhen, China	14.0m
8. Guangzhou, China	11.9m
9. Rio de Janeiro, Brazil	11.4m
10. Dongguan, China	10.3m

Population of metropolitan area in millions.
Sources: NASA Atmospheric Science Data Center and Demographia, 2009.

Our goal is to grow a membership network of major municipalities across the globe by 2015, and to have widespread installation of cool surfaces by 2030.

Action on the Ground

Catalyzing strong action on the part of city governments will be the most effective way to ensure progress on the ground. GCCA is launching a network of city partners designed to support city level implementation of cool surfaces throughout the world's major cities. GCCA is already gaining traction in the marketplace. Five cities – Athens, Chicago, New York, Singapore, and Taipei – have already joined the network. And several others, including Delhi, Houston, Hyderabad, Montreal, São Paulo, and Tokyo, have expressed interest in launching cool roof programs with the support of GCCA.

Comparative Landscape

Currently, there is a tremendous opportunity for an organization to promote cool roofs and cool pavements. GCCA is uniquely focused in its role as an advocate for worldwide adoption of highly reflective roofs and pavements as a global solution to climate change. GCCA's positioning and services are designed to enhance, expand, and complement existing efforts and policies at city, state, national, and international levels. GCCA's role is inherently complementary to the existing field.

GCCA will provide subject matter and policy expertise around cool roofs and pavements to the broader context of building efficiency and climate change mitigation efforts. By integrating cool roofs into the multitude of new building codes, standards, and financing mechanisms, and disseminating critical research, and best practices, GCCA can more effectively increase global adoption of cool surfaces over time.

GCCA will collaborate with the range of organizations already actively working on building codes and other energy efficiency policies in the US and in other nations and cities around the world. Most of these organizations have broader missions than GCCA, and do not have the expertise on cool roof technology that GCCA brings to the table. GCCA will provide support that its partners are not already getting in the important areas of research and technology for cool surfaces. Additionally, GCCA will work closely with the leading cool roof research organizations to ensure the latest in cool roofs science and technology is widely disseminated.

Potential Partners: City-Level Action

- **ICLEI—Local Governments for Sustainability** – ICLEI—Local Governments for Sustainability has about 1,000 members, including most of the global megacities and over 500 local governments in the US.

The organization's focus is to provide technical consulting, training, and information services to implement sustainable development at the local level by sharing knowledge and building capacity among local government members. Through its Climate Program, ICLEI has launched a Cities for Climate Protection (CCP) Campaign as a tool to initiate local mitigation and adaptation actions and provide key inputs in global climate advocacy efforts of cities and local governments. GCCA intends to work with ICLEI to provide the research on benefits of cool roofs which can be easily disseminated and adopted by member cities. Together, GCCA and ICLEI will help develop the capacity of global cities to roll out cool roof and cool pavement programs. Cool surface installations will complement and drive ICLEI's GHG emissions reduction and sustainability goals, and the organization has already expressed an interest in working with Global Cool Cities Alliance.

- **Clinton Climate Initiative (CCI) / C40** – CCI has partnered with C40, a group of large cities forming a network and forum of cities working together, sharing information, and demonstrating leadership in tackling climate change at the city level. CCI assists the cities in developing projects across a range of programs, including building efficiency and retrofits. There would be great synergy between GCCA and CCI/C40 with cool roofs as one initiative in which cities can execute their climate change action plans and achieve their energy efficiency goals. GCCA would work with CCI by providing the technical and project assistance, financial advice, network access, and analytical and measurement tools for cool roof projects.
- **Sierra Club** – Sierra Club's Cool Cities Program, in partnership with US Green Building Council, has over 1,000 city and county leaders internationally that have made a commitment to reduce their city's carbon footprint. The program provides resources such as activist tools, best practice guides and technical information for member cities. GCCA could

coordinate with the Sierra Club to highlight the benefits of cool roofs and pavements for member cities' climate action plans, and to build the capacity of cities to implement cool roof and cool pavement programs.

Potential Partners: Energy-Efficiency

- **American Council for an Energy-Efficient Economy (ACEEE)** – ACEEE is committed to advancing energy efficiency primarily by conducting technical and policy analyses, advising policymakers and program managers, and educating and collaborating with businesses, government officials, public interest groups, and other organizations. ACEEE is an important partner candidate for GCCA because it supports, among many other things, emerging technologies and practices around building energy codes. Cool roofs are a relatively new cost-effective initiative that could be incorporated into building code standards, compliance, and implementation. GCCA plans to provide ACEEE with technical input on the benefits of cool roofs to inform its legislative and building code improvement platforms.
- **Alliance to Save Energy (ASE)** – ASE supports energy efficiency as a cost-effective energy resource and advocates energy-efficiency policies that minimize costs to society and individuals, lessen GHG emissions, and minimize impact on the global climate. The organization carries out its mission by undertaking research, educational programs and policy advocacy; designing and implementing energy-efficiency projects, promoting technology development and deployment; and building public-private partnerships globally. GCCA could provide the research, and project design and implementation for cool roofs which would fit into several of ASE's topic areas, including building codes, national energy use, international energy efficiency, financing energy efficiency, home energy assessments, and educational programs.

- **ClimateWorks** – The ClimateWorks Foundation is in the process of establishing a Best Practices Network (BPN) focused on energy efficiency in buildings. This Global Buildings Performance Network (GBPN) will prioritize and focus on China, India, US, EU, and Latin America. The GBPN could prove a strong partner and useful international platform for cool roofs. Informing the efforts of the GBPN and dovetailing with its work should be a good means of amplifying the efforts of GCCA around global adoption of cool roofs.
- **New Buildings Institute** – The New Buildings Institute is undertaking a new effort to strengthen the next round of supplements to the IECC commercial code. Working with the NBI to include cool roofs in their proposals could also provide an effective way to push commercial codes.

Potential Partners: Building Materials

- **Cool Roof Rating Council** – The Cool Roof Rating Council (CRRC) provides credible, third-party radiative energy performance rating systems for roof surfaces. Additionally, the CRRC supports research on energy-related studies of roofing surfaces and provides education and support to parties interested in understanding and comparing various roofing options. GCCA would complement the CRRC's efforts, particularly in conducting and disseminating research. Furthermore, the CRRC members and products are a valuable resource and connection to the market, technology, products, and companies, including roofing manufacturers, suppliers, and distributors.
- **EU Cool Roofs Council** – The EU Cool Roofs Council (EU-CRC) was recently created with the following goals:
 1. Support policy development by improving understanding of the actual and potential contributions by cool roofs to heating and cooling consumption in the EU.

2. Remove market barriers and simplify the procedures for the integration of cool roofs in construction.
3. Change the behavior of decision-makers and stakeholders to improve acceptance of cool roofing technologies.
4. Promote the development of innovative legislation, codes, permits and standards concerning cool roofs.

The EU-CRC is also in the process of developing its own database of cool roofing products which currently includes over 100 products from six companies in Germany, Greece and Italy.

Geo-engineering Initiatives

Geo-engineering describes the range of efforts to combat or counteract the effects of climate change through large-scale modification of our environment. Oft-mentioned geo-engineering schemes include fertilizing the ocean with iron and seeding clouds to affect weather patterns. The efficacy and side effects of such geo-engineering schemes are largely unknown and the field is generally considered to be risky, expensive, and full of moral hazards. Cool roofs are distinct from these other geo-engineering schemes for a number of important reasons, namely they are safe (no suspected or known side effects), inexpensive, create direct GHG reductions, and do not require any kind of international agreement.

Since increasing the albedo of the earth with cool roofs is technically a geo-engineering scheme (albeit a mild one), GCCA will participate in the geo-engineering dialog as a way of promoting cool roofs as a safe and cheap alternative. GCCA believes that any governing body interested in geo-engineering schemes should implement cool roofs as a logical first step.

Structure, Staffing and Governance

Advisory board members:

Hashem Akbari,
Concordia University

Ronnen Levinson,
Lawrence Berkeley National Laboratory

Arthur Rosenfeld,
Lawrence Berkeley National Laboratory

Stephen Wiel,
Collaborative Labeling and Appliance Standards Program (CLASP)

John Wilson,
The Energy Foundation

Global Cool Cities Alliance is a non-profit organization developed by a consortium of scientists and environmental leaders to promote the global adoption of cool surfaces. It is currently being incubated by the Energy Foundation, under the Foundation's Buildings Program. GCCA has 501(c)3 tax status as a project of the Trust for Conservation Innovation (TCI), and has received a \$5,000 contribution from an individual donor.

Design

GCCA's long term headquarters will be in North America, either in Washington, DC, or in San Francisco, CA, in close proximity to the Energy Foundation, Lawrence Berkeley National Laboratory, and ClimateWorks, a potential partner. The core GCCA staff will be responsible for designing the organization's primary programmatic areas as well as identifying on-going opportunities. Over time, as the network of its partner cities grows, GCCA will build a stable of highly-skilled partners around the world who can provide on-the-ground technical assistance to the network. GCCA will also call on these partners to help design building codes and financial mechanisms, in all target countries.

Governance

GCCA is led by an advisory board composed of five leading energy experts. The advisory board has the ultimate responsibility to govern GCCA's programs, and to make strategic decisions about organizational structure and activities. The current board is composed of the following individuals. Please see Appendix 2 for board member biographies.

- Hashem Akbari, Concordia University
- Ronnen Levinson, Lawrence Berkeley National Laboratory
- Arthur Rosenfeld, Lawrence Berkeley National Laboratory
- Stephen Wiel, Collaborative Labeling and Appliance Standards Program (CLASP)
- John Wilson, The Energy Foundation

As GCCA grows and expands its international reach, it will expand its board and change the composition to better reflect its international character. GCCA intends to spin out from TCI and secure independent 501(c)3 status within a few years time. Once GCCA is an independent organization, it will require a dedicated governing board responsible for both fiscal and programmatic governance of the organization. We anticipate that the standing advisory board would transition to a governing board at that time.

Staffing

Currently, GCCA is being driven by the advisory board, with operating support from California Environmental Associates (CEA), a consulting firm. CEA is performing a limited range of functions in the absence of full-time employees, including website construction and maintenance, partnership development, board support, work planning, and administration.

By 2014, GCCA expects to employ a staff of six full time employees: an executive director responsible for charting organizational priorities, high level partnerships, and fundraising; three program directors responsible for building and managing GCCA's four program areas; a program associate to support all of the programs; and an administrator to support the office.

Over the next 6-12 months, GCCA plans to secure launch funding, hire key personnel, develop key technical partners, and begin implementing its highest priority activities.

GCCA will provide its services through a combination of employees and partner consultants. While the balance may change over time as circumstances dictate, GCCA intends to maintain a small core staff and rely on a wide collaboration of partners throughout the world to achieve its mission.

Funding Model

GCCA is in a strong position to take advantage of the growing interest in global cooling by government agencies and private foundations. GCCA has already received considerable assistance from the Energy Foundation in the form of organizational planning grants and incubation support. In the near term, GCCA will be philanthropically supported, primarily through grants from government agencies and private foundations. Potential funders include the following organizations:

- **Government funding** – Under Secretary Chu’s leadership, the US Department of Energy is an active proponent of cool roofs and has mandated that all DOE buildings be retrofitted with cool roofs, where cost-effective. The Office of Building Technology will support further research and development efforts for cool roofs and has dedicated funds directly to GCCA for program development in the US. GCCA will also explore the possibility of securing grants from other relevant national agencies in the US including EPA, US Agency for International Development, the Department of Transportation, and the State Department. As GCCA expands its work internationally, it will seek funding from the national agencies of other countries, especially development agencies of EU member countries.
- **Private foundations and individual donors** – To date, GCCA has received support from two sources: 1) the Energy Foundation – a private foundation based in San Francisco, CA, and 2) a donation from an individual board member. GCCA will work to expand its base of financial support from private foundations and individual donors over the next few years, specifically targeting organizations that are focused on climate mitigation, adaptation, and building efficiency.
- **Corporate support** – GCCA has a promising opportunity to raise funds from corporate partners that have a commercial interest in advancing cool roofs, including construction companies, utility companies, and companies that develop and manufacture advanced roofing materials. Indeed, cool roof projects are already attracting corporate sponsorship as demonstrated by The Dow Chemical Company’s participation in Philadelphia’s Retrofit Philly “Coolest Block” contest. The winning block will be retrofitted with energy efficient building products, including cool roofs.
- **Revenue generation** – Over time, GCCA will develop revenue-generating activities including: membership fees from partner cities, annual conferences and workshops for city governments and building professionals, and technical assistance. GCCA will have a tiered pricing structure for many of its services so that it can effectively serve cities and buildings professionals in less-developed parts of the world.

Staff Allocation Summary (# people)

	2010	2011	2012	2013	2014
Staff (FTE) Count	0.25	2.00	3.50	5.50	6.00
Executive Director	0.25	1.00	1.00	1.00	1.00
Program Director, City-Level Action	—	1.00	1.00	1.00	1.00
Program Director, Building codes	—	—	0.50	1.00	1.00
Program Director, Financing & R+D	—	—	—	0.50	1.00
Program Associate	—	—	—	1.00	1.00
Admin	—	—	1.00	1.00	1.00

Work Plan

Global Cool Cities Alliance was launched in June of 2010. Since June, GCCA has been working to recruit partner cities, and to lay the groundwork for program development in 2011. GCCA recently unveiled its web presence at **GlobalCoolCities.org**. The site is currently being used to introduce the concept of cool surfaces, disseminate the latest scientific research from the field, and highlight municipal initiatives involving cool roofs. GCCA board members are also taking an active role in forwarding the agenda of the organization by providing comments to building code development, providing technical input to key leaders in the US DOE, and initiating relationships with mayors' offices in key cities around the world, five of which have already signed on to be charter partners of Global Cool Cities Alliance.

The GCCA board has also been building a solid foundation for its management and continuing operations. Over the next 18 months, GCCA will build on the foundation that the board has laid, scaling up its operations significantly according to the priority activities detailed below.

Near-Term Activities

GCCA's near-term activities are designed to support its four program areas, all of which push on different levers to accelerate the adoption of cool roofs. In the first few years, GCCA will have limited resources and will need to prioritize those activities that can be ramped up with modest effort but can build the foundation for scaling broader efforts over time.

Over the next several months, GCCA's primary focus will be on building a solid network of city governments dedicated to implementing cool roofs, while developing a suite of services to support their commitments and actions.

As a secondary priority, GCCA will dedicate staff time in its first few months of operations to evaluate immediate opportunities to influence building codes and pavement specifications, and financial mechanisms in each of its target regions (US, China, and India) to understand where its efforts will have the greatest impact. GCCA will then develop a focused plan to address these top opportunities.

Finally, GCCA will continue to participate in research and development efforts, both helping to chart the research agenda of the relevant research institutions by identifying outstanding questions for cool surfaces, and disseminating existing research to all key audiences.

Specifically, GCCA will pursue the activities described in the following chart, ramping up efforts and programs over time. In its first year of operations, GCCA's objectives will include:

- Hiring an executive director and a City-Level Action program director.
- Recruiting the founding city partners.
- Hosting its first workshop for charter and target city partners.
- Surveying target countries other than the US for legislation that could include cool roof provisions.
- Developing a partnership with ICLEI to disseminate GCCA's educational and technical services.
- Securing strong provisions for cool roofs in ASHRAE and IECC US national model building codes.
- Maintaining a current and robust web presence to disseminate the latest scientific and popular literature on cool surfaces.

Global Cool Cities Alliance Work Plan

	2010	2011	2012	2013	2014
City-Level Action					
Hold first workshop for target cities		////			
Recruit founding GCCA partners	//////////				
Develop partnerships with ICLEI and other organizations, including municipal government associations, to encourage the inclusion of cool surfaces in municipal level climate plans		//////////			
Annual conferences and workshops for GCCA city partners		//////////			
Build out best practices database			//////////		
Cool materials market adoption		//////////			
Assessment of LEED-like standard for cool cities			//////////		
Develop technical assistance services that can be deployed globally			//////////		
Building Codes and Pavement Specifications					
Provide technical input into ASHRAE and IECC US national model codes		//////////			
Evaluate priority opportunities for further building code work and implementation (e.g. key US states, China, and India)			//////////		
Provide technical input into pavement specifications				//////////	
Financial Mechanisms					
Evaluate priority opportunities for financing incentives in the US and work to include cool roofs			//////////		
Provide technical input into design of carbon markets and adaptation funds, so that cool surfaces can be eligible				//////////	
Dissemination of Research and Development					
Maintain GlobalCoolCities.org as a clearing house of the latest scientific literature and news regarding cool roofs		//////////			
Provide input into the research agencies of relevant government agencies and private foundations	//////////				
Develop standard monitoring protocols			//////////		

Budgets and Timelines

Global Cool Cities Alliance will remain a lean organization with an ambitious reach. By 2014, it will employ six full time professionals and deploy an annual budget of approximately \$4.2 million. GCCA's fiscal year begins on January 1st.

GCCA's budget (excluding technical partners and direct support for member cities) will be approximately \$2 million in 2014. With this budget and a staff of six full time employees, GCCA will build and operate its four program areas. Its leading program, City-Level Action, is focused on implementing cool surfaces in partner cities around the world. This work will often require technical assistance which GCCA will provide through partners. In some cases, the cities will be in a position to subcontract directly with these in-country technical partners. In other cases, the contracts will be covered by GCCA. We anticipate a budget for technical assistance partners of close to \$700,000 by 2014. Additionally, individual cities will require funds for the implementation of their programs. Here again, GCCA will be flexible as to how funds are obtained. In some cases, the cities will be in a position to secure these funds directly. In other cases, GCCA will raise funds and then pass them through to the cities. We anticipate a budget for direct support of partner cities of approximately \$2 million by 2014.

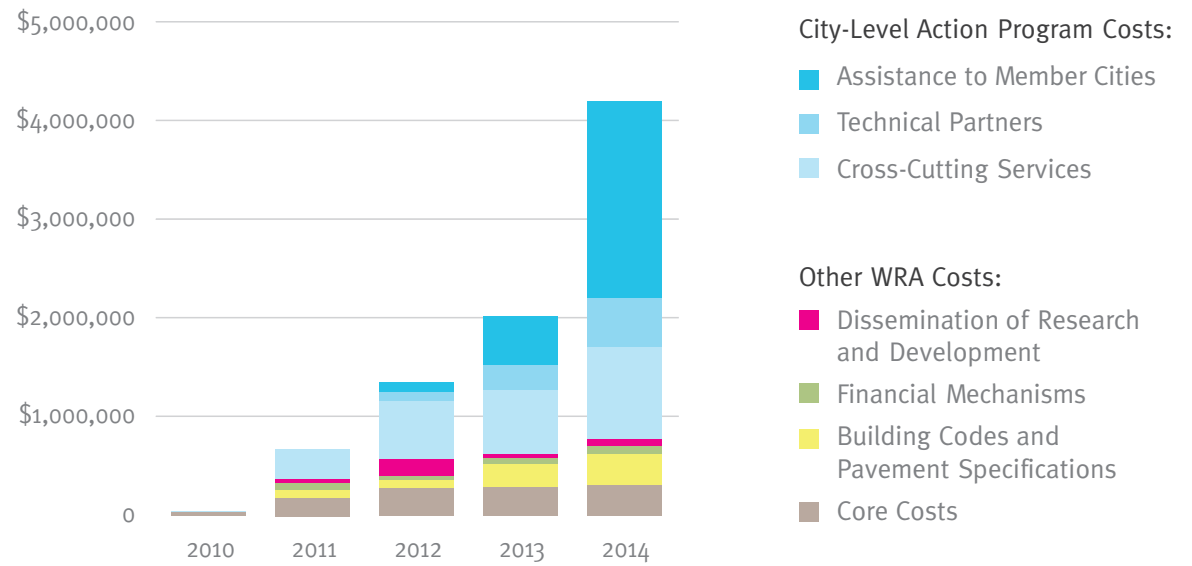
Operating Costs by Category (in US dollars)

	2010	2011	2012	2013	2014
Total	\$46,500	\$673,500	\$1,360,500	\$2,028,500	\$4,209,000
Staff	\$37,500	\$259,500	\$378,500	\$535,500	\$609,000
Scientific advisors & consultants	—	\$227,500	\$453,500	\$173,000	\$245,000
Technical assistance partners	—	\$5,000	\$110,000	\$360,000	\$680,000
Conferences & workshops	—	\$50,000	\$150,000	\$350,000	\$550,000
Direct support to GCCA partners	—	—	\$100,000	\$500,000	\$2,000,000
Publications & web maintenance	\$5,000	\$77,500	\$110,500	\$30,000	\$25,000
Office & operations	\$4,000	\$54,000	\$57,500	\$80,000	\$100,000
Staff (FTE) Count (# people)	0.25	2.0	3.50	5.50	6.0

Operating Costs by Program Area (in US dollars)

	2010	2011	2012	2013	2014
Total	\$46,500	\$675,500	\$1,362,500	\$2,028,500	\$4,209,000
Core costs	\$39,500	\$183,500	\$284,500	\$288,000	\$309,500
City-Level Action	\$7,000	\$300,000	\$781,500	\$1,400,500	\$3,430,000
Building and pavement codes	—	\$75,000	\$75,000	\$236,500	\$320,000
Financial mechanisms	—	\$77,000	\$50,000	\$63,000	\$77,500
Research and development	—	\$40,000	\$172,000	\$41,000	\$72,500

Costs by Program Area (in US dollars)



Appendix 1: Country Level Building Code Work

US

In the US, there are several important channels to work through to advance cool roofs in building codes. A comprehensive building code effort in the US would first advocate for the inclusion of cool roofs in the national model codes and then lobby on a state-by-state basis for the adoption of these codes, or for the adoption of more advanced codes.

- **National model codes** – In the US, there are two professional organizations that govern national model codes: the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and the International Code Council (ICC). These organizations are granted the authority to publish building codes through the Energy Policy Act (EPACT). Both ASHRAE and ICC publish codes for commercial and residential buildings, covering new construction as well as upgrades to existing buildings.

Near term efforts will focus on strengthening existing cool roof measures in the next round of revisions to ASHRAE Standard 90.1, which covers commercial and high-rise residential buildings. 2010 updates to Standard 90.1 have just been completed and will stand until 2013. But efforts to influence the 2013 updates will begin almost immediately, and GCCA intends to be at the table to provide a louder voice for cool roofs throughout the next round of revisions to ASHRAE Standard 90.1. GCCA will also build its capacity to strengthen the cool roof measures in ICC's residential code, Chapter 4, although the next round of revisions won't be made until 2015, and efforts to develop proposals for 2015 won't begin until 2013. GCCA will join the Energy Efficient Codes Coalition (EECC), an existing coalition of energy efficiency non-profits that have been proposing a "30% solution" which is designed to achieve 30% energy efficiency gains through the ICC's codes. GCCA will provide input into the EECC platform to ensure that cool roofs are an integral part of its next proposal.

- **Code implementing jurisdictions** – Building codes are set at the state level except for in a handful of states that claim "home rule," leaving it up to the cities to define their own energy and building codes. The national model codes serve as the basis for the majority of state and municipal codes. Technically, states and municipalities are required to adopt code that is at least as strong as the current model code with respect to energy efficiency. However, in reality, many jurisdictions lag behind since there is no penalty for not upgrading. States and local municipalities are also free to modify the national codes by adding or subtracting measures, meaning that any individual measure can be rendered irrelevant by individual jurisdictions. A few states, such as California and Florida have adopted code that is more rigorous than the national code, but they are the exception.
- **Voluntary green building programs** – There are several voluntary codes and rating systems for buildings and building materials in the US and international markets that are designed to support the demand for buildings that perform above the regulated building codes. The theory is that such advanced systems will provide a pathway for accelerating the advancement of mainstream codes by testing the market and proving cutting edge technologies. They also provide a brand, credential, and/or technical guidance to those wishing to push the envelope on building efficiency. Such "above code" systems in the US include the Leadership in Energy and Environmental Design (LEED) Green Building Rating System, ASHRAE Standard 189.1, International Code Council's International Green Construction Code, and the US DOE and EPA Energy Star program. Cool roof provisions are included in many of these "above code" mechanisms, but could be expanded or strengthened throughout.

China

In China there are three national building codes for residential buildings in different climate zones, and one building code for commercial buildings. To our knowledge, cool roofs are currently not included in any of these codes. Like the US codes, the China codes are split into mandatory, prescriptive, and performance categories, and do include energy efficiency measures. The codes are not terribly rigorous in terms of energy efficiency, but they are improving, and have made efficiency gains of 50% since 1980. The codes are updated every three to five years, with the most recent updates published in 2007. Once building codes are passed at the national level, they cover the whole country. There is no local jurisdiction over building codes. However, implementation and enforcement of the codes remain significant challenges. A multi-pronged effort in China, focusing on winning the support of Chinese technical and scientific experts, and also proving the efficacy of demonstration projects, should yield significant opportunity in the country.

India

In 2007, the Bureau of Energy Efficiency (BEE) launched The Energy Conservation Building Code (ECBC), which specifies the energy performance requirements for all commercial buildings that are to be constructed in India. In large part thanks to the work of Dr. Hashem Akbari and LBNL, there is a provision for cool roofs in the ECBC. Although this code is a national code, it is voluntary and thus there is no enforcement and implementation rates are low. There is a reasonable chance that this building code will be made mandatory within the next few years, but enforcement, which would be done at the municipal level, would still be extremely difficult. Further investigation is needed to see whether GCCA can play a role in bolstering India's building codes, either by helping make them mandatory, or by encouraging implementation in key cities. Efforts may be better spent working directly with municipal governments through GCCA's City-Level Action program.

Appendix 2: Board Member Biographies

Hashem Akbari

Dr. Akbari is a Building, Civil, and Environmental Professor and Research Chair at Concordia University in Montreal, Canada, a post he has held since June 2009. At Concordia, Dr. Akbari teaches courses in engineering and urban energy and environment and continues his research in urban heat islands and mitigation technologies. He is also developing research programs in building automation and demand response. Prior to joining Concordia University he was the founding Group Leader of the Heat Island Group, a Senior Scientist, and a principal investigator in the Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory.

During his tenure, the Heat Island Group conducted several experimental and simulation studies to quantify the energy saving potentials of cool roofs and shade trees, performed meteorological and air-quality simulations to characterize the air quality benefits of heat island mitigation technologies, collaborated with leading roofing materials manufacturers to produce advanced cool roofing materials, and worked with many agencies and organizations to develop related codes and standards for implementation of heat island technologies. Some notable contributions include: helping the California Energy Commission and California utilities to develop cool roof rebate programs; leading efforts to incorporate cool roof provision in the ASHRAE building energy efficiency standards 90.1 and 90.2; leading efforts to incorporate cool roof provisions in the California Title 24 building energy efficiency standards; helping cities and states to develop cool roof standards; and assisting air quality management districts to develop heat island mitigation guidelines for improving ambient air quality. Dr. Akbari also initiated the creation of the Cool Roof Rating Council, a non-profit organization which measures, rates and labels the optical properties of

roofing material surfaces, and is currently serving on its board.

Dr. Akbari earned his Ph.D. (1979) in engineering and M.Sc. (1978) in industrial engineering and operation research from the University of California, Berkeley (1979, 1978). He has also holds a M.Sc. in nuclear engineering from MIT (1977) and a B. Sc. in gas engineering from the Abadan Institute Technology (1971).

Ronnen Levinson

Dr. Levinson is the acting leader of the Heat Island Group at Lawrence Berkeley National Laboratory in Berkeley, CA. Dr. Levinson has developed cool roofing and paving materials, improved methods for the measurement of solar reflectance, and helped bring cool roof requirements into building energy efficiency standards. He holds a B.S. in engineering physics from Cornell University (Ithaca, NY) and an M.S. and a Ph.D. in mechanical engineering from the University of California at Berkeley. Dr. Levinson has authored or co-authored over 40 publications.

Art Rosenfeld

Dr. Rosenfeld received his Ph.D. in Physics in 1954 at the University of Chicago under Nobel Laureate Enrico Fermi, and then joined the Department of Physics at the University of California at Berkeley. There he joined, and eventually oversaw, the Nobel prize-winning particle physics group of Luis Alvarez at Lawrence Berkeley National Laboratory (LBNL) until 1974. At that time, he changed his research focus to the efficient use of energy, formed the Center for Building Science at Lawrence Berkeley National Laboratory, and led it until 1994.

From 1994 to 1999 Dr. Rosenfeld served as Senior Advisor to the US Department of Energy's Assistant Secretary for Energy Efficiency and Renewable Energy. In 2000 California Governor Gray Davis appointed him

Commissioner at the California Energy Commission, and in 2005 he was re-appointed by Governor Arnold Schwarzenegger. He was responsible for the Public Interest Energy Research program, with an annual budget of \$82 million for Energy Efficiency, including the California energy efficiency standards for buildings and for appliances. He also collaborated with the California Public Utilities Commission to oversee California's Energy Efficiency Program with an annual budget of \$1 billion. He retired from the CEC in January, 2010.

Dr. Rosenfeld is the co-founder of the American Council for an Energy Efficiency Economy (ACEEE), and the University of California's Institute for Energy and the Environment (CIEE).

He is the author or co-author of over 400 refereed publications, and received the Szilard Award for Physics in the Public Interest in 1986, the Carnot Award for Energy Efficiency from the US Department of Energy in 1993, and the Berkeley Citation in 2001 from the University of California. He is most proud to have received in 2006 the Enrico Fermi Award, the oldest and one of the most prestigious science and technology awards given by the US Government.

Stephen Wiel

Dr. Wiel is an engineer with forty-nine years of experience dealing with various energy and environmental matters. Dr. Wiel retired from Lawrence Berkeley National Laboratory (LBNL) in 2005 and is currently serving as the President of the Board of the Collaborative Labeling and Appliance Standards Program (CLASP), an organization which grew out of a collaborative partnership that he initiated at LBNL in 1996 to stimulate the use of energy efficiency

standards and labels worldwide. He also is currently serving as the Nevada Representative of the Southwest Energy Efficiency project (SWEEP).

From 1992 to 2005, he worked for the Lawrence Berkeley National Laboratory, where he served as Head of the Energy Analysis Department. During his career at LBNL he also established LBNL's Washington Office, served as senior advisor to the US Department of Energy on integrated resource planning and demand-side management in the utility sector, led the greenhouse gas mitigation component of the US Country Studies Program, and created the initiative on international energy efficiency standards and labels that evolved into CLASP.

For the eight years prior to joining LBNL, Dr. Wiel was a Public Service Commissioner, regulating the prices and conduct of Nevada's investor-owned utility companies. For seven years before that, he owned an energy and environmental planning firm in Reno, and was a part-time Engineering Professor at University of Nevada, Reno. He served as the Chairman of NARUC's Conservation Committee for four years, contributing significantly to the development of electric and gas utility companies' integrated resource planning, their investment in demand-side management, incentives for conservation profitability, and environmental accounting. He currently serves on the Board of Directors of the American Council for an Energy Efficient Economy.

Dr. Wiel has Bachelor's and Master's degrees in Chemical Engineering from Stanford University, and a Doctorate from the University of Pittsburgh, Graduate School of Public and International Affairs. He has published 151 books, articles, reports and papers on

the subject of energy efficiency and the environment. He has served as a member of teams advising officials in Pakistan, the Philippines, Indonesia, Japan, China, Australia, Poland, Czechoslovakia, Romania, the Russian Federation and Mexico, and has otherwise travelled extensively in his work.

John Wilson

Mr. Wilson is the Buildings Program Director at the Energy Foundation. Prior to joining the Energy Foundation, he was an economist and commissioner advisor at the California Energy Commission from 1977 to 2008. His activities emphasized developing new appliance efficiency standards, oversight of the Commission's \$80 million per year Public Interest Energy Research program, and developing long-term scenarios for California's energy system. He was a winner of the American Council for an Energy Efficient Economy's "Champion of Energy Efficiency" award in 2006 for his work on increasing the efficiency of appliance power supplies. Mr. Wilson was a founding board member of the New Buildings Institute. He has B.A. and M.A. degrees in economics from the University of California (Berkeley and Davis).

Endnotes

1. MIT Joint Program on the Science and Policy of Global Change, <http://globalchange.mit.edu/resources/gamble/no-policy.html>
2. <http://building.dow.com/media/news/2010/20100217a.htm>
3. H. Akbari, S. Menon and A. Rosenfeld. 2009. Global cooling: increasing world-wide urban albedos to offset CO₂. *Climatic Change*, 94, pp. 275-286.
4. Ibid.
5. R. Levinson and H. Akbari. 2010. Potential benefits of cool roofs on commercial buildings: conserving energy, saving money, and reducing emission of greenhouse gases and air pollutants. *Energy Efficiency*, 3 (1), 53-109.
6. Cool colored roofs strongly reflect the invisible “near-infrared” radiation that makes up nearly half of sunlight. White roofs strongly reflect both visible and near-infrared sunlight, and thus perform even better than cool colored roofs.
7. Taha, H. 1997. “Modeling the Impacts of Large-Scale Albedo Changes on Ozone Air Quality in the South Coast Air Basin”, *Atmospheric Environment*, Vol. 31, No. 11, pp. 1667-1676 (1997).
8. “Potential benefits of cool roofs on commercial buildings: conserving energy, saving money, and reducing emission of greenhouse gases and air pollutants”, Levinson and Akbari. *Energy Efficiency*, 2009.
9. Radiative forcing is the change in the difference between the incoming radiation energy and the outgoing radiation energy, measured in Watts per meter squared. A positive forcing (more incoming energy) tends to warm the earth’s climate system, while a negative forcing (more outgoing energy) tends to cool it.
10. Climate Progress, July 5, 2010, <http://climateprogress.org/2010/07/05/heat-wave-global-warming/>
11. Including Turkey, Pakistan and Afghanistan
12. ASEAN member states include Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam
13. Asia-Pacific Economic Cooperation (APEC) includes Japan and Australia as well as 19 other countries with coastlines on the Pacific Ocean.
14. US Secretary of Energy. “Memorandum for Heads of Departmental Elements,” June 1, 2010.
15. Correspondence with Dr. Hashem Akbari.
16. Associated Press, “Bloomberg Hypes Energy-Efficient Rooftop Painting,” *NYPPost.com*, September 24, 2009. <http://www.nypost.com>.



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