# Cool Communities Approach to an Energy-Efficient Economy and Beyond

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Pursuant to the United Nations Framework Convention on Climate Change, President Clinton set forth Cool Communities as an action program to reduce the threat of global climate change. Global temperature is affected by accumulation of greenhouse gases in the earth's atmosphere that is partially due to human activity. In addition to global climate changes, urban temperatures are rising due to displacement of vegetation and use of heat absorbing exterior surfaces. These urban heat islands, excessive use of energy for air conditioning, smog formation, and other related problems are economically reduced by local community use of urban forestry and reflective surfaces on roofs and pavements to decrease electricity demand for heating and air conditioning. While reducing local heat islands, the public has on opportunity to better understand global climate change issues. The Department of Energy (DOE) is the lead Federal agency supporting the Program in which many other agencies and private organizations participate. DOE is also the lead Federal agency supporting urban heat island research with the Environmental Protection Agency and other organizations. Specific goals are to designate Federal facilities and cities as Cool Communities; combine ecological and engineering perspectives in energy-efficiency decisions; develop standards for measuring surface reflectivity; develop a list of available ''cool'' construction materials; develop new ''cool'' materials; reduce U.S. household air conditioning costs by 20%; increase urban tree cover; increase solar reflectivity of surfaces in cities; improve air quality; reduce urban temperatures; and reduce carbon emissions by 25 million metric tons in the year 2015.

## INTRODUCTION

Cool Communities is a simple and cost effective approach to an energy-efficient economy and beyond. Consideration of efficiency goes beyond energy alone, and also, beyond U.S. borders. Urban heat island problems and Cool Communities solutions together provide investment opportunities for cities, communities, private businesses, scientists, and government agencies in the U.S. and other countries. The Cool Communities strategy encourages people to think globally while improving the own local community. Communities can be actively involved in deciding for themselves what an energy-efficient economy means and how profitable it is to be part of both the urban heat island problem and the Cool Communities solution. Urban heat islands are simple to understand as are the Cool Communities solutions that include planting urban trees and using light colored surfaces on roofs and pavements as they are installed or normally replaced. This paper brings together the following points showing why Cool Communities is a cost-effective approach to an energy efficient economy and beyond:

- The climate for an energy-efficient economy is international;
- An energy-efficient economy has multiple resource dimensions;
- An energy-efficient economy in a non-regulatory environment requires political definition;
- Urban heat islands are complex but simple to understand;
- Cool Communities impacts on both local and global issues; and
- Cool Communities is an ecosystem approach to building an energy-efficient economy within sustainable communities.

### The Climate for an Energy-Efficient Economy is International

The traditional measure of an energy-efficient economy in terms of productive output per British thermal unit (Btu) input is fine for studying individual technologies such as refrigerators, vehicles, and power plants. Gaining the greatest return from an investment is usually considered efficient and economical. The U.S. economy and U.S. energy requirements are affected by global influences that have economic costs and benefits that are not easily internalized into energy-efficiency calculations. Global climate change is considered such an influence, and this issue has attention of scientists, and politicians worldwide (UNEP 1992).

The United Nations Framework Convention on Climate Change established a basis for global concern in 1992 on the part of 154 developed and undeveloped countries as well as countries with emerging economies. The U.S. response was set forth in President Clinton's Climate Change Action Plan (The White House 1993). Cool Communities was one of many action programs intending to reduce accelerated greenhouse gas emissions, stimulate economic development, improve the body of research on energy efficiency, protect the environment, and increase public awareness of this important issue.

The International Panel on Climate Change (IPCC) was established under the Convention to oversee development of the scientific basis for concern. A recent IPCC report shows that the impact of countries with emerging economies on global greenhouse gas emissions over the next several decades will be significant (Bolin et al. 1995). If countries such as China or India develop their energy resources using the same per capita energy consumption and efficiency that the U.S. has demonstrated during the past several decades, whatever the U.S. does in the future will have a relatively insignificant effect on global green house gas emissions. The report illustrates why an energy-efficient economy must be considered on an international scale, and it helps justify another part of the U.S. response to the Convention, that is The U.S. Country Studies Program (Dixon 1995).

The U.S. Country Studies Program is an interagency effort to provide assistance in the global community whereby the U.S. assists developing countries to study greenhouse gas emissions, vulnerability to the threat of climate change, and mitigation options that could apply as part of each country's climate change action plan. The U.S. is helping because economic development and related energy use in these other countries relates directly to the potential for climate change that could have environmental and economic impacts in the U.S. Since an energy-efficient economy is affected by global influences, the climate for an EEE is international. The efficiency with which the U.S., and other countries, use global energy resources is considered to have direct bearing on global human welfare. Eileen Claussen discusses this subject in a recent paper entitled, Environment and Security: The Challenge of Integration (Clausen 1995).

## An Energy-Efficient Economy has Multiple Resource Dimensions

Energy efficiency is affected by the efficiency with which other resources are used. Consideration for efficient use of water, air, land, living resources (fauna and flora sharing our global ecosystem), and human resources should be included as part of consideration for an energy-efficient economy. Other variables besides Btu's per unit of output must be factored into the economics equation. Considerations for all other resources are important in order to internalize all costs and benefits in the economic analysis. The growing body of information on global climate change clearly demonstrates connections between energy, air, water, land, living, and human resources that make energy efficiency an integral part of a much larger multiple resource management consideration (Bolin et al. 1995).

Gifford Pinchot's definition of ''conservation'' has historically applied in forestry, but according to his writing, Pinchot intended for conservation to apply in energy management as well. His definition consists of the following three basic principles that apply to management of all resources:

- conservation stands for development, and the rights of the present generation to use natural resources,
- conservation stands for the prevention of waste,
- natural resources must be developed and preserved for the benefit of the many and not merely for the profit of a few (Pinchot 1910).

The point here is, as people use resources, how much does today's population use for development compared with what is saved for future generations while also preventing waste. Ideally, the best scenario is for resources to be used for productive purposes without adversely affecting each of the other resources. People have diverse opinions as to what constitutes efficiency and they have varying commitments to conservation. Similarly, they have differing levels of understanding about how the use of one resource affects other resources. An energy-efficient economy involves not only Btu's per product output, but it involves taking into account differing values and priorities of every individual entitled to use energy resources and all other resources affected by the use of energy.

## An Energy-Efficient Economy in a Non-Regulatory Environment Requires Political Definition

With wide variation in perspectives on what constitutes an energy-efficient economy and differing views on resource conservation, political process must apply to the development of policy and its implementation. The challenge, particularly in a non-regulatory environment, becomes one of informing people about the issues so they can respond intelligently when making their own choices about achieving energy efficiency. Compounding the issue is a lack of scientific data that establishes quatifyable values for all external costs and benefits related to energy-efficiency policy. Scientists have the challenge to determine credible standard measures in which the public is confident. Unfortunately

resources have not been prioritized to allow scientists to quantify all the external effects. In the absence of regulations and in the absence of fully quantifiable effects, public decisions must rely on political process that is often not often directed by science.

Today's environmentally aware public wants science and technology presented in simple easy to understand terms so people can understand costs and benefits related to energy efficiency and make informed decisions. People find satisfaction participating in solutions from which they can personally benefit. The Cool Communities approach to an EEE offers an opportunity as simple as urban heat islands, trees, and surfaces. It is simple enough for everyone in the world to understand, and yet behind the simplicity is a scientific foundation that is visible to whoever is inclined to study it.

## Urban Heat Islands are Complex but Easy to Understand

The urban heat island is a complex phenomenon easy for anyone to understand particularly on a hot summer day in the city. Urban areas are normally about 5–8 degrees F. warmer on a hot day than the surrounding countryside thus creating an urban heat island due to the displacement of trees and installation of heat absorbing surfaces(Akbari 1993). Cool Communities actively involves people in learning about urban heat islands and provides opportunities for strategic tree planting and light colored roofs and pavements in an ecosystem management approach.

Solar reflectivity, surface emissivity, photosynthesis, evapotranspiration, photochemical reactions, human health, and the relationship of all this to energy efficiency in cities is more complex than ordinary citizens chose to comprehend. At the same time they are interested in understanding the the weather, air pollution, their breathing problems, and the relief they find in an urban park on a hot day or standing barefoot on the white line in a black colored parking lot.

Smog formation in relation to urban temperature is complex (Taha 1995). Urban temperature, volatile organic carbon(-VOC's), nitrogen oxides (NOx), ozone (O3), and human health is fairly easy to understand without having to know the chemical details. Scientists at the Lawrence Berkeley Laboratory (LBL) have studied heat islands for over fifteen years, but have only recently completed new simulation models showing significant relationships between urban temperature and ozone formation in Los Angeles, CA. The new simulations demonstrate significant opportunity for applying Cool Communities technology to reduce heat islands which reduces smog formation. Human health effects of reducing smog by 12% is estimated to be worth $360M per year (Rosenfeld, Romm et al. 1996).

Many cities demonstrate the heat island effect(USEPA 1992). The magnitude of the opportunity in the U.S. is significant. Rosenfeld et al describe the assumptions and calculations for arriving at the figures that follow. In Los Angeles, the opportunity, projected out to the year 2015, is estimated at $100M in direct savings on annual cooling bills by using two shade trees and light color roofing on buildings. An additional savings of $70M per year on cooling bills can be gained from the cooling of ambient air outside the buildings due to evapotranspiration of trees in combination with reflecting solar energy from urban roofs and pavements. Adding in $360M worth of human health and productivity per year that would be gained by reducing smog 12%, the total is $530M per year in savings. For electric utilities, reduced peak power demand by an estimated 1.5 gigawatts (GW) due to planted trees and light colored surfaces may help companies avoid or postpone expensive investments. Projecting to the year 2015 allows time for growth of the trees and replacement of roofs and pavements on normal maintenance schedules.

Extrapolating benefits to a nation wide scale, scientists at LBL estimate potential annual savings at $5B on cooling bills from both the direct effects of shading and light roofing on buildings plus the indirect effects of ambient air cooling in urban areas where buildings are located. Nationally, summer peak load demand reduction is estimated at 15 GW (Rosenfeld, Romm et al. 1996).

## Cool Communities Goals Impact on Both Local and Global Issues

Gaining local community commitment to take action to reduce global problems is difficult unless problems can be brought down to the local level where people can understand how they are personally affected. Urban heat islands although not directly related to global warming provide an important link that is needed to gain local understanding and commitment to the threat of global climate change. Cool Communities goals are to:

- designate 100 Federal facilities and 250 cities as Cool Communities by the year 2005;
- develop standard procedures for measuring reflectivity of surface products;
- develop a comprehensive list of ''cool'' construction materials available on the market;
- work with industry to develop new ''cool'' materials;
- save U.S. households 20% on air conditioning costs;
- increase percent urban tree cover;

- increase solar reflectivity of surfaces in cities;
- improve air quality by reducing urban temperature; and
- reduce emissions of carbon by 25 million metric tons by the year 2015 (Sampson 1995).

The Program strategy combines scientific research with outreach implementation, ecological techniques with engineering techniques, and private initiative with government support. Table 1. outlines the combination of scientific research with outreach deployment. Research programs have been publicly criticized for failing to bridge the gap between the results of research and their practical application. Heat island research and Cool Communities implementation can be considered as one program that integrates research with its practical application.

The combination of engineering technologies with ecological technologies is illustrated in Table 2. The Cool Communities program emphasizes conservation of not only energy but also air, water, land, living, and human resources in the same action. Ecology professionals and interest groups often have perspectives that differ from those of land development engineers. By combining perspectives Cool Communities takes advantage of a growing need for engineers and ecologists to share perspectives that broadens the foundation for better and more sustainable decisions as communities develop. The building industry is being called upon by their customers to include energy-efficiency and ecological considerations in building design.

Table 3. shows another strategy of combining private industry partnerships with government support. Private industry and government are after all part of the same government, but too frequently they are perceived as separate. Government and private industry can accomplish much more working together than either can accomplish working separately. The strategy of the Clinton-Gore administration encourages partnership between government and private industry. Combining private and government organization in administering the Cool Communities Program strengthens delivery and helps promote public recognition.

The approach to Cool Communities is tailored to meet the specific needs of the nine currently designated communities. There are interesting examples of success in each of them. Participation by utility companies in each of the Cool Communities is important. Through a related program called Climate Challenge, also sponsored by DOE, utility companies sign up to voluntarily implement various green house gas reducing strategies one of which is tree planting to sequester carbon in the form of living trees. In order to be designated as Cool Community the applicant must show a local utility company as a program partner. The Utility Forest Carbon Management Program, managed by the Edison Elec-

***Table 1.*** *Scientific Research Combined with Outreach Deployment*

| Scientific Research | Outreach Development |
|---|---|
| 1. Coordinate Research Program | 1. Form Strategy and Develop Partnerships |
| 2. Characterize Urban Heat Island | 2. Designate Cool Communities |
| 3. Develop Cool Roofing and Pavement Products for Market | 3. Include Trees and Surfaces in Building Performance Standards |
| 4. Develop Standard Measurements and Product Labels | 4. Encourage Utility Incentives to Plant Trees and use Cool Roofs and Pavements |
| 5. Assess Scope of the Cool Communities Opportunity | 5. Public Education on Heat Islands and Benefits of Cool Communities Investments |
| 6. Support Outreach with Demonstrations and Education Materials | 6. Develop Smog Reduction Credits for Trees and Light Surfaces in Alternative Commodity Markets ie. RECLAIM |
| 7. Develop Market Incentives | 7. Apply Ecosystem Management Principles |
| | 8. Public Recognition for Participation |

***Table 2.*** *Benefits from Combined Ecological and Engineering Techniques*

| | |
|---|---|
| Energy- | cool surfaces and trees reduce demand for cooling and heating<br>cool surfaces and trees reduce peak load facility investments |
| Air- | photosynthesis by vegetation removes CO2 and produces O2<br>vegetation removes other pollutants<br>trees attenuate noise<br>evapotranspiration helps cool and humidify air<br>cool surfaces and trees reduce power plant emissions |
| Water- | trees increases storm water interception and reduced flooding<br>vegetation improves groundwater recharge<br>cool pavement improves groundwater recharge<br>cool pavement improves temperature of storm water runoff |
| Land- | trees improve water storage capacity of soil<br>ecological/engineering considerations support better land-use decisions<br>Living-trees improve habitat for wildlife and other biological processes |
| Human- | participation improves sense of community and sharing of perspectives<br>use of human energy improves human environment<br>active involvement improves public understanding<br>involving community in improvements increases community pride<br>improved conditions increases comfort level and human productivity |

tric Institute, grew out of a need to provide assistance to utility companies investing in forestry projects to sequester carbon to help balance carbon emissions at generating plants (Kinsman and Trexler 1995).

The potential of urban trees to help reduce urban heat islands, save on air conditioning bills, improve air quality, and other benefits are of particular interest to utility companies investing in trees to reduce atmospheric carbon (Rosenfeld, Romm et al. 1996). Comparing the relative value of trees and light color surfaces for saving on air conditioning costs, he showed that urban trees account for more than half the total benefits. In city ecosystems trees sequester carbon just as they do when grown in rural areas, but carbon emission reductions due to decreased electricity use for air conditioning is worth about eight times the carbon benefit from similar trees in a rural area outside the city. Carbon reductions and energy savings in cities are due to three processes:

(1) Direct shade on buildings causes cooler exterior building surface and cooler air inside buildings;

(2) Indirect cooling from evapotranspiration and shade that does not directly shade air conditioned buildings; and

(3) Carbon sequestration from photosynthesis.

The data summarized in Table 4. showed the relative potential benefits of trees, cooler roofs, and cooler pavements in reducing costs for air conditioning in buildings. From the standpoint of costs for carbon reduction, the carbon reduction by a number of trees in cities is about eight times the carbon reduction by the same number of trees grown in rural areas. There are also other benefits from trees in both rural and urban areas that are also important to consider such as the impact of trees on storm water management not discussed in the paper. There is discussion of considerations for energy efficiency that goes beyond energy alone as is illustrated by the data on air quality and human health.

## Cool Communities is and Ecosystem Approach to Building an Energy-Efficient Economy Within Sustainable Communities

The National Performance Review called for Federal agencies to adopt ‘‘a proactive approach to ensuring a sustainable economy and a sustainable environment through ecosystem management’’ (Interagency Ecosystem Management Task Force 1995). An Interagency Ecosystem Management Task Force was established to carry out this mandate. Members of the Task Force worked to develop an understanding of the ecosystem management approach within government. Recently in October 1995 each agency signed an interagency Memorandum of Understanding setting forth the ecosystem management approach that recognizes the interrelationship between natural systems and healthy, sustainable economies of which an energy-efficient economy is an important part. The Cool Communities approach emulates the ecosystem management approach set forth by the Interagency Ecosystem Management Task Force. The approach is outlined in an interagency agreement signed in 1995 to emphasize the following eight principles:

- Consideration of all ecological and economic consequences;
- Improving coordination among Federal agencies;
- Partnerships among Federal, state, local, Indian tribes, landowners, and others;

***Table 3.*** *Private Industry and Government Partnership*

| Private Industry | Government |
|---|---|
| American Forests | Department of Energy |
| American Assn. of Nurserymen | Environmental Protection Agency |
| American Public Power Assn. | Department of Defense |
| Edison Electric Institute | Department of Agriculture |
| National Concrete Masonry Assn. | Forest Service |
| National Tree Trust | Extension Service |
| Concrete Paver Institute | Natural Resource Cons. Service |
| National Assn. of Home Builders | Housing and Urban Development |
| American Ready-Mix Concrete Inst. | NASA |
| American Portland Cement Alliance | |

- Improving communication with general public;
- More efficient and cost- effective government;
- Use best science and improved data management capabilities; and
- Adjust management direction as needed.

The ecosystem management and sustainable development concepts are part of an evolution in public thinking that is becoming more environmentally sensitive and demanding for government programs. Professionals are challenged to adapt to evolving perspectives. Cool Communities is part of meeting that challenge. Other programs in which DOE is involved work synergistically with the Cool Communities approach. Some examples are New Communities, Rebuild America, Climate Challenge, and Clean Cities.

## CONCLUSIONS

Global greenhouse gas emissions represent a well documented international concern that is directly related to an energy-efficient economy. Urban heat islands are a threat to local welfare in many cities and communities world wide. The Cool Communities Program supported by the Department of Energy and other government and private organizations is a viable approach to reducing urban heat islands and involving the public in understanding the global climate change issue. Local people help achieve an energy-efficient economy by saving money on their cooling and heating bills, making valuable improvements in their communities, and supporting conservation of other resources as economic development progresses. Specific conclusions are as follows:

(1) The definition of an energy-efficient economy goes beyond considering energy resources alone and should include consideration for other resources including air, water, land, living, and human resources;

(2) The definition of an energy-efficient economy goes beyond considering efficiency within U.S. borders alone. Economic development in the U.S. is affected by global influences such as the prospects of climate change caused by greenhouse gas emissions;

(3) Policies affecting achievement of an energy-efficient economy require political process in which the public expresses differing interests related to the use or conservation of energy and other resources;

(4) Urban heat islands provide easily understood targets for involving local citizens in energy efficiency action that will improve not only local conditions but also reduce global climate problems; and

(5) Cool Communities provides a simple and successful structure for mobilizing local action and investments

***Table 4.*** *Estimated Benefits (million $/year) from Cool Surfaces and Trees in Los Angeles, CA*

| Benefit | Attributable to: Roofs | Trees | Pavement | TOTAL |
|---|---|---|---|---|
| Direct savings by using cool technology on individual buildings | 46 | 58 | 0 | 104 |
| Indirect savings for all city buildings by cooling urban air 3 degrees F. | 21 | 35 | 15 | 71 |
| Smog reduction valueto human health by cooling urban air 3 degrees F. | 104 | 180 | 76 | 360 |
| TOTAL: | 171 | 273 | 91 | 535 |

(Rosenfeld & Romm 1996)

in an energy-efficient economy that is based on a foundation of ecological and engineering perspectives and technologies.

## RECOMMENDATIONS

(1) State and local governments should include urban forestry measures and light color roofing in energy performance standards for buildings as a means of promoting energy efficiency.

(2) The Environmental Protection Agency should extend authority to state and local governments to set up open markets for smog offset trading to include trees and light color roofing as a means of air quality control that also provides other pollution prevention benefits.

(3) Utility companies should institute incentive programs for tree planting and light color roofing as a means of reducing the need for expensive peak demand generating facilities and maintaining good customer relations within their respective service areas.

(4) Federal government should be authorized and provided Congressional appropriations to provide research support for characterizing the occurrence and effects of urban heat islands and also for supporting implementation of Cool Communities outreach to demonstrate world leadership in dealing with global climate change issues in accordance with commitments to the UN Framework Convention on Climate Change.

(5) Federal government should actively support educational, financial, technological, and recognition support to community partnerships interested in making Cool Communities investments for sustainable development.

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