# Global Warming Solutions that Work

## Cutting-Edge Efforts to Curb Global Warming Pollution and the Lessons they Hold for America

ENVIRONMENT AMERICA
RESEARCH & POLICY CENTER

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Environment America
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# Executive Summary

Global warming is the defining challenge of our time. The latest climate science tells us that the United States must reduce its emissions of global warming pollutants quickly and dramatically if we hope to avoid the most catastrophic impacts of global warming. The rest of the world must take strong action as well.

For the United States to make the emission reductions science tells us will be necessary—cutting emissions by at least 15-20 percent by 2020 and by 80 percent by 2050—will require major changes in many areas of America's economy, from the increased use of clean, renewable energy to dramatic improvements in the efficiency with which we use energy in our homes, businesses and vehicles. But solutions exist today that can get us much of the way there. And communities across the country—and around the globe—are making those solutions a reality.

This report details more than 20 examples of cutting-edge policies and practices that communities, states and countries are using to reduce global warming pollution. These examples show that while actions to reduce global warming pollution require commitment and creativity, they also bring with them other benefits—reduced dependence on fossil fuels, cleaner air and healthier communities, economic growth and new jobs.

America should learn from these initiatives by adopting public policy "best practices" that can achieve similar benefits nationwide. The United States—as well as individual states—should foster further innovation by adopting mandatory caps on global warming pollution, coupled with policies that will promote the transition to a cleaner, more efficient energy system.

**Cities and states across America are achieving impressive results in the fight against global warming.**

- **Texas** has added more than 4,000 megawatts of wind power generating capacity in the last decade. Once a marginal source of electricity in the state, wind power now produces about 3 percent of Texas' electricity, enough to avoid about 8 million metric tons of global warming pollution per year.

- **New Jersey** doubled its solar power generating capacity within just two years through aggressive public policies that promote solar panels on rooftops in the Garden State.

- **California** uses 20 percent less energy per capita than it did in 1973, thanks to strong energy efficiency policies for buildings and appliances.

- **Wisconsin** avoids about 200,000 metric tons of carbon dioxide pollution per year through its innovative programs to promote energy efficiency in industry—programs that also help save businesses money and keep jobs within the state.

- **Portland, Oregon**, has doubled the number of bicyclists on city streets in just six years through investments in bicycle infrastructure and bike-friendly transportation policies. The percentage of people who bike to work in Portland is now eight times the national average.

- In the Rosslyn and Ballston neighborhoods of **Arlington County, Virginia**, about 40 percent of residents take transit to work and about 10 percent walk, thanks to investments in transit service to Washington, D.C. and smart land-use planning that has created vibrant, compact, mixed-use communities around transit stops.

- **Southeastern Pennsylvania** saw a 20 percent increase in the number of riders on energy efficient trains linking Harrisburg and Philadelphia following investments that increased travel speeds along the line. A similar 20 percent ridership jump occurred recently on the Northeast's Acela high-speed train line.

**Other nations have also made significant progress, with lessons for the United States.**

- **Germany** recycles 60 percent of its municipal waste (compared to 32 percent in the United States) and has kept its garbage output steady for nearly two decades thanks to policies that put the responsibility for recycling waste on product manufacturers and not individual consumers and taxpayers.

- In **Israel**, more than 90 percent of homes use solar water heaters, which dramatically reduce the need for natural gas or electricity for water heating. Israel requires that all new homes come equipped with solar water heaters.

- **Copenhagen, Denmark**, has revitalized its downtown by giving pedestrians and bicycles preference over cars in large parts of its city center. Walking and cycling now account for more than 40 percent of all trips made in Danish urban areas.

- **Spain** has sparked the creation of new renewable energy industries through aggressive clean energy policies. Spain now ranks third in the world for installed wind power capacity and is the world's fourth leading market for solar photovoltaics. Spanish companies are increasingly taking a leading role in renewable energy development in the United States and elsewhere.

**Communities and states across the country are laying the groundwork for even larger changes in the years ahead.**

- Concentrating solar power, which uses heat from the sun to generate electricity, has the potential to serve a large

share of America's electricity needs. **Southwestern states** have enacted policies that are contributing to a solar power boom that could result in more than 4,000 megawatts of solar thermal power coming on line in the next several years.

- Plug-in hybrid vehicles can dramatically reduce carbon dioxide pollution from vehicles while weaning America from its dependence on oil. **Austin, Texas**, citizens and public officials are pushing for the development of plug-in hybrid vehicles and enlisting people from around the country in the effort.

- "Green" buildings and zero-energy homes could revolutionize America's building stock by providing pleasant, comfortable spaces with dramatically lower impact on the global climate. **Pittsburgh** and other cities are driving innovations in green building, while engineers, home builders and researchers are building the first wave of "zero energy homes" across the country.

- Addressing global warming will require efforts from people of all walks of life. Communities like **Greensburg, Kansas**—a small rural town nearly wiped off the map by a devastating tornado in 2007—and the **South Bronx** neighborhood of New York City are showing how residents can come together to weave efforts to reduce global warming pollution into strategies for community development.

**Cities, states and the federal government should build upon the successes of these efforts by setting mandatory, science-based caps on global warming pollution, adopting strong clean energy policies, and investing in the transition to a low-carbon economy.**

- Individual states and the federal government should adopt mandatory, science-based caps on global warming pollution. At minimum, those caps should be consistent with a national goal of reducing emissions by at least 15-20 percent below today's levels by 2020 and by at least 80 percent below today's levels by 2050. Revenues from any program that puts a price on global warming pollution should be used to aid in the transition to a clean energy economy and to reduce the cost of emission reductions to consumers.

- Cities, states and the federal government should make energy efficiency improvements and accelerated development of renewable energy the centerpiece of their environmental and economic development policies. Advanced building energy codes; strong energy efficiency standards for buildings, appliances and vehicles; and mandatory targets for renewable power generation and energy efficiency savings are among the policies that can reduce global warming pollution and put the nation on a clean energy path.

- Global warming and fossil fuel dependence should become central considerations in land-use planning and public sector investment decisions. America should increase its investment in public transportation and rail transportation to reduce emissions from transportation. All new public buildings should meet rigorous standards for energy efficiency and the use of clean energy.

# Introduction

Where there's a will, there's a way.

The old adage may sound trite, but throughout our history, Americans have demonstrated its truth.

Achieving independence from Great Britain, building the transcontinental railroad, winning World War II, placing a man on the moon—time and again our nation has set visionary goals and mobilized the creativity and resources to achieve them.

Today, our nation and the world face one of history's greatest challenges: global warming. Scientists warn that if we don't act quickly and boldly to reduce our emissions of global warming pollution, the United States and the world risk devastating damage to our environment, our natural resources and our economy.

So far, at the federal level, America has failed to rise to the challenge. The president and some in Congress continue to make energy and environmental policy as if global warming didn't exist, with every year of delay making the challenge that much harder—and the potential damage that much greater.

But in cities, towns and states across the nation, Americans are waking up to the implications of global warming and are responding in innovative and compelling ways. The fight against global warming is happening in all sorts of places, from a rural Kansas town ruined by natural disaster to the economically and environmentally devastated South Bronx. It's happening in ways both large and small—from the massive expansion of wind power in Texas to an increase in the number of people trading in cars for bikes in Portland, Oregon.

In some places, it is private citizens and businesses creating a vision and leading the charge to achieve it, as with the boom in green buildings in Pittsburgh and elsewhere. In other cases, government programs are acting as a catalyst for change, as with highly effective energy efficiency programs in New York, Wisconsin and elsewhere.

And the fight against global warming isn't just happening in the United States. We have a lot to learn from successful public policy initiatives and community efforts in many other countries.

This report documents just a handful of the ways communities are responding to global warming—providing models that individuals, businesses, cities, states and the federal government can use to

successfully reduce global warming pollution.

These efforts are also reminders that addressing global warming has the potential to make our lives today *better*—creating new economic opportunities, rescuing America from its dependence on fossil fuels, reducing pollution and threats to our health, and bringing new life to cities and small towns alike.

Many of the solutions we need to address global warming already exist—and there are communities making them happen. What is missing is the commitment, on the part of most states and the federal government, to implement these good ideas and innovative actions on a broad scale and to do what is necessary to respond to the challenge of global warming.

That commitment must take the form of mandatory caps on global warming pollution that are sufficient to prevent the most dangerous impacts of global warming. With a firm commitment to reduce our impact on the climate, America can unleash the creativity and the resourceful spirit we need to win the fight against global warming.

The examples in this report show that America has the ideas, technologies and can-do spirit to address global warming. Responding to the threat won't be easy, and many years of delay in taking action have made the task that much more challenging. But if any nation can do it, and show the rest of the world what an effective, nationwide response to global warming looks like, it is America.

# Reducing Global Warming Pollution from Homes, Businesses and Industry

Buildings—including homes and businesses—are responsible for about half of America's contribution to global warming.[1] The way we choose to heat and light our buildings and power our appliances, along with the choices made in designing those buildings in the first place, have a large impact on America's ultimate emissions of global warming pollution.

Industry, meanwhile, accounts for 30 percent of the nation's carbon dioxide pollution. American industry uses energy for a wide variety of purposes—to power electric motors, provide heat for industrial processes, and to light shop floors. Yet, more than one-third of the energy used in industrial energy systems is "lost" and much of that energy could be saved through improvements in energy efficiency.[2]

Further energy savings and emission reductions in industry could result from reusing recycled material and cutting down on packaging waste rather than producing vast amounts of new material that is used once and then thrown away.

Across the country, individuals, businesses, government agencies and others are finding ways to make today's buildings and industrial facilities use less energy and constructing a new generation of "green buildings" with significantly less impact on the climate.

## Saving the Environment and Saving Money: Energy $mart Homes in New York State

Donna and Mark Denley of Albany, N.Y., bought their dream home in December 2003. At 1,600 square feet, the house featured three bedrooms and one and a half baths. It also featured old appliances, air leaks, and poor insulation; the Denleys' new residence was so inefficient that their first month's utility bill was $400.[4]

The Denleys, like many New York State homeowners, were able to turn to the Energy $mart program for help. The program, launched in 1996, builds homeowners' awareness about energy efficient products and provides financial assistance to help them improve the energy efficiency of their homes. By making homes more

## Solution: Residential Energy Efficiency

**What it is:** Statewide program that helps homeowners assess the energy efficiency of their homes and provides incentives for the installation of energy-saving appliances.

**Who is doing it:** New York State's ratepayer-funded energy-efficiency program.

**What it has achieved:** Reduced carbon dioxide emissions by 360,000 metric tons per year while saving money for New York electricity consumers.

**Why it is important:** Homes account for 17 percent of America's global warming pollution. Energy consumption in buildings (including homes and businesses) could be reduced by 23 percent below business-as-usual levels by 2025 through energy efficiency improvements.[3] Successful programs like New York's could be used elsewhere to cut household energy consumption and global warming pollution.

**Public policy best practices:** Ratepayer-supported programs that provide home energy audits and financial incentives for energy efficiency improvements.

energy efficient, the program also helps New York reduce fossil fuel consumption that contributes to global warming.

Through the program, the Denleys received a home energy audit and identified potential improvements. They chose to install an Energy Star-certified boiler and refrigerator, added attic insulation, and performed air sealing and duct work. The improvements were financed through a low-interest loan. By installing energy-efficient products, the Denleys were able to cut their energy consumption by 40 to 50 percent, thus dramatically reducing their household's energy bills and their impact on global warming.[5]

The Energy $mart program has benefited thousands of New York State homeowners, but it also benefits the state as a whole. Energy efficiency improvements are often the fastest, least expensive way to address energy needs—alleviating demand for new power plants and transmission lines and helping to ensure the stability of the electric grid. The program is funded

*Sealing air leaks is one of many steps homeowners can take to reduce energy consumption. Home energy audits, such as those provided by New York's Energy $mart program, can help homeowners identify low-cost opportunities for energy savings.* (Credit: gwmullis/istockphoto.com)

through a small "systems benefit charge" assessed to electricity ratepayers. The charge raises approximately $170 million per year that is used to support the Energy $mart program.[6]

New York's Energy $mart program is comprehensive and casts a wide net, targeting single-family residences, multi-family residences, renters, and low-income households. First, it works to educate the public on ways they can use energy more efficiently. To encourage New Yorkers to purchase appliances bearing the Energy Star label, the Energy $mart program runs public service campaigns, including print and television advertisements, magazine articles, store displays, and inserts in utility bills.

The program also works with consumers to integrate more environmentally friendly appliances and technologies into their homes, providing low-interest loans for homeowners who wish to perform renovations recommended by certified, program-provided energy auditors. These renovations may include more efficient appliances, heating and air conditioning systems, lighting, windows and hot water systems, or insulation and weatherization improvements.[7]

In addition, the Energy $mart program provides guidance to homebuilders on how to build energy efficient residences using the most up-to-date practices. The program also works to promote advanced technologies like solar electric systems and geothermal heating and cooling.

Altogether, New York's Energy $mart programs currently save about 3.1 billion kWh of electricity per year, and prevent the emission of over 360,000 metric tons of carbon dioxide annually.[8] The program also saves New Yorkers a lot of money. In 2006, more than 3,200 homes participated in the program and received upgrades, with an average savings of $600 per year.[9] According to a very conservative cost-benefit analysis, the program's benefits were more than double its costs.[10]

The Denleys, for example, now save $1,847 annually on their energy bills—for every dollar spent on the project, the family saves $2.56—all the while decreasing their global warming pollution.[11]

This win-win scenario can be replicated nationwide. In fact, many states have initiated similar programs to reduce residential energy consumption. Vermont, for example, has established a first-of-its- kind "energy efficiency utility"—called Efficiency Vermont—whose mission is to promote energy efficiency in all sectors of the state's economy. In 2007, Efficiency Vermont saved enough energy to fully offset the growth in electricity demand in the state, and did so at a levelized cost of 2.6 cents/kilowatt-hour—about a quarter of the cost of supplying additional electricity to meet increased demand.[12] As of 2007, energy savings delivered by Efficiency Vermont were meeting approximately 6.5 percent of the state's electricity needs.[13]

In 2006, state residential energy efficiency programs like those in New York and Vermont reduced electricity consumption nationwide by 18,765 gigawatt-hours, or about 1.4 percent of U.S. residential electricity consumption.[14] Yet, the bulk of these savings are concentrated in a small number of states—many other states spend little or nothing on energy efficiency programs. States in New England, the Mid-Atlantic region, and the Pacific Northwest, along with California and Hawaii, were responsible for 85 percent of all electricity savings through energy efficiency programs in 2006.[15] In other regions, particularly the Southeast, energy efficiency programs are generally poorly funded or non-existent.

The New York Energy $mart program shows that energy efficiency can bring large benefits to homeowners and the economy—while at the same time helping America to reduce its emissions of global warming pollution.

## Greening the Bottom Line: Adobe Systems and California's Commercial Energy Efficiency Program

America's commercial buildings—its office towers, big-box stores, restaurants and institutions—consume vast amounts of energy, much of it wasted. In 2006, the commercial sector in the United States was responsible for more than 1 billion metric tons of carbon dioxide emissions—a 33 percent increase from 1990 levels.[16] Nearly 80 percent of this global warming pollution resulted from the use of electricity.[17]

Energy costs are a large and growing expense for businesses. In California, for example, businesses collectively spend more than $15 billion a year on heating, cooling, lighting and other energy uses.[18] Reducing energy consumption, therefore, can be good for the environment and the bottom line.

*Adobe Systems Incorporated has slashed energy use and global warming pollution at its San Jose headquarters while also saving money.* (Credit: Proehl Studios April 2006)

San Jose-based Adobe Systems Incorporated is a case in point. The company is

### Solution: Commercial Energy Efficiency

**What it is:** Energy efficiency improvements at a corporate headquarters.

**Who is doing it:** Adobe Systems, with support from California's ratepayer-supported energy efficiency programs.

**What it has achieved**: Reduced carbon dioxide emissions by 11 million pounds per year at just one facility—cutting emissions by 16 percent despite a nearly one-third increase in the number of employees.

**Why it is important:** Commercial buildings account for 18 percent of global warming pollution. Large reductions in energy consumption are possible through cost-effective energy efficiency improvements. Adobe's experience shows that many companies can both reduce global warming and save money through smarter use of electricity.

**Public policy best practices:** Ratepayer-supported energy efficiency programs that provide technical expertise and financial incentives to companies aiming to reduce their energy consumption.

famous for its Portable Document Format (.pdf) files—which by one estimate make up nearly 10 percent of the content of the World Wide Web.[19] The company also develops design and communication software for print, video, film and digital media.

Since 2000, Adobe has engaged in a series of efforts to reduce energy consumption at its corporate headquarters complex in San Jose. Since 2000, Adobe has reduced per-employee electricity use at its headquarters by 35 percent and natural gas use by 41 percent. The company has done this by retrofitting old lights with newer energy-saving models and maximizing the efficiency of heating and air-conditioning systems.[20]

The result has been changes that have both saved energy and saved money. For example:[21]

- Turning off lights and fans in the parking garages when they weren't needed yielded savings $43,000 per year at essentially no cost.

- Reprogramming the central air conditioner and water heater to operate more efficiently and according to the actual needs of the building yielded over $50,000 a year in energy savings at a one-time cost of $1,000.

- Replacing the lighting system in the garage with more efficient fluorescent lamp technology required an up-front investment of $157,000, but yielded annual savings of $138,000.

- Replacing the motors that drive the building's air fans with more efficient variable-speed technology cost $126,000. The improved motors save $46,000 per year in energy costs and earned a $51,000 rebate from California's energy efficiency program.

- The installation of a real-time monitoring system for the building's electricity use helped to identify opportunities for more savings. The monitor enabled staff to track energy use in different parts of the building, discover inefficiencies and fix them. In just three months, the monitor helped point out measures worth another $46,000 per year.

The company invested a total of $1.1 million in the projects, yielding total energy savings of just over $1 million per year.[22] Adobe's investment in energy efficiency will clearly pay for itself many times over. The company's efforts have also brought recognition from leaders in the green building movement. The complex's West Tower was the first office building to receive the Leadership in Energy and Environmental Design (LEED) Platinum certification for an existing building from the U.S. Green Building Council—the highest level of recognition now available.

Adobe's efforts to save energy reflect a strong commitment on the part of the company, but Adobe did not have to act alone: the company received strong support from California's ratepayer-supported energy efficiency programs. (For more on California's overall energy efficiency efforts, see page 16.) Adobe has received over $350,000 in rebates from its utility and the state's energy efficiency programs to implement energy-efficient practices. Californians benefit from that public investment, both through reduced global warming pollution and through reduced demand for natural gas and electricity, which curbs the growth in energy prices for all consumers.

As a result of the company's efforts, Adobe has cut overall carbon dioxide emissions from its headquarters by 16 percent, despite increasing the number of employees working there by nearly one-third. Overall, carbon dioxide emissions are down by more than 11 million pounds per year.[23]

Nearly every commercial facility nationwide has the potential to benefit from efficiency improvements—the average building can reduce energy use by about 30 percent.[24] Too often, however, companies lack the expertise to make sensible energy efficiency improvements or face financial incentives that prioritize short-term cost reductions at the expense of long-term savings on energy bills.

Commercial energy efficiency programs like California's can help businesses overcome these barriers to make improvements that benefit the companies and society as a whole.

The experience of Adobe Systems shows that achieving large reductions in energy consumption and global warming emissions can pay off—in more ways than one.

## Building a Better Future: The Green Building Revolution in Pittsburgh and Beyond

The Felician Sisters, an order of Roman Catholic nuns, occupy a beautiful hilltop campus just down the Ohio River from Pittsburgh, consisting of a chapel, convent and high school. With many of the buildings dating from the 1930s, the sisters decided in 2001 to undertake a thorough renovation of the campus. And, in keeping with their order's dedication to the principles of St. Francis of Assisi, patron saint of the environment, they decided to go green.

The resulting renovation included insulation of the buildings, the installation of

### Solution: Green Buildings

**What it is:** Initiatives to promote green building in Pittsburgh and elsewhere in the United States.

**Who is doing it:** Led by architects and design professionals, commitments to green building are being embraced by government officials, institutions and homeowners.

**What it has achieved:** On average, certified green buildings reduce energy consumption by 25 to 30 percent, while reducing other environmental and public health impacts.

**Why it is important:** By 2035, 75 percent of our built environment will be either new or renovated.[25] Encouraging energy efficient building techniques can ensure that America's building stock consumes less energy and produces less global warming pollution.

**Public policy best practices:** Requirements that public buildings meet stringent energy efficiency criteria; tax credits and incentives for green building; advanced building energy codes that ensure that energy efficiency improvements are incorporated in all new buildings.

*The Felician Sisters campus is one of many examples of "green building" in the Pittsburgh area.*

solar water heating and solar photovoltaic systems, and the removal, restoration and reuse of more than an acre of hardwood flooring, two miles of baseboards and wood trim, and 200 doors.[26] The renovated complex uses approximately 30 percent less energy and has been recognized with a Leadership in Energy and Environmental Design (LEED) Gold rating from the U.S. Green Building Council (USGBC).

"Green buildings" are described by the USGBC as those that incorporate elements of energy efficiency, water efficiency, location on a sustainable site, the use of recycled and sustainable materials in construction, and measures to preserve indoor air quality.[27] Certified green buildings can dramatically reduce the impact of a building on the environment, with the average LEED-certified new building reducing energy consumption by 25 to 30 percent.[28]

The Felician Sisters' convent is just one of several notable green building projects in and around Pittsburgh—a city once world-renowned for its smoky air but now establishing itself as a pioneer in the burgeoning "green building" movement. In the last several years, the city has seen the construction of a LEED Gold-certified convention center, the opening of a LEED Silver-certified corporate office center downtown, and the beginning of construction of a new children's hospital complex that will incorporate at least two certified green buildings.[29] Pittsburghers can now shop at a certified green supermarket, listen to programs beamed from a certified green radio studio, take out money at a green bank branch, and visit a green children's museum and plant conservatory.[30]

Pittsburgh is now home to at least 21 certified green buildings, and, despite ranking only 57th in population in the United States, ranks eighth in the nation for the amount of LEED-certified floor space.[31]

Pittsburgh's leadership in green building goes back to the early 1990s, when local philanthropists, led by the Heinz Endowments, teamed up with architects and building professionals to launch the Green Building Alliance—the first nonprofit organization in the United States devoted to promoting green commercial building on a regional level.[32] The alliance focused on encouraging local institutions to take leadership on green building, providing support to green builders, and building a base of expertise on green building techniques in the community. As local leaders have gained experience with the benefits of green building, the demand for environmentally responsible buildings has only grown.

While the green building movement in Pittsburgh was initiated by the private and non-profit sectors, government policies have played a key role in adding momentum to the spread of green building. Public agencies such as the Sports and Exhibition Authority of Pittsburgh and Allegheny County have invested in green buildings, and in 2007, the city of Pittsburgh adopted zoning incentives for developers to build green.[33]

Pittsburgh is not alone. Businesses, governments, institutions and homeowners across the country are recognizing the benefits of energy-efficient green buildings—and are driving a revolution in what

Americans expect from their buildings. A recent report found that commercial property customers were willing to pay an average of $15 per square foot extra for buying an industry-certified green building.[34] In the past seven years, more than 2.2 billion square feet of commercial space have been certified by the LEED Building Rating System.[35]

Architects are beginning to respond to this demand. In 2002, for example, architect Ed Mazria established Architecture 2030 to mobilize design and building professionals across the country and around the world to respond to the global warming crisis.

Architecture 2030 issued the "2030 Challenge" in January 2006. The challenge asks the global architecture and building community to adopt the following targets:

- All new buildings, developments and major renovations should be designed to achieve a fossil fuel consumption performance standard of 50 percent below the current regional average for that building type.

- At a minimum, an equal amount of existing building area shall be renovated annually to meet a fossil fuel consumption performance standard of 50 percent of the current regional average for that building type.

- The fossil fuel reduction standard for all new buildings will be increased over time, until new buildings are carbon-neutral in 2030.[36]

The 2030 Challenge is gaining momentum: it has been adopted by the U.S. Conference of Mayors, the American Institute of Architects, as well as hundreds of firms and organizations across the globe.[37]

While Architecture 2030 is a private-sector initiative, the involvement and support of governments in green building efforts is critical. Cities and states across the nation have adopted policies to reduce energy consumption at government buildings and to ensure that new construction is energy-efficient. The state of New Mexico, for example, now requires new, large state buildings to achieve at least LEED Silver certification and smaller buildings and building renovation projects to incorporate energy efficient technologies and practices.[38] State and local governments have also created tax breaks and other incentives to encourage green building.

The potential impact of green building on global warming pollution is large. By 2035, 75 percent of our built environment will be either new or renovated.[39] Building energy efficient and environmentally responsible buildings now will ensure that America can achieve the dramatically reduced levels of global warming pollution we will need to reach in the decades to come.

## Zero-Energy Homes: Combining Energy Efficiency and Renewable Energy to Slash Pollution

Imagine living in a home that produces as much energy as it uses and that emits only a fraction of the global warming pollution of a typical American home. For a small but growing number of American homeowners, that dream is becoming a reality with the development of "zero-energy homes."

Zero-energy (and near-zero energy) homes combine a host of energy efficiency and renewable energy technologies to slash household fossil energy consumption. A zero-energy home might integrate an energy-saving building envelope with highly efficient heating and air conditioning systems, judicious use of windows to

## Solution: Zero-Energy Homes

**What it is:** Initiatives to design and build "zero-energy" homes.

**Who is doing it:** Builders, architects, non-profit organizations and government agencies.

**What it has achieved:** Zero-energy homes have been built in a variety of climates, demonstrating the potential to achieve large reductions in fossil fuel use at reasonable cost.

**Why it is important:** Zero-energy homes serve as models for energy efficiency and renewable energy improvements that can be implemented in all homes in the years to come.

**Public policy best practices:** Government-supported research and development of zero-energy building techniques; tax incentives and rebates for energy efficient construction and distributed renewable energy equipment; utility "net metering" policies; energy efficiency mortgages; public investment in energy efficient construction for low-income housing.

*"Zero-energy" homes, like those under construction in this Sacramento subdivision, couple energy efficient design with small-scale renewable energy generation to dramatically reduce consumption of fossil fuels.* (Credit: Sacramento Municipal Utility District)

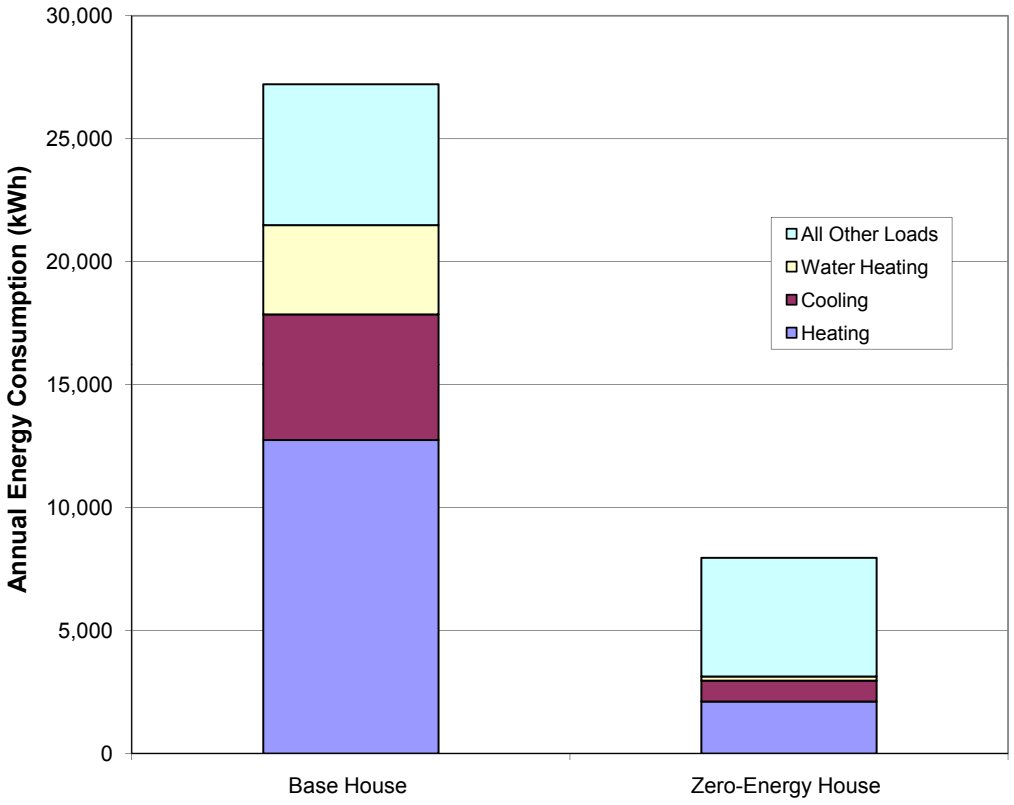
provide light and heat during the day, and renewable energy technologies such as geothermal heat pumps, solar water heaters and solar photovoltaic panels. Not every home billed as "zero energy" truly meets that standard, but all of them consume significantly less fossil fuel and electricity than conventional homes.

In Frisco, Texas, local radio host Chris Miles scoffed at a caller who claimed that his June electric bill was just $60. Miles invited the home's designer, Jim Sargent, onto his show, and became enthralled with the idea of energy efficient construction. The pair then collaborated to bring Texas its first zero-energy home: 3,800 square feet, architecturally pleasing, and comfortable.[40] The home uses 45 percent less energy than a typical home, with the remaining needs met by the renewable energy produced by the photovoltaic and solar hot water systems.[41]

Zero-energy homes use state-of-the-art technology, but they are not just for the rich. Indeed, government officials, builders, building material suppliers, non-profit organizations and individual citizens are engaged in efforts to make zero-energy homes not only green, but also affordable for everyone.

In 2005, for example, Habitat for Humanity of Metro Denver teamed with the National Renewable Energy Laboratory to build an affordable zero-energy home. The Colorado home was built without complex systems, with off-the-shelf technologies, and using volunteer labor.[42] In its first year, the house produced more energy than it consumed, with an average utility bill (electric and natural gas) of $17 per month.[43]

**Figure 1: Energy Usage in Standard Home Compared to Zero-Energy Home[47]**



In Lenoir City, Tennessee, experts at the Oak Ridge National Laboratory teamed with Habitat for Humanity to build a series of low-cost, near-zero energy homes. The houses include airtight building envelopes, solar photovoltaic panels, and heat-pump water heaters, among other energy-saving technologies. The houses cut energy consumption by approximately half compared to a typical home (not counting the energy supplied by the photovoltaic system), with total energy costs of approximately $1 per day.[44]

A similar affordable near-zero energy home project in western Massachusetts has also achieved impressive results. In its first year, the home, built by a non-profit organization providing housing for low- and moderate-income families, consumed less than 700 kilowatt-hours of electricity from the utility grid—less than the average American home consumes in a single month.[45] The non-profit agency, Rural Development, Inc., is now applying its experience with the initial house in the construction of a mixed-income development of 20 near-zero energy homes.[46]

Zero-energy homes are being built in locations as diverse as California, Massachusetts, Wisconsin and New Jersey.[48] State and local governments are also developing programs to provide incentives for the construction of zero-energy and near-zero energy homes. New Mexico, for example, has created tax incentives to encourage highly efficient residential construction.[49]

Investing in zero-energy homes and fostering their market penetration could result in large reductions in global warming pollution. An analysis conducted by the National Renewable Energy Laboratory found that, by investing in zero-energy home technology now through research and development and public policy support, zero-energy homes could reduce energy consumption in single-family homes by 17 percent by 2050, averting up to 100 million metric tons of global warming pollution per year.[50]

While the technology to build zero-energy homes exists today, investment in research and development can continue to play an important role in making zero-energy homes more efficient and affordable. The U.S. Department of Energy's Building America program, for example, brings together teams of engineers to design buildings that maximize energy efficiency, and then monitors those buildings as they are used to further improve and refine those designs.

With new building techniques and strong public policy support, zero-energy homes can quickly be brought from the fringes to the mainstream—with large benefits for homeowners and the planet.

## The Energy Efficiency Revolution in California: Getting More Done with Less Energy

In the fall of 1973, particle physicist Arthur Rosenfeld had an epiphany.

It was a time of skyrocketing oil prices and long lines outside gas stations as America reeled from the impacts of the Arab oil embargo. One day during the crisis, Rosenfeld did a little math. Leaving the lights on in his office all weekend, as he usually did, would consume the equivalent of four gallons of gasoline, he concluded.[51] The realization led Rosenfeld to think that, perhaps, the solution to the nation's energy woes could be found in reducing the amount of energy America wastes.

Rosenfeld went on from that realization to a new career devoted to exploring how energy was used—and often wasted—in American buildings. In the mid-1970s, Rosenfeld and other researchers found that

## Solution: Statewide Energy Efficiency Efforts

**What it is:** California's three decade-long economy-wide energy efficiency effort.

**Who is doing it:** California policy-makers, businesses and individuals.

**What it has achieved:** California uses 20 percent less energy per capita than it did in 1973, and produces 30 percent less carbon dioxide per capita than in 1975. California's innovations in energy efficiency have also set the stage for national adoption of many efficiency policies.

**Why it is important:** California's example shows that economic growth and greater energy efficiency go hand in hand. Aggressive and thoughtful energy efficiency policies can achieve significant reductions in energy use and global warming pollution.

**Public policy best practices:** Aggressive building energy codes and energy efficiency standards for appliances; ratepayer-supported energy efficiency programs and extensive public education efforts.

there were vast differences in the amount of energy used by various refrigerators, and that establishing minimum efficiency standards for refrigerators could save 1,500 megawatts of generation capacity—about the size of one-and-a-half typical nuclear power plants.[52] The researchers gave their conclusions to California's governor, Jerry Brown, and in 1976 California became the first state to establish energy efficiency standards for refrigerators—a move that eventually led to the adoption of similar federal standards. Today, the average American refrigerator uses 75 percent less energy than a typical 1974 model, despite being larger and having more features.[53]

California's early lead in energy efficiency continued through the 1970s. The state implemented the first building energy code in the nation in 1978. And over time, the state has continued to adopt increasingly stringent standards for appliances—in

*For more than three decades, California has made energy efficiency improvements a key part of its energy strategy. Here, a technician installs energy efficient lighting at a children's hospital in central California.* (Credit: Children's Hospital Central California)

most cases, setting the bar for the adoption of similar standards at the federal level years later.

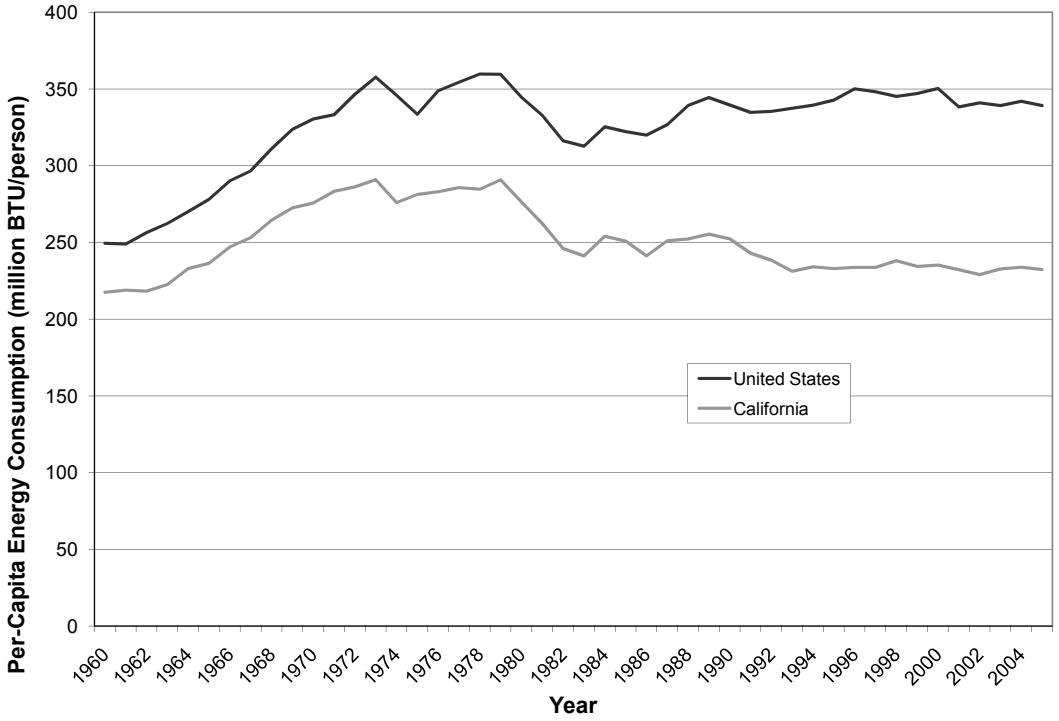
California has also turned to energy efficiency in times of crisis. In 2000 and 2001, manipulation of electricity markets by Enron and others led to a wrenching energy crisis for Californians—a time of rolling blackouts, utility bankruptcies and skyrocketing energy bills. To bring the electric grid back into working order, policy-makers needed to reduce energy demand quickly—on a scale of months rather than years. To address the issue, they devised a program to educate the public on the need to work together to conserve electricity. The "Flex Your Power" campaign was born. Within a year, Californians, who were already using energy much more efficiently than the rest of the nation, worked together to reduce their demand for electricity by 14.1 percent, equivalent to the output of 10 large power plants.[54]

California's efforts as a leader in energy efficiency have paid off. Since the state's energy efficiency efforts began in the mid-1970s, California's per capita energy consumption has declined at a faster rate than that of the rest of the country. (See Figure 2.) In 1973, California's per capita energy consumption was 19 percent lower than that of the United States as a whole. By 2005, California was using 32 percent less energy per capita than the whole of America.[55]

Statistical analysis of declining per capita energy consumption in California relative to the rest of the nation found that, after controlling for retail price of fuel, per capita income, technological change and climatic conditions, energy efficiency measures were largely responsible for this trend.[56]

California's energy efficiency efforts have not only reduced global warming emissions, but have also delivered substantial benefits for the economy. From 1975 to 2001, the state's building and appliance efficiency standards reduced energy costs

**Figure 2. Per Capita Energy Consumption Declining in California Relative to Rest of the United States[57]**



for individuals and businesses in the state by $56 billion, achieving an annual energy savings of 4,760 gigawatt-hours, enough electricity to power more than 800,000 California households.[58]

California is turning to energy efficiency again in its efforts to address the crisis of global warming. The state has dramatically ramped up its already aggressive energy efficiency programs over the last two years and is designing new programs that will go even further. Since 2006, California's investor-owned utilities have installed energy efficiency measures that save at least 6,000 gigawatt-hours of electricity—about 2 percent of the state's total electricity consumption.[59] And the state is in the process of taking dramatic next steps—directing utilities to come up with a long-range energy efficiency plan, developing long-term efficiency goals for the state, and laying a path toward "zero energy" homes and buildings within the foreseeable future.[60]

Over the past 30 years, Californians have learned that using energy more efficiently can be the cleanest, cheapest, fastest way to address energy supply challenges. Thanks to those efforts, California produces 30 percent less carbon dioxide per capita than it did in 1975, and the state's per capita emissions are approximately half those of America as a whole.[61] Time and again, California has set the standard for clean energy policy. The nation as a whole can learn from California's lesson.

## Saving Energy in Industry: Wisconsin's Focus on Energy Program

Food processing is big business in Wisconsin, with more than 1,000 food processing businesses employing 62,000 people and

### Solution: Industrial Energy Efficiency

**What it is:** Incentives for energy efficiency improvements in industrial operations.

**Who is doing it:** Wisconsin's ratepayer-supported energy efficiency program.

**What it has achieved:** Wisconsin's industrial energy efficiency programs have saved more than 141 million kWh of electricity and 15 million therms of natural gas—accounting for approximately 200,000 metric tons of averted carbon dioxide emissions.

**Why it is important:** Industrial use of energy accounts for 30 percent of America's carbon dioxide emissions. Improving industrial energy efficiency can reduce emissions while often saving money for manufacturers and improving their competitiveness.

**Public policy best practices:** Ratepayer-supported energy efficiency programs that provide industry-specific technical expertise and financial assistance.

*Manufacturing plants are large consumers of energy. Programs like Wisconsin's Focus on Energy help manufacturers use energy more efficiently.* (Credit: winhorse/istockphoto.com)

generating $10 billion in revenue.[62] Energy costs are a significant expense for these companies, which must cook, refrigerate, freeze and otherwise process vast amounts of food.

Nestlé USA, the global food conglomerate, operates several facilities in Wisconsin, including an infant formula plant in Eau Claire that uses large amounts of heated water in its operation. The company had long considered ways to recapture some of the heat that had been lost in the plant's exhaust. But low natural gas prices meant that it would take too long for the company to recover the cost of the investment.[63]

With natural gas prices on the rise in recent years, however, Nestlé began to reconsider, and the company turned to Wisconsin's Focus on Energy program for help. Focus on Energy is supported by a small systems benefit charge on Wisconsin ratepayers' electric bills, and operates energy efficiency programs that help homeowners and businesses. The program's industrial efforts, which began statewide in 2001, have been recognized as an "exemplary" energy efficiency program by the American Council for an Energy-Efficient Economy (ACEEE).[64]

Focus on Energy provides expert technical advice and financial assistance to industries seeking to improve their energy efficiency. The program has special programs devoted to five common and energy-intensive industries in the state: food processing, metal casting, plastics, pulp and paper, and water and wastewater treatment.[65] The potential for energy savings in these industries is vast: Focus on Energy estimates that energy efficiency improvements in the dairy and food processing industries alone could shave $60 million off the industries' total energy bill of $400 million.[66]

In Nestlé's case, Focus on Energy provided financial assistance that, combined with the higher cost of natural gas, made it cost effective for the company to install condensing economizer systems on its boilers, which capture lost heat from the stack and use it to preheat cold water heading into the boilers. The system saves Nestlé an estimated 142,000 therms of natural gas each year, and the investment is expected to pay for itself in just 2.7 years.[67]

In total, Focus on Energy has worked with over 1,500 industrial customers for a net savings of over 141 million kWh of electricity and 15 million therms of natural gas.[68] Assuming that the saved electricity came from Wisconsin power plants, those savings represent over 200,000 metric tons of averted carbon dioxide emissions.[69] Conserving energy results in lower bills as well. Focus on Energy has resulted in a net savings of over $262 million for Wisconsin industries.[70] The program budget for that period was a total of $22

million, yielding an exceptional benefit-cost ratio of 11.9.[71]

America's industrial facilities have massive, untapped potential for improved energy efficiency. The use of advanced motors, more efficient equipment, better management of heat energy, and combined heat-and-power (which uses waste heat from industrial operations to generate electricity) can all dramatically reduce energy consumption in industrial facilities. Programs such as Wisconsin's Focus on Energy show that this potential can be tapped in ways that not only reduce emissions but that also keep American businesses competitive and thriving.

## Turning Trash into Treasure: Germany Sets the Standard for Recycling and Waste Reduction

Like any developed country, Germany creates a lot of trash—nearly 30 million tons of it annually.[72] Germany is densely populated and open land is scarce, leading to a serious problem: where to put all of this garbage? By the late 1980s, Germany faced both a shortage of landfill capacity and strong opposition to placing new facilities on available land.[73]

In 1991, Germans took a bold step

### Solution: Recycling

**What it is:** A society-wide effort to encourage recycling and waste reduction.

**Who is doing it:** Germany.

**What it has achieved:** Germans recycle more than half their garbage, eliminating 4 million metric tons of global warming pollution each year.

**Why it is important:** America produces vast amounts of waste and recycles far less of it than Germany. Reducing waste and recycling more of the waste we produce would significantly reduce global warming pollution and avert other environmental problems.

**Public policy best practices:** Requiring product producers to take responsibility for waste; imposing sliding scale fees based on volume and content of packaging; providing wide-scale recycling infrastructure.


*Germany's recycling rate is nearly double that of the United States, thanks in large part to policies that put the responsibility for recycling on product manufacturers, not consumers and taxpayers.* (Credit: GFDL file/Kaihsu Tai)

toward a new way of dealing with waste, through the adoption of a cutting-edge law known as the "Waste Act." The Waste Act specifically targeted product packaging, which at the time accounted for over 30 percent by weight and 50 percent by volume of all municipal solid waste produced in Germany.[74]

The philosophy underlying the Waste Act is based on the "polluter pays" principle. In the United States, the responsibility for dealing with waste disposal lies entirely with taxpayers (with a few exceptions, such as bottle deposit laws), giving manufacturers no incentive to reduce the amount of wasteful packaging. By contrast, Germany requires the consumer products industry to take responsibility for packaging waste, thereby providing an incentive for companies to design less wasteful products from the very beginning. This shift of responsibility effectively internalizes waste management costs by integrating them into the prices of products and packaging.[75]

It can be difficult for individual companies to take full responsibility for the waste their products create, but German law provides a convenient solution: manufacturers can opt out of taking back their own product packaging by helping to pay for and participating in a cooperative recycling scheme. Germany's packaging collection company, Duales System Deutschland (DSD), fulfills that role.

DSD is financed by a fee paid by member companies, which are charged a one-time fee when they join, then are periodically charged based on the quantity and type of material they produce. The fees for materials that are more costly or difficult to recycle are higher than those for more easily recyclable products, providing incentives for manufacturers to reduce the amount of packaging on their products and to use recyclable materials. In return for the fees, DSD allows these companies to place its trademark "Green Dot" on their products. DSD uses the revenue to hire waste collectors to pick up recyclables and to operate recycling facilities that handle the waste after it is collected.[76]

In the German model of recycling, consumers participate voluntarily, without explicit financial incentives. Why, then, are the nation's recycling rates so high? First, German consumers are enthusiastic recyclers for environmental reasons. Moreover, because manufacturers must meet government-imposed recovery quotas for the packaging they produce, they have an incentive to design recovery systems that Germans will use.

Germany now has one of the most ambitious and successful recycling programs on the planet. The nation of about 80 million boasts that each resident recycles 167 pounds of packaging alone in a year.[77] The country's recycling rate for product packaging is an astonishing 78 percent.[78] And, incredibly, the sum total of waste from households in Germany has remained constant since 1990, during a period in which waste production in the United States was increasing by 22.5 percent.[79] By 2005, Germany was recycling more than 60 percent of its municipal waste.[80] By comparison, in the United States, only 32 percent of waste was recycled by 2006.[81]

Recycling can reduce global warming pollution in several ways. First, it typically takes less energy to create products from recycled materials than from virgin wood, metal or petrochemicals. Second, waste that is sent to landfills or incinerators creates global warming pollution. Landfills produce methane as organic materials in garbage decompose, while incinerators produce pollution when garbage is burned.

Germany's exceptional recycling system reduces the nation's contribution to global warming. In 2005, recycling of paper, glass, metal, wood and packaging in Germany reduced global warming pollutant emissions by nearly 4 million metric tons of carbon dioxide per year.[82] These savings

only reflect the energy savings gained by using recycled as opposed to new materials, and do not reflect the emissions that would have been produced if these materials were landfilled or incinerated instead. Nor do they reflect Germany's success in keeping the overall volume of waste down.

America is a long way from reaching the standard for recycling that has been established in Germany—America's recycling programs are run by local governments, vary from place to place, and are often underfunded. In many parts of the country, workable recycling programs don't exist.

The German model of recycling has been emulated by other European nations, but the closest the United States has come to that standard is with the bottle deposit laws that are currently on the books in 10 states. Those laws place a 5 to 10 cent deposit on beverage containers, which are then returned for recycling. Containers covered by bottle deposit laws are recycled at twice the rate as those that are not.[83] While bottle deposits are required only for soda and beer containers in many states, several states have expanded their laws to cover bottled water, sports drinks and other non-carbonated beverages.

The German example shows that the benefits of a society-wide recycling effort are profound—reducing waste and curbing global warming emissions. By requiring product manufacturers to do their part to reduce packaging waste and promote recycling, America could achieve similar benefits.

# Reducing Global Warming Pollution from Transportation and Land Use

America's transportation system produces more carbon dioxide pollution than the entire economy of any nation in the world, other than China.[84] Americans drive far more miles on average than their counterparts in the rest of the developed world, fueling a crippling addiction to foreign oil that threatens our economy and our national security.

Transportation has also long been considered among the most difficult sectors of the economy in which to achieve large reductions in global warming pollution. Since World War II, the United States has implemented land use policies that make driving an automobile a necessity, even for the simplest of daily errands. Our massive investment in highways has also helped cement our dependence on automobiles. At the same time, the United States has failed to invest in public transportation and rail transport—two options we will need to expand if we hope to reduce global warming pollution.

But reducing global warming pollution from transportation and land use is feasible. Manufacturing more energy efficient vehicles is one part of the equation, but perhaps more important is changing our transportation and growth patterns. Efficient cars will play an important role in reducing emissions, but those reductions will not last long if Americans continue to increase the number of miles we drive each year.

Cities and towns across America and elsewhere are showing, however, that there is a path toward a cleaner, less polluting transportation system. By embracing a vision of future growth centered around compact, vibrant communities, and investing in low-carbon transportation infrastructure, America can significantly reduce global warming pollution from transportation.

## Building Around Transit: An Alternative to Sprawl Blooms in Northern Virginia

After World War II, Arlington County, Virginia—just across the river from Washington, D.C.—came to be defined by the automobile. Like many inner-ring suburbs

## Solution: Transit-Oriented Development

**What it is:** Compact development near transit stations.

**Who is doing it:** Arlington County, Virginia.

**What it has achieved:** Eliminates an estimated 35,000 single-passenger automobile trips to workplaces per day, cutting carbon dioxide emissions by tens of thousands of tons each year.

**Why it is important:** Arlington's experience shows that there are attractive alternatives to car-dependent sprawl. Transit-oriented development reduces vehicle travel, conserving scarce oil and reducing global warming pollution.

**Public policy best practices:** Expansion of transit infrastructure; routing of transit lines through existing town centers; land-use policies that encourage compact, mixed-use development near transit stations.

*Walkable, mixed-use developments have sprung up around transit stations in Arlington County, Virginia—the result of investments in public transportation and sound community planning.* (Credit: Coalition for Smarter Growth)

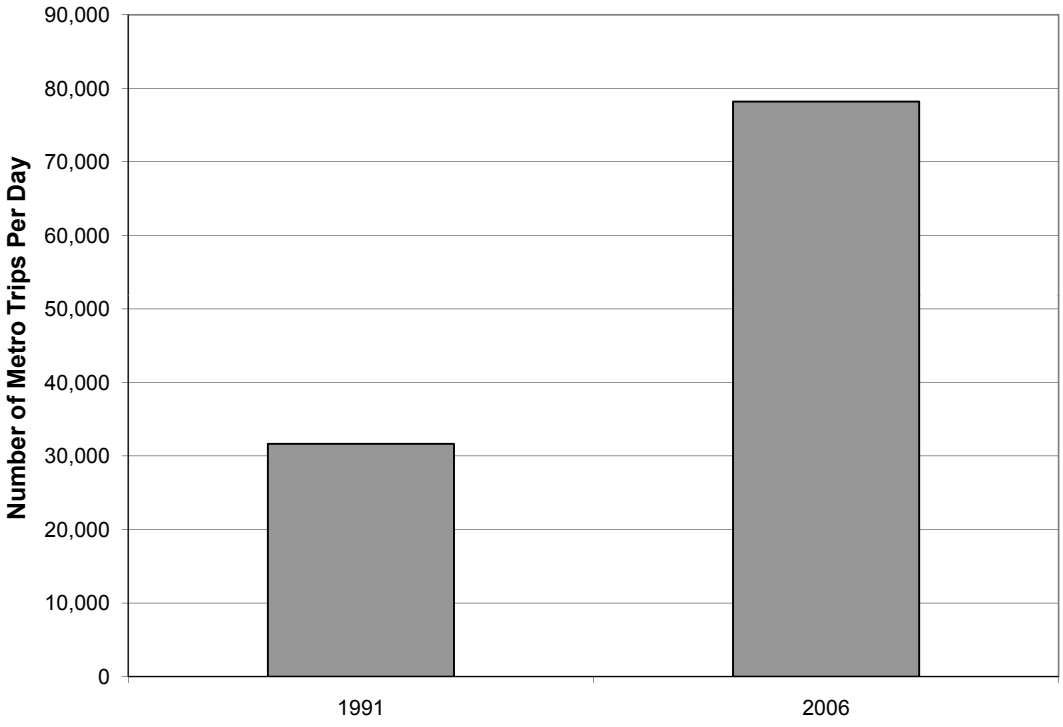
outside American cities, Arlington was home to strip malls, car dealerships, garden apartments and tracts of single-family housing. The county even had what was believed to be one of the largest parking garages in the United States, outside the aptly named Parkington shopping center.[85]

By the late 1970s, however, as population moved further and further out into suburbia, much of the county's retail and housing infrastructure was in decline. So, it was no surprise that when design began for the Washington, D.C. Metrorail network—a transit system that would link Arlington to the nation's capital—local officials saw it as an opportunity.

What was surprising, however, was that local officials saw the coming of the Metro not only as a transportation link, but as an opportunity to reshape its neighborhoods—bringing new jobs, new housing and new life to the community. Arlington was one of the first communities in the nation to embrace what is now known as "transit-oriented development"—the construction of communities where residents can use a variety of modes of transportation to get to and from work. Transit-oriented development is a potent tool to reduce global warming pollution from vehicles. Residents of compact communities drive 20 to 40 percent fewer miles than residents of sprawling communities, generating a similar percentage reduction in global warming pollution.[86]

The neighborhoods of Ballston and Rosslyn—both situated along the Metro's Orange Line—experienced the greatest transformation. Local officials urged that the Metro line be built through the existing business districts of the two neighborhoods and not along the median strip of a new highway, as had also been proposed. Arlington County officials also prepared for the Metro's arrival by creating a new vision for community development. In 1980,

**Figure 3: Average Daily Metro Orange Line Ridership, Arlington County, Virginia[93]**



Arlington County approved a land-use plan for the Ballston area that envisioned the creation of a new downtown around the Metro station that included a mix of commercial and residential development.[87] By concentrating the most intense development around its Metro stations, the county was able to preserve the low-density, single-family character of the rest of the area, while also giving residents of those neighborhoods new access to shops and jobs—often within walking distance.

The result has been a boom in development near the stations. Since 1970, the square footage of office space in the Ballston-Rosslyn corridor has nearly quadrupled, from 5.5 million square feet in 1970 to 20.5 million now, the number of jobs has increased from 22,000 to 90,000, and the number of residential units has jumped from 7,000 to 26,200.[88] Arlington County now has more office space than the downtown areas of Pittsburgh, Denver or Dallas.[89]

Yet, despite this tremendous growth, traffic on the area's streets has grown only modestly.[90] The reason: residents of the Ballston-Rosslyn corridor are far more likely to walk or take transit to work than their counterparts in other suburbs. About 10 percent of the people living in the Ballston-Rosslyn corridor walk to work.[91] Nearly 40 percent take transit to get to work, and residents of the area own far fewer cars per capita than people in the rest of Arlington County or other Washington suburbs.[92]

The impact on traffic has also been moderated because Arlington officials have zoned the Ballston-Rosslyn corridor for a mix of commercial and residential development—avoiding the problems faced by other suburbs whose residents jam highways leaving town to go to work in the morning and jam them in the other direction coming home at night.

If residents of Arlington County drove to work alone at the same rate as residents of other Washington-area inner suburbs, they would take approximately 35,000 more vehicle trips per work day.[94] Even assuming relatively short commutes—for example, 5 miles each way—the savings would add up to more than 45 million avoided vehicle-miles over the course of a single year, or more than 19,000 metric tons of avoided carbon dioxide emissions.[95] If those residents had opted instead to live in sprawling communities further from their jobs, the savings would be even greater.

Transit ridership continues to soar in the corridor, growing by nearly 150 percent since 1991.[96] (See Figure 3.) Indeed, the success of the Ballston-Rosslyn corridor has left transportation officials with a new challenge: crowded conditions on the Metro subway.

Arlington County has several advantages that make it unique—its location adjacent to the nation's capital and the presence of numerous subway stops. But the tools used to drive smart growth in the county—ranging from investment in transit expansion to the use of innovative land-use tools to promote the right kinds of development in the right places—can be applied in almost any American city, reducing global warming pollution, curbing congestion and improving the quality of life.

## Walking in Copenhagen: Making Room for Pedestrians on City Streets

The Strøget, which runs through the center of downtown Copenhagen, is the world's longest pedestrian-only street. Lined with shops, restaurants, and street performers, the Strøget is a charming blend of modernity and old-world Scandinavian charm.[97]

## Solution: Pedestrian-Friendly Streets

**What it is:** The creation of pedestrian-only and pedestrian-priority streets.

**Who is doing it:** Copenhagen, Denmark.

**What it has achieved:** Reduces carbon dioxide emissions by at least 90,000 tons per year; more than one-third of work commutes now take place by bike.

**Why it is important:** Copenhagen's four decade-long efforts to carve out space for pedestrians in its city center show that well-planned efforts to develop pedestrian-friendly spaces can pay off in reduced emissions and improved quality of life.

**Public policy best practices:** Investment in pedestrian infrastructure; land-use planning that encourages the development of vibrant, walkable neighborhoods; investment in infrastructure for bicycles, including a widespread bikeshare program.

*The Strøget, once a typical, car-jammed street, is a haven for pedestrians—a testament to Copenhagen's success in promoting non-motorized forms of transportation and vibrant urban life.* (Credit: Jason Kottke)

However, the Strøget was not always such a pleasantly walkable destination. By the early 1960s, the street was often packed with cars. In 1962, city officials, desiring to keep some of Copenhagen's streets car-free in the interest of historical preservation, transformed the Strøget into a road for pedestrians only.[98]

Eliminating automobile traffic from the Strøget was initially controversial, but it turned out to be an enormously successful experiment. Shopkeepers found that revenues actually increased when cars were forbidden.[99] Residents appreciated quality of life improvements, including improved mobility and decreased congestion and noise.

The initiative was popular enough that Copenhagen began gradually converting other streets into pedestrian malls. In ensuing years, the city has closed off additional streets, erected new plazas, and eliminated parking spaces. By 1996, Copenhagen had six times the amount of car-free space as it did in 1962 when the pedestrian initiatives began.[100]

Copenhagen also pioneered the development of "pedestrian priority" roads, in which pedestrians, bicyclists and drivers share lanes of the street. Bikers and pedestrians may travel both ways, but cars may only move in one direction, and must yield to other modes of traffic at all times.[101] The effect is greater safety and mobility

for non-drivers, while maintaining some access for automobiles as well.[102]

New amenities for pedestrians weren't the only transportation innovations Copenhagen undertook. The city has a vigorous public transportation network and is also one of the world's premier biking cities. Copenhagen's ubiquitous "City Bike" program has more than 2,000 public bikes available at 100 racks throughout the city.[103] Anyone can use any available bike at any time by dropping a deposit into a coin box on the bike rack. Riders can then return the bike to any rack in the city, where they can reclaim their deposit.

The result of these innovations has been a massive shift in Danes' traveling behavior, and even, some believe, Danish culture. Walking and cycling account for 41 percent of trips made in Danish urban areas—an increase of more than 25 percent from 1975 levels.[104] By comparison, only 10 percent of trips are made by walking or biking in American cities.[105] In Copenhagen itself, as of 1995, about one-third of all trips to work were made by bicycle.[106] Bicycling alone averts approximately 90,000 tons of carbon dioxide emissions in Copenhagen each year.[107] Moreover, the shift to a pedestrian-friendly city center changed the way Danes spent their time—as the city devoted more space to pedestrians, Copenhagen residents spent more time in public spaces rather than at home.[108]

Merely shutting down a street to vehicle traffic—as was tried in many American cities in the 1970s—is not enough to realize the results achieved in Copenhagen. The city combined its focus on pedestrians with the creation of a diverse transportation system and land-use planning that encouraged a strong residential presence in the center city, adding both to the number of people on the street and the feeling of security and warmth.

Over the course of more than four decades, Copenhagen has taken a development path away from automobile dependence and toward the creation of more space for pedestrians and bicyclists—resulting not only in less pollution, but in vigorous, fun places that attract tourists and residents alike.

## Portland, Oregon: Building "Bike City, USA"

Portland, Oregon, takes pride in its nickname of "Bike City, USA." Each year, more and more residents are finding that they can get by just fine with two wheels rather than four, swelling the ranks of bicyclists on city streets and creating a vibrant "bike culture" in the city.

But the success of bicycling in Portland isn't just the result of individual preferences or a quirky Northwestern sensibility. Rather, it is the result of decades of investment, hard work and planning by citizens and government officials to make Portland a bicycle-friendly metropolis.

The seeds for the bicycle revolution in Portland were planted more than three decades ago. In 1971, the state of Oregon passed the "Bicycle Bill," mandating that a minimum of 1 percent of its highway funds be set aside for bicycle and pedestrian developments.[109] This led the city of Portland to begin to integrate cycling into its transportation system, with the installation of bicycle lanes on many roads. [110]

Portland's Bicycle Transportation Alliance succeeded in 1991 in convincing the city's transit authority to install bike racks on all buses and light rail trains.[111] In addition, the city has implemented aggressive minimum bike parking standards in places like housing units, transit stations, and retail and office buildings.[112]

In 2002, Portland implemented Smart Trips, a program that works to reduce solo driving by focusing on one city neighborhood at a time. Smart Trips encourages

## Solution: Bicycling

**What it is**: Bike lanes and programs to encourage bicycling.

**Who is doing it:** Portland, Oregon.

**What it has achieved:** Reduces carbon dioxide emissions by at least 8,500 metric tons per year; the percentage of Portlanders commuting to work by bike is eight times the national average.

**Why it is important:** After three decades of investing in bicycling infrastructure, Portland is experiencing a biking boom. Other American cities could achieve similar results by creating safe and widely available bike lanes along with other inducements for bicycle travel.

**Public policy best practices:** Planning policies that treat bicycling as an integral part of the transportation system; public investment in bicycle lanes and associated infrastructure; programs to encourage bicycle commuting targeted at employers and commuters; bicycle parking requirements for new developments; installation of bike racks on transit buses.

*Bicycling has increased dramatically in Portland in recent years, the result of the city's longstanding policies to encourage alternatives to driving.* (Credit: Jonathan Maus/bikeportland.org)

alternatives to driving by giving away maps and transit schedules, organizing strolls and bike rides, educating local youth on bike safety, offering free bike tune-ups, and more.[113]

The city of Portland now has nearly 200 miles of bikeways—bicycle lanes, boulevards, and multi-use trails.[114] Among Portland residents, 4.2 percent bicycled to work in 2006, a rate eight times the national average.[115]

The number of trips taken over the four bike-friendly bridges in Portland has more than quadrupled since 1992, to more than 14,000 trips per day.[116] Bicycle trips now represent more than 11 percent of all vehicle trips on the four bridges; in 2000, they represented less than 5 percent.[117] Bicycle traffic in the city increased by more than 18 percent in a single year from 2006 to 2007, the third consecutive year of double-digit percentage increases.[118]

Portland's combination of bike lane expansion and cycling encouragement has yielded significant reductions in global warming pollution. In 2006, the Smart Trips program in the city's Northeast area was responsible for reducing vehicle travel by more than 19 million miles, reducing carbon dioxide emissions by 8,500 metric tons.[119]

Global warming pollution from the transportation sector in Portland has decreased by 1.6 percent since 1990.[120] This is in part due to the city's encouragement of bicycling and expansion of services for bike riders, though investments in new transit lines and the city's well-known efforts to promote "smart growth" have also played important roles.

The explosive growth of bicycling has sparked other changes in the city. A vigorous sub-economy has developed around bicycling in the city, with about 125 bike-related businesses in Portland, including companies that make bike racks, high-end components for racing bikes, and aluminum for bikes mass-produced elsewhere.[121] In 2006, an estimated 600 to 800 people in Portland were employed in the "cycling industry."[122] Economic activity related to cycling totaled $63 million in Portland in 2005, and in a recent survey, more than 80 percent of businesses responded that Portland's reputation for being bicycle friendly was good for their business.[123] Portland's bike push is good for public health as well, encouraging city residents to boost their level of physical activity by biking or walking more of the places they need to go.

Portland's transformation into "Bike City, USA" is the result of actions by private citizens and public officials to make bicycling a safe and convenient means of emission-free transportation. Many of the initiatives that have set off the bicycling boom in Portland could easily be adapted to other American cities.

## Speedier Rail Service in Eastern Pennsylvania: Drawing New Riders and Reducing Pollution

The "Keystone Corridor" of Amtrak's passenger rail network has a long and storied past, linking the cities of Harrisburg and Lancaster, Pennsylvania, with Philadelphia since 1834.[124] By the turn of the 21st century, however, rail service along the corridor bore too many reminders of the 19th century—with slow speeds, frequent delays and decaying infrastructure.

Demand for travel along the corridor has expanded dramatically in recent years as suburban development has spread west from Philadelphia, bringing with it increasing concerns about traffic congestion. Pennsylvania officials saw improving service on the Keystone Corridor as one potential solution to the problem.

## Solution: Fast and Efficient Rail Service

**What it is:** Improved rail service in eastern Pennsylvania.

**Who is doing it:** Amtrak and the Commonwealth of Pennsylvania.

**What it has achieved:** Increased ridership on a popular rail line by 20 percent within a single year.

**Why it is important:** Passenger rail is a cleaner and more efficient means of transportation than cars or airplanes. America's passenger rail infrastructure is aging and has been the victim of disinvestment. Investing in passenger rail improvements can generate increased ridership and reduced emissions.

**Public policy best practices:** Public investment in rail improvements.


*Electrification of the Keystone Corridor line from Harrisburg to Philadelphia has led to higher speeds and more passengers.* (Credit: Xb-70; licensed under Creative Commons Attribution-Share Alike 2.5)

In August 2004, Amtrak and Pennsylvania governor Ed Rendell announced that the two parties would split the $145 million cost of bringing 110 mile-per-hour electrified service to the Philadelphia-Harrisburg line.[125] The project was completed, within budget, in October 2006.

Now, express trains now travel between Harrisburg and Philadelphia, stopping in Lancaster, in only 90 minutes, a 30 minute improvement over previous express train service, and significantly faster than a downtown-to-downtown automobile trip.[126] Local train travel times have been reduced to 105 minutes, and service has been expanded to offer 14 round-trip trains between Harrisburg and Philadelphia, with 10 continuing on directly to New York City.[127] On-time performance on the line has increased to 87.8 percent, providing travelers with both a fast and reliable alternative to driving.[128]

The investment has paid off in booming ridership. During fiscal year 2007 (which, for Amtrak, ran from October 1, 2006 to September 31, 2007), ridership on the Keystone Corridor increased by 20 percent over the year before, adding more than 160,000 new riders.[129] There are no data available on the degree of global warming emission reductions generated by the Keystone service upgrade, but the recent surge in ridership shows the potential for emission reductions over the long haul.

The success of the Keystone Corridor improvements mirrors the success of Amtrak's high-speed service along the East Coast, from Boston to Washington, D.C. In fiscal year 2007, Amtrak's high-speed Acela service carried more than 3 million riders, a 20 percent increase over the previous year.[130]

Improving passenger rail service can be a critical strategy for the United States in the fight against global warming. Per passenger-mile, Amtrak intercity rail service uses 17 percent less energy than air travel and 21 percent less energy than travel in a car.[131] Yet, America's passenger rail network trails far behind those of other countries—particularly Japan and European nations—in both extent and speed. America has only one rail line—the Acela line along the northeast corridor—that minimally qualifies as a "high speed" rail line by international standards. By contrast, Europe and Japan have extensive high speed rail networks, where trains regularly travel at 125 miles per hour or faster, with the fastest trains approaching speeds of 200 miles per hour. Spain, for example, is planning to build a rail line that will cover the distance between Madrid and Barcelona—a trip of approximately 375 miles—in two-and-a-half hours.[132]

In the late 1990s, the federal government designated 11 high-speed rail corridors in the United States, including the Keystone Corridor between Philadelphia and Harrisburg and its extension west to Pittsburgh. A 2006 study estimated that if all of these corridors were upgraded to high speed rail, 2.7 million metric tons of carbon dioxide could be saved per year.[133] That means 29 million fewer automobile trips and 500,000 fewer flights by 2025. [134]

Rising gasoline prices and increased congestion on roads and in airports has led to a resurgence in interest in high-speed rail, particularly in California. The experience of improved rail service in eastern Pennsylvania shows that other areas that invest in better rail service are also likely to meet with success—and take a significant step toward reducing global warming pollution from transportation.

## DART Hits the Bullseye: Light Rail in Dallas, Texas

"Texans won't get out of their cars to ride a train," the Texas Mass Transportation Commission flatly declared in a 1971

## Solution: Light Rail Transit

**What it is:** Light rail service in Dallas, Texas.

**Who is doing it:** Dallas Area Rapid Transit (DART)

**What it has achieved:** Reduces carbon dioxide emissions by 144,000 metric tons per year; further expansions of the light-rail network will result in greater emission reductions.

**Why it is important:** Dallas is a city that was once highly skeptical of public transportation. The success of light rail in Dallas and other growing "Sunbelt" cities shows that public transportation can succeed in reducing emissions in cities across the country.

**Public policy best practices:** Public investment in transit system expansion.

manual.[135] Indeed, skepticism about public transportation has deep roots in Texas—a state known more for pick-up trucks than light-rail cars.

But today, public transportation is booming in the Dallas metropolitan area.


*Dallas' light rail system, DART, has shown that public transportation can deliver benefits even in traditionally car-dependent cities.* (Credit: Adam E. Moreira, Licensed under Creative Commons Attribution Share Alike 3.0)

The city's light rail transit system—Dallas Area Rapid Transit (DART)—boasted the seventh-highest ridership among U.S. light-rail systems in 2006.[136] And local attitudes toward public transportation have undergone a sea change—where communities surrounding Dallas once fought to keep light rail out, they now fight to see who can be first in line for new service.

Dallas is a city plagued by congestion and gridlock. Between 1990 and 2000, the Dallas-Fort Worth area added 1.2 million residents—about 325 per day—for an explosive 29 percent increase in population.[137] Because most Dallas residents have historically had few viable transportation options, the growth in population also meant a dramatic growth in traffic congestion, with Dallas residents wasting more than 152 million hours and $2.7 billion sitting in traffic in 2005 alone.[138] The average commuter in Dallas now spends 58 hours—nearly two and a half days—in congested traffic every year.[139]

Despite rising congestion, however, getting light rail built in Dallas was not easy. Plans to construct a light rail system

began in 1983 and faced many roadblocks, including a series of votes in which several suburban cities opted out of DART.[140] Finally, in 1996, DART's initial light rail line began service, despite well-funded opposition including from Dallas Cowboys owner Jerry Jones.[141]

When DART unveiled its 20-mile starter system, ridership defied all expectations and quickly silenced critics who claimed that it was a waste of funds or would simply draw riders from buses, not cars. Indeed, as of 2000, 41 percent of light rail riders in Dallas had not been DART users previously.[142]

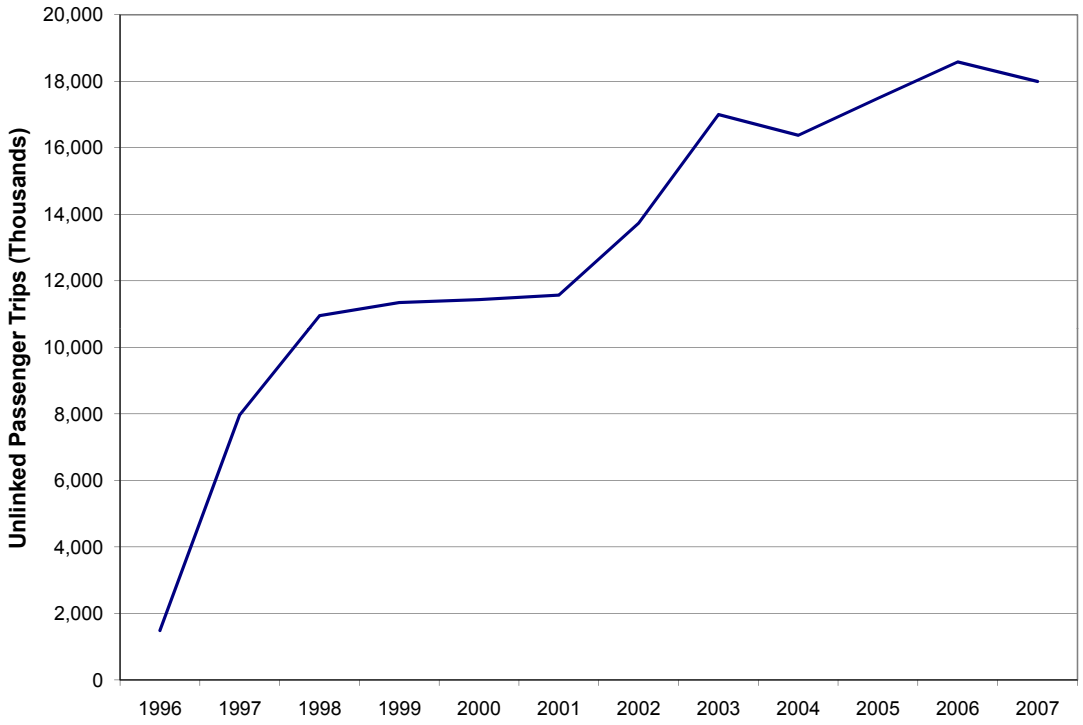
The DART light rail network is currently comprised of two lines that stretch about 50 miles. The system is expanding at a rapid rate to meet growing demand for public transit: the construction of two more lines is expected to bring the system to about 90 miles by 2013.[143] The expansion plans were made possible largely by a $700 million grant from the Federal Transit Administration.[144] Expanding the rail infrastructure will provide more suburban commuters with public transit access and will extend service to the airport as well as the University of Dallas and Baylor University.

As a result of the popularity of the existing light rail lines, DART has upgraded stations and service. According to Pat Evans, mayor of nearby Dallas suburb Plano, "The crowds are definitely a vote for mass transit. It's all the more reason to get more cities on the line and spread the cost."[145]

Since 2001, ridership on DART's light rail system has increased by more than 55 percent (see Figure 4).[146]

By displacing many car trips, especially those from Dallas' far-reaching suburbs into downtown, DART substantially decreases the city's global warming pollution. In 2006, Dallas' light rail reduced carbon dioxide emissions by more than 144,000

**Figure 4: Annual Ridership Increasing on Dallas' Light Rail[147]**



metric tons. Furthermore, the light rail network saved the city more than 20.5 million gallons of oil.[148]

The light rail system has been a boon to Dallas' economy as well as the environment. A study by the University of North Texas Center for Economic Development found that DART has spurred $4.3 billion worth of development projects since 1999.[149]

Dallas is not the only city to have built new or expanded light-rail transit networks in recent years. Los Angeles, Houston, Denver, Salt Lake City and St. Louis are among the other cities that have initiated light-rail service and are now reaping the benefits in emission reductions, oil savings, and reduced congestion. The example of Dallas and these other cities shows that expansion of public transportation can be a powerful force in reducing emissions and helping to reshape urban areas to reduce dependence on the automobile.

## Public Transportation in a Small New England Community: Free Rides and High Ridership

The Upper Connecticut River Valley of New Hampshire and Vermont is New England at its picture postcard finest, filled with natural beauty and small-town charm. At the region's core are the towns of Hanover and Lebanon, N.H., which are home to Ivy League Dartmouth University and the world-renowned Dartmouth-Hitchcock Medical Center.

The growth of the university and medical center in recent decades has helped spur the region's economy. But that growth also created problems: traffic congestion in the region's town center areas continued to worsen, while more and more land was needed for parking—driving up costs for the region's institutions and threatening

### Solution: Public Transportation

**What it is:** Free public transit service in the Upper Connecticut River Valley of New Hampshire and Vermont.

**Who is doing it:** Advance Transit with the support of local institutions and governments.

**What it has achieved:** Reduces carbon dioxide emissions by 5 tons per year and reduces dependence on automobiles.

**Why it is important:** The six towns served by Advance Transit have a combined population of 43,000 residents. The success of public transportation in small town New England shows that quality transit service can reduce emissions in small towns as well as in large cities.

**Public policy initiatives:** Public and private investment in transit service; reductions in transit fares; land-use policies that encourage compact development.

*Advance Transit provides free bus service to riders in its New Hampshire-Vermont service area, helping New England small towns retain their traditional character.* (Credit: Advance Transit)

the area's walkable, small-town feel.

The region had a local transit authority, called Advance Transit, which began in the 1980s as a project of the local senior citizens' council.[150] The agency, like many in small towns, struggled to maintain minimal operations until the late 1980s, when the agency began making connections with the business community, which saw the potential role transit could play in addressing the region's transportation challenges. Advance Transit expanded to include a free shuttle between Hanover and the Dartmouth-Hitchcock Medical Center in 1994 and gradually added additional routes to its system.

Finally, in 2002, Advance Transit partnered with local governments and major area employers to try a bold experiment: make all buses free. It was an audacious move for a transit agency that covers six small towns, but the decision to forego fares has had benefits for the region that have exceeded expectations.

Despite a population of only 45,000 in the six towns served by the agency, Advance Transit accounted for 1.5 million passenger-miles of travel in 2004.[151] Advance Transit has seen double-digit percentage increases in ridership over the past few years. In 2005, for example, and again in the first six months of 2006, passenger volume increased 14 percent.[152] The majority of riders use the bus on their daily commute: on average, more than 50 percent of patrons ride during high-traffic "peak" hours.[153]

Free fares have made it both easier and more attractive for local residents to ride transit. In addition, by eliminating fares, Advance Transit has been able to eliminate the cost of fare collection. The agency's executive director, Van Chesnut, says that the agency is probably better off in cost-benefit terms from not charging fares, and that, while free fares play a role

in attracting new riders, "You can't give away bad service."

High-quality transit service comes with a price. Advance Transit's fixed-route bus service had a $1.4 million budget in 2005. But a 2005 study by the Upper Valley Transportation Management Association estimated that Advance Transit provided significant economic benefits to the region, including:

- An estimated $1.2 million paid in wages to workers who depended on the bus for transportation to and from work.
- Approximately $375,000 in avoided transportation expenses for private vehicle owners who took the bus instead.
- At least $16,000 per year in avoided need for new parking spaces.
- At least $170,000 in avoided taxi trips.
- Additional, unquantified benefits for quality-of-life improvements, avoided local traffic congestion, avoided pollution, and land-use impacts.[154]

Advance Transit is also helping reduce global warming emissions in its Connecticut River Valley neighborhood—each year, the services cut greenhouse gas pollution by 5 tons.[155] Those emission reductions are not large, but they are a good starting point and significant for a community of such a small size. Moreover, by reducing congestion and the need for parking in town centers, Advance Transit helps keep the towns of the Upper Valley friendly for pedestrians, bicyclists and other non-motorized travelers.

The Upper Connecticut River Valley has developed a unique solution to ever-increasing traffic congestion and demand for parking. By investing in free, high-quality transit service, the region—including the major employers who support the program financially—is preserving its traditional, walkable downtowns while enhancing mobility, sustaining economic growth and reducing pollution. Other small communities nationwide can look to the valley for an example of how to achieve the same goals in their communities.

## Austin, Texas: Paving the Way for Plug-In Hybrids

Texas was the epicenter of the American oil boom. And, if local officials and residents have anything to say about it, Austin, Texas, will play a big role in ending America's dependence on oil to fuel cars and trucks.

The city of Austin is at the forefront of a national effort to promote the development and sale of plug-in hybrid electric vehicles, or PHEVs. Plug-in hybrids are similar to vehicles such as the Toyota Prius that use an electric motor to help propel the vehicle, thereby saving gasoline. But there is one important difference: PHEVs have larger batteries that store power drawn from the electric grid, allowing the electric motor to do more of the work of moving the vehicle.

A PHEV's battery pack is sufficient to power the vehicle 20 to 60 miles on battery charge alone.[156] PHEVs are superior to regular hybrids and standard vehicles for a number of reasons. Outfitted with a battery pack providing a 40-mile electric range, a PHEV could accommodate more than 60 percent of the total annual miles traveled by the average U.S. driver using the all-electric mode.[157] Unlike a typical hybrid, which derives all of its energy from gasoline, a plug-in hybrid can get more than half of its energy from electricity.[158] All in all, a PHEV gets about twice the fuel economy of a conventional vehicle and 30

## Solution: Plug-In Hybrid Vehicles

**What it is:** A campaign to convince consumers, government agencies and others to commit to purchase plug-in hybrid vehicles once they are introduced—thereby ensuring a market for the vehicles.

**Who is doing it:** Austin, Texas and other cities nationwide.

**What it has achieved:** Generated 31,000 petition signatures in support of plug-in hybrids and dozens of commitments to purchase the vehicles once they become available.

**Why it is important**: Automakers have historically lagged in bringing new, environmentally sensitive technologies to the market. Efforts such as the Plug-in Partners campaign demonstrate the strength of consumer interest in advanced vehicle technologies and ensure that government agencies "lead by example" by purchasing the vehicles when they become available.

**Public policy best practices:** Government purchases of low-emitting vehicles; public sector planning for the transition to alternatively fueled vehicles.


*The city of Austin, Texas is pushing automakers to introduce plug-in hybrid vehicles, which use electricity rather than gasoline as their primary source of power.* (Credit: Argonne National Laboratory)

to 50 percent better fuel economy than a standard hybrid.[159]

Cars that run on electricity are generally better for the environment than cars that use gasoline—even if the electricity used to drive those cars comes from polluting sources. The reason is that electric motors are far more efficient than internal combustion engines. And electric vehicles can be powered with renewable resources, such as solar and wind power. A PHEV deriving its electric power from renewable sources has a carbon intensity per mile that is 45 percent less than a standard hybrid.[160] If America were to shift to PHEVs while also shifting away from polluting sources of electricity such as coal-fired power plants, we could reduce carbon dioxide pollution from vehicles by as much as 612 million metric tons per year by 2050. [161] (See Table 1.)

While PHEVs are likely to be more expensive than conventional vehicles, they are also likely to be cheaper to fuel. At $3 for a gallon of gas, driving a non-hybrid car costs 8 to 20 cents per mile; with a PHEV, the cost of local travel drops to 2 to 4 cents per mile.[163]

For many Austin residents, the benefits of plug-in hybrids are clear. But local residents have been frustrated by automakers' failure to bring plug-in hybrids to the market.

The Austin City Council, along with the city's forward-thinking municipal utility, Austin Energy, launched the Plug-In Austin campaign in 2005 to throw their support behind PHEVs. The Austin City Council passed a resolution supporting the mass production of PHEVs.[164] Austin Energy, as well as other utilities, set aside over $1 million to provide incentives for the purchase of a first round of plug-in hybrids, whenever they become available.[165] The campaign has obtained commitments for fleet orders from a number of businesses and government agencies, as well as thousands of public petitions in support of the introduction of PHEVs.

Plug-In Austin served as the model for the Plug-In Partners national campaign, which was launched in early 2006. Thus far, the campaign has garnered more than 31,000 signatures on a petition urging automakers to develop PHEVs and has enlisted the support of hundreds of cities, businesses, electric utilities, environmental organizations and other non-profits nationwide.

Several automakers—including Toyota and General Motors—have announced that they are moving forward with the design of plug-in hybrids. Should they succeed, they will have a willing and enthusiastic market across the country, thanks in part to the leadership and foresight of people in Austin.

**Table 1: Annual Carbon Dioxide Emission Reductions from PHEVs in 2050**[162]

| **2050 Annual $CO_2$ Reduction (million metric tons)** | | **Electric Sector $CO_2$ Intensity** | | |
|---|---|---|---|---|
| | | **High** | **Medium** | **Low** |
| PHEV Fleet Penetration | Low | 163 | 177 | 193 |
| | Medium | 394 | 468 | 478 |
| | High | 474 | 517 | 612 |

# Reducing Global Warming Pollution with Renewable Energy

Electric power plants produce approximately 39 percent of America's global warming pollution, with most of that pollution coming from plants that burn coal. To achieve steep reductions in global warming pollution, America will have to replace our dirtiest sources of electricity with clean, renewable forms of energy, such as solar, wind and geothermal power. Renewable energy can also substitute for some of the natural gas, oil and other fuels burned in American homes and businesses.

Renewable energy has long been considered a pie-in-the-sky dream—something that was too impractical or too expensive to satisfy America's thirst for energy. But the last decade has seen a renewable energy boom, both in the United States and worldwide, as clean energy technologies have broken new technological and cost barriers.

The experience of the past decade has also shown that there are large benefits to be had from taking leadership on clean energy. From the revitalization of rural areas in Texas due to wind power development to the creation of a burgeoning renewable energy economy in Spain, cities, states and countries that are embracing renewable energy are reaping the rewards—both environmentally and economically.

## The New Texas Energy Boom: Wind Power

Nearly a century ago, wildcatters fanned out over the Texas plains in search of "black gold." Now, a new energy rush is taking place in Texas—only in this case, it is wind turbines, not oil derricks, that are sprouting on the plains.

Texas has the nation's second-greatest potential to generate power from the wind. Yet, as of the late 1990s, the state had only one utility-scale wind farm.[166]

That changed—and quickly—beginning in 1999. In that year, Texas, with George W. Bush as governor, adopted a renewable electricity standard, requiring investor-owned utilities in the state to install 2,000 MW of new renewable energy capacity by 2009. In 2005, with the 1999 target already in sight, the state upped its commitment to 5,880 MW of renewable

## Solution: Wind Power

**What it is:** Dramatic growth in wind power.

**Who is doing it:** Texas.

**What it has achieved:** Wind power now accounts for 3 percent of electricity generation in Texas, averting approximately 8 million metric tons of carbon dioxide emissions per year.

**Why it is important:** States across the country are using renewable electricity standards and other policies to drive investments in renewable energy. By doing so, states can reduce their reliance on fossil fuel-fired power plants and curb global warming pollution.

**Public policy best practices:** Renewable electricity standards; federal tax incentives for renewable energy development; efforts to provide access to transmission for new wind energy plants; incentives for research and development of new renewable energy technologies.

*Wind power has brought new economic opportunity to rural areas of Texas.* (Credit: NREL PIX; Cielo Wind Power)

energy by 2015, which is about 5 percent of the state's demand.[167]

Incredibly, Texas is poised to surpass even that goal early, perhaps as soon as 2008. In less than a single decade, Texas has seen the installation of more than 4,000 MW of wind power generating capacity, with another 1,200 MW under construction as of early 2008.[168] In 2006 Texas became the largest producer of wind powered electricity in the United States, a title California had held for decades.[169]

In the space of just a few years, wind power has gone from being a marginal source of electricity for Texas to providing 3 percent of the state's annual electricity needs—enough to power about 1 million homes.[170] Assuming that the state's wind farms have an average capacity factor of 35 percent, and that the wind farms displace power from a typical Texas power plant, the state's wind power generators avert an estimated 8.6 million metric tons of carbon dioxide pollution per year.[171]

The wind energy boom in Texas is the result of a variety of factors. The state's early initiative to establish a renewable electricity standard played a key role, as has the presence of federal tax credits that provide financial incentives to wind energy developers. At the same time, rising prices for fossil fuels and conventional power plants, coupled with continued advances in wind power technology, have given wind power a leg up in the marketplace.

The benefits of wind power in Texas go far beyond environmental issues. Wind farm developers pay royalties to farmers and ranchers who host wind turbines on their land and property taxes to local communities—money that provides a much-needed shot in the arm to rural economies. The construction of wind turbines creates jobs in construction and engineering, while turbine maintenance creates skilled, local jobs that can help sustain small communities.

Texas is by no means alone in experiencing a boom in wind power. States such as Washington, Oregon, Minnesota and Colorado have also experienced a recent surge in wind power installations. All of these states—and a total of 26 states across the country—have adopted renewable electricity standards (RES), which require that a minimum percentage of a state's electricity come from renewable sources. Establishing even higher targets for renewable energy development—on both the federal and state levels—can ensure that more states follow Texas' lead in reaping the benefits of wind power.

## The Renewable Energy Revolution in Spain: Building a New Clean Energy Economy

Spain is blessed with abundant sunlight and wind but not much in the way of fossil fuels. With little indigenous coal, oil or natural gas, Spain has relied heavily on imports for most of its energy needs. As the nation's economy grew over the last 15 years, Spain's emissions of global warming pollution increased steadily—as did its dependence on imported energy.

Now, however, Spain is emerging as a world leader in several renewable energy technologies. The country is the world's third-leading producer of wind energy and is poised to take the lead in solar power generation as well. Spanish companies are reaping the benefits of that growth, as they take the expertise gained during Spain's renewable energy boom and export it to markets around the world, including the United States.

Spain has encouraged growth in its domestic renewables market as far back as the 1980s. But the cornerstones of Spain's renewable energy revolution were placed

## Solution: Renewable Energy Policies

**What it is:** Development of renewable energy industries.

**Who is doing it:** Spain.

**What it has achieved:** Spain is now the world's third leading producer of wind power and is poised to add more than 2,000 MW of solar generating capacity to its electric grid by 2012. Spain expects renewable energy to avert 11 million metric tons of carbon dioxide pollution per year by 2010.

**Why it is important:** Spain's aggressive strategies to promote renewable energy are not only reducing emissions, but are also fostering economic development. Spanish renewable energy companies are now engaged in building projects in the United States and other nations.

**Public policy best practices**: Renewable electricity standards; feed-in tariffs for renewable energy; requirements for the use of solar energy on new buildings.

*Spain has become a global leader in wind and solar energy development, helping to spur new industries in the increasingly competitive global renewable energy market.* (Credit: Copyright European Community, 2008)

in the late 1990s, when Spain established financial incentives for renewable energy. The incentives give renewable energy companies a choice: they can receive a set, above-market-value amount per unit of renewable energy that they feed into the national power grid (a feed-in tariff), or they can sell their electricity on the open market and receive a fixed premium in addition to the market price. The incentive values are determined annually, and each year renewable electricity producers can decide which incentive—the fixed price or the premium—they want to receive.

As a result of these policies, the amount of wind power installed in Spain has increased nearly 30-fold in the course of a single decade—from just over 500 MW in 1997 to more than 15,000 MW in 2007.[172] A country with just one-seventh the population of the United States, Spain now rivals the wind-power production of both America (16,000 MW) and Germany (22,000 MW). Spain also ranks as the world's fourth leading market for solar photovoltaics.[173]

Spain is also taking a global lead in solar power production, both with photovoltaic panels and concentrating solar power (CSP). In 2007 alone, 11 large-scale photovoltaic plants began operation, delivering a total of over 100 MW of electricity to Spain's grid.[174] The number of solar panels mounted on buildings is growing as well: in 2006, the government passed a law requiring all new and renovated buildings to install solar energy equipment—either for water heating or for electricity production.[175] And in 2006, Spain inaugurated PS10, a central receiver concentrating solar power (CSP) plant near Seville—the first of its kind in Europe.[176] A larger, 50 MW CSP facility is also under construction outside Granada.[177] Overall, Spain plans to add 2,570 MW of CSP power to its grid by 2012, with more projects in its construction pipeline.[178]

Spain's recent growth in renewable energy is just the beginning. The country plans to build even more, setting a target of 42,500 MW for 2010.[179] Spain's plans to promote solar and wind power alone are expected to reduce its emissions of global warming pollution by 11 million metric tons (carbon dioxide equivalent) per year by 2010.[180]

Beyond benefits to Spain's environment and public health, renewable energy is also helping the Spanish economy by attracting millions of investment dollars and creating thousands of new jobs. The Ernst & Young Renewable Energy Group, for example, ranked Spain in the top five of its Renewable Energy Country Attractiveness Index, demonstrating Spain's strong renewable energy investment appeal.[181] Spain's wind industry generated 30,000 jobs as of 2005—a figure projected to reach 60,000 in 2010 if the country attains 20,000 MW of installed wind power.[182] And solar power is doing its part for job growth as well: the 50 MW Andasol-1 plant, for example, created 50 permanent positions and over 500 temporary construction jobs. At this rate, concentrating solar power will produce a total of 5,500 jobs as the more than 500 MW of CSP projects currently in development are built.[183]

Spanish companies have assumed leadership in renewable energy development worldwide. Companies such as Abengoa, Acciona, Iberdrola and Gamesa have taken the lead in development of several solar and wind power projects in the United States—using the expertise gained during Spain's renewable energy boom to gain a leadership position in other renewable energy markets worldwide.

These successes did not happen on their own. Spain actively paved the way to its renewable energy growth by setting ambitious goals for renewable energy development and investing the resources needed to achieve them. The experience of Spain—along with other European nations and American states that have prioritized

renewable energy—suggests that renewable energy investments can have powerful environmental and economic benefits, while also reducing global warming pollution.

## Solar Thermal Power: Heating Up in America's Desert Southwest

The sunlight that strikes the southwestern United States each day brings with it enough energy to power the nation several times over. Harnessing that energy, and doing so at reasonable cost, holds tremendous potential to reduce global warming emissions in the United States.

Solar thermal power plants—otherwise known as concentrating solar power (CSP) plants—are beginning to tap that potential and can play an important role in America's transition to a lower-carbon economy. CSP plants generally use mirrors to focus sunlight on a receiver fluid, which is then used to produce steam to turn a turbine and generate electricity. CSP is a fundamentally different technology from the form of solar power most familiar to Americans, solar photovoltaics, which generate electricity directly from sunlight.

Seven states in the Southwest have the potential to generate nearly 7,000 GW of concentrating solar power—seven times America's electric generating capacity.[184] In theory, an array of CSP collectors covering a 100 mile by 100 mile area of the Southwest—an area equivalent to 9 percent of the area of Nevada—could supply 100 percent of the electricity used in America.[185]

### Solution: Solar Thermal Power

**What it is:** Generation of electricity from the sun's heat.

**Who is doing it:** Utilities and power plant developers in the American Southwest.

**What it has achieved:** More than 400 MW of solar thermal power plant capacity has been built in southwestern states, with another 4,400 MW in the development pipeline.

**Why it is important:** The United States has vast potential to generate electricity from the sun's heat. High-quality solar resources in the southwestern United States alone could generate more electricity than is currently generated by all of America's existing power plants. By combining solar thermal power plants with thermal energy storage, these power plants can provide a dependable source of power even when the sun is not shining, enabling renewable energy to play a greater role in meeting America's energy needs.

**Public policy best practices:** Renewable electricity standards with solar set-asides; federal research and development funding.

CSP has one important advantage over other forms of intermittent renewable energy in that it can be paired with cost-effective thermal energy storage. Thermal storage devices generally function like a large Thermos, storing heated fluid until it is needed to produce electricity. Wind turbines and solar photovoltaic panels, on the other hand, directly generate electricity, which is more expensive and less efficient to store. The ability to store thermal energy allows many concentrating solar power plants to provide electricity to the grid even at night. Indeed, the potential of thermal storage makes CSP a candidate to compete directly against "baseload" power sources, such as coal and nuclear power.

The United States has more than two decades of experience with CSP. In the late 1980s, several concentrating solar power plants were built in the deserts of California—plants that continue to supply renewable electricity to the grid today. Declining fossil fuel prices delayed further development of CSP, but a concentrating solar power boom is now beginning to take shape in the Southwest. In 2006, America's first new solar thermal power plant in 15 years went on-line in Arizona, and in 2007, the 64 MW Nevada Solar One plant began operation in Boulder City, NV. As of February 2008, California utilities had signed contracts for between 1,600 MW and 2,500 MW of solar thermal power to be developed in California and neighboring states.[186] CSP is even making inroads outside of the Southwest. Florida Power & Light has committed to building 300 MW of concentrating solar power in Florida, provided that an initial 10 MW plant meets its cost and performance goals.[187]

In total, CSP projects currently in the development pipeline in the U.S. could contribute 4,430 megawatts (MW) of power over the next several years.[188] And interest in CSP continues to grow: in California alone, as of March 2008, the federal Bureau of Land Management had received requests for the use of federal land sufficient to produce more than 38,000 MW of solar thermal power. All of those requests have been filed since the beginning of 2006, and the vast majority were filed since the beginning of 2007.[189] While only a fraction of those projects are likely ever to be completed, the large number of applications is an indicator of the accelerating interest in CSP development.

*Concentrating solar power plants like this one in Kramer Junction, California, provide reliable, renewable electricity.* (Credit: Gregory Kolb, Sandia National Laboratories)

One critical factor driving the development of CSP has been the renewable electricity standards (RES) adopted by California, Nevada, Arizona, Colorado and New Mexico. California's RES, which requires the state to get 20 percent of its electricity from renewable sources by 2012, has been particularly important in driving new proposals for CSP power plants. In addition, RES policies in Nevada, Colorado and New Mexico have special targets for solar power, which has also helped drive the recent surge in CSP power plant proposals.[190]

Just how much global warming pollution can be avoided by CSP use? The Western Governors' Association Solar Task Force estimated in 2006 that CSP would save 545 metric tons of carbon dioxide annually for every gigawatt-hour of CSP power generation.[191] Building 80 GW of solar thermal power—a target that is achievable

by 2030 with sufficient public policy support—would save 152 million metric tons of carbon dioxide emissions annually, or 6.6 percent of carbon dioxide emissions from the U.S. electricity industry in 2000.[192] This is the rough equivalent of removing 28 million cars from the road, and is greater than the amount of carbon dioxide produced annually by the entire economies of the states of Arizona or Colorado.[193]

Advances in CSP technology are increasingly making solar thermal power cost-competitive with other sources of energy. But public policies—particularly the adoption of aggressive renewable electricity standards with special targets for solar power—are also helping to drive utilities and power plant developers to consider the special benefits of CSP.

## Solar Water Heating: A Way of Life in Israel

In the United States, we heat water for cooking, bathing and other uses with electricity or fossil fuels. Israelis, however, let the sun do much of the work of heating water, reducing their dependence on fossil fuels.

Solar water heating systems, which were first patented in 1891, use rooftop collectors to harness sunlight to heat water. Israel began taking advantage of solar water heating well before global warming was a concern. In the 1950s, fuel shortages in Israel led to power outages and water heating was outlawed during certain times of day to ration electricity. After a special committee suggested purchasing more fossil fuel-fired generators to solve the problem, an Israeli engineer quipped, "How about an already existing energy source which our country has plenty of—the sun? Surely we need to change from electrical energy to solar energy, at least to heat our water."[194] The engineer, Levi Yissar, went on to become the first manufacturer of solar water heaters in Israel, and the systems could be found on about 5 percent of Israeli homes by 1967.

When oil fields captured during the Six Day War and imports from Iran gave Israelis access to cheap oil, the price of electricity dropped and with it the demand for solar hot water systems. It wasn't until the oil boycott of 1973 following the Yom Kippur War that Israel again turned to the sun for hot water. By 1983, 60 percent of households used solar water heaters, and when oil prices dropped again, Israel passed a law requiring all houses to use the systems, in order to avoid repeating the backsliding of the late 1960s.[195]

Today, Israel has twice as much solar hot water capacity as the United States, despite having one-50$^{th}$ of the population.[196] Solar water heating systems can displace 75 percent or more of the natural gas or electricity used to heat water in a building.[197] Because water heating accounts for approximately 17 percent of residential energy consumption, solar water heaters can make a big contribution toward reducing energy costs and avoiding global warming pollution.[198]

A recent analysis by Environment California Research & Policy Center estimated that taking full advantage of that state's potential for solar water heating in homes would result in emission reductions of 6.8 million metric tons carbon dioxide equivalent per year.[199] Further opportunities exist to use solar water heating in commercial and industrial applications.

In addition to emission savings, solar water heating makes good economic sense. Even without state incentives, a new system can start generating net profits in less than 10 years. Including solar hot water in the construction of a building cuts upfront costs and payoff time roughly in half.[201] Solar water heating also benefits the economy as a whole by reducing demand

## Solution: Solar Water Heating

**What it is:** Residential solar water heating.

**Who is doing it:** Israel.

**What it has achieved:** The majority of Israeli homes have solar water heaters, which reduce fossil fuel consumption for water heating by an average of 75 percent. Israel has twice the solar water heating capacity of the United States, despite having one-50$^{th}$ of the population.

**Why it is important:** Solar water heaters are a simple, proven, reasonably priced technology to reduce fossil fuel consumption for water heating. Israel has used aggressive public policies to make solar water heaters a common feature of Israeli homes and the United States could do the same.

**Public policy best practices:** Requirements that solar water heaters be mandatory features on new homes; rebates, low-interest loans or tax incentives for installation of systems.

*Solar hot water systems can supply most of a home's hot water without the use of fossil fuels. Israel is a world leader in solar water heating.* (Credit: VELUX/ESTIF)

for natural gas, thereby reducing prices for all consumers.

Several U.S. states, including California, Florida and Hawaii, have already taken action to promote the use of solar water heating. As the example of Israel shows, however, the United States can go much farther in using the sun to heat our water—cutting our use of fossil fuels and the impact of water heating on the climate.

## The Sun Shines on New Jersey: The East Coast's Solar Capital

New Jersey is the birthplace of solar photovoltaics, the solar panels that convert sunlight directly into electricity. Today's photovoltaic (PV) systems owe their success to the advances made at Bell Laboratories in Murray Hill, N.J., in the 1940s and 1950s, where Russell Ohl patented the first solar cell in 1946.[202] New Jersey has recently built upon its legacy as the birthplace of PV by becoming the East Coast's leader in installing PV systems on homes and commercial rooftops.

New Jersey now has the second-largest amount of installed PV capacity in the United States, trailing only California. In 2007 alone, New Jersey installed at least 20 MW of solar PV systems—more than had been installed in the entire state prior to 2006.[203] New Jersey now has 47 MW of solar PV installed, with a goal of installing 210 MW by 2010 and at least 1,500 MW by 2021.[204] By 2021, solar PV will be generating about 2 percent of New Jersey's electricity.

Replacing 2 percent of the state's electricity may not seem like much, but it is a very important 2 percent. First, PV generates more electricity at times when

### Solution: Solar Photovoltaics

**What it is:** Solar photovoltaic power.

**Who is doing it:** New Jersey.

**What it has achieved:** The Garden State has installed more than 40 MW of solar photovoltaic (PV) capacity—most of it since 2005. New Jersey now ranks number two in the nation, after California, in installed PV capacity. Solar power in New Jersey averted approximately 15,000 metric tons of carbon dioxide pollution in 2007.

**Why it is important:** Solar photovoltaics generate electricity at times when demand for electricity is highest, reducing strain on the electric grid. PV panels are also a distributed technology, meaning that no energy is lost in the long-distance transmission of power. New Jersey's efforts show that PV can make rapid inroads in the densely populated Northeast with the right set of public policy incentives.

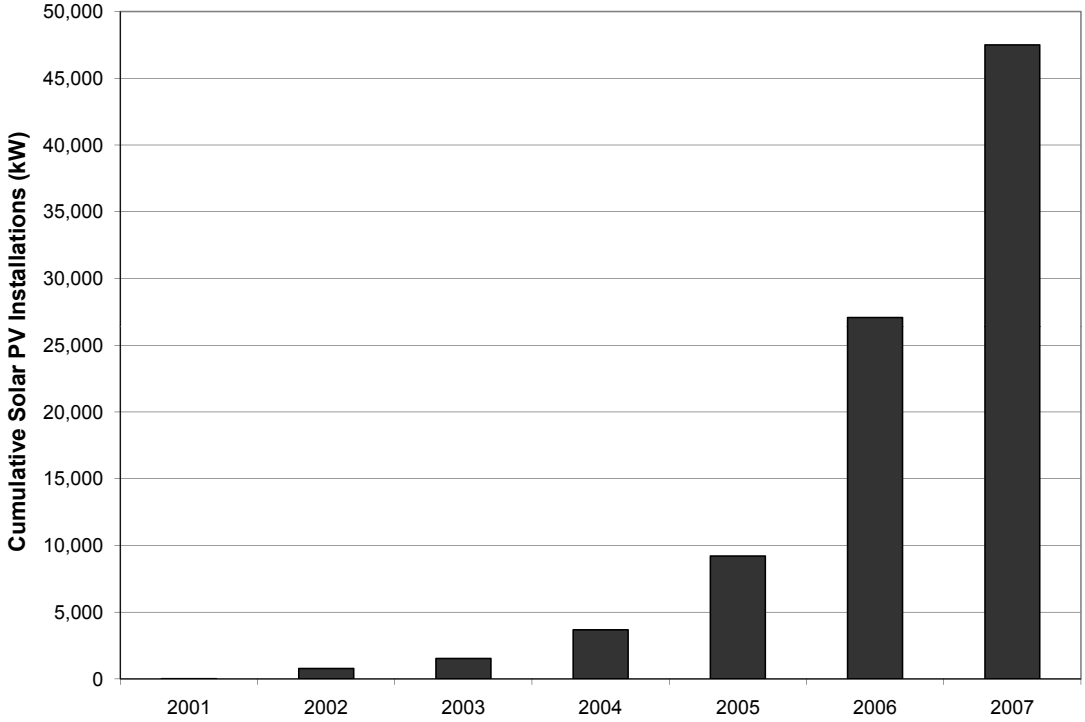
**Public policy best practices:** Renewable electricity standards with solar carveout; rebates and market-based incentives for solar photovoltaics; net metering policies.

it is needed the most—on sunny, hot summer days when power is most in demand. Solar PV, therefore, can help New Jersey avoid the need to build new power plants or build new transmission lines to serve peak demand—an important benefit for a densely populated state that has limited capacity to build new plants or import power from elsewhere. Second, the investments that New Jersey and other states make now in solar PV will help the industry achieve large-scale production, which should bring prices down and make PV available to a wider variety of consumers.

How has New Jersey managed to boost solar power? The state has had a long history of providing incentives for solar PV. Since 1980, New Jersey has exempted solar and wind systems from the 7 percent sales tax in the state to help account for the benefits of generating energy through clean renewable sources over the fossil fuel sources they compete with.

*New Jersey is a national leader in solar photovoltaics, thanks to aggressive public policies to promote solar power. Other East Coast states have recently taken action to follow in the Garden State's footsteps.* (Credit: Robb Williamson, NREL/PIX)

**Figure 5. Cumulative Photovoltaic Capacity Installed with New Jersey's Rebate Program[209]**



In 1999, New Jersey passed a law providing rebates to homeowners and businesses that installed solar panels. The first 10 kilowatts earned $4.10 per watt, and smaller rewards were given for even bigger systems. The cost of the program was paid for by the societal benefits charge paid by all electricity consumers in New Jersey.

But the biggest and most lasting step the state has taken is to create a solar "carve-out" in its renewable electricity standard (RES). New Jersey's RES requires that, by 2021, 22.5 percent of all electricity sales in the state be generated by renewable energy sources, including at least 2.12 percent from solar.

The adoption of the RES has led New Jersey to reconsider its strategy for incentivizing solar PV systems. The state is now in the process of transitioning from a rebate-based system to one that relies on a market-based mechanism: solar renewable energy credits, or SRECs. Under the new system, homeowners and businesses will be rewarded when they generate electricity from solar panels with credits that can be sold to utility companies or brokers on the open market. Over the last two years the average reward for solar electricity each month has usually stayed above $200 per megawatt-hour. At those rates, a typical 2.5 kilowatt household system would earn nearly $650 per year.[205] Homeowners installing small PV systems will still receive upfront rebates, though of declining amounts, for the next several years as the new system is phased in.

In 2007, New Jersey generated approximately 47,000 MWh of electricity from solar power.[206] If that power were to have been generated at a typical New Jersey power plant, it would have produced an additional 15,000 metric tons of carbon dioxide.[207] The solar panels that have been installed under the state's programs will continue to generate electricity—and carbon dioxide emission savings—for decades to come.

Other East Coast states are already following New Jersey's lead in promoting solar photovoltaic power. In 2007 alone, four East Coast states—Delaware, Maryland, New Hampshire and North Carolina—adopted solar set-asides in their renewable electricity standards.[208]

By setting out clear goals for solar power and adopting policies designed to meet them, New Jersey has become a national and world leader in developing its solar power markets. New Jersey's success will pay big dividends down the road, in both energy savings and reductions in global warming pollution.

## Tapping the Power of the Earth: Geothermal Energy in Oregon

Residents of parts of the West and other parts of the United States are sitting on a vast source of energy. Geothermal energy—the energy contained in hot water and rock below the earth's surface—is a large potential energy resource for the nation. Between conventional geothermal (which taps reservoirs of hot water underground to provide heat or generate electricity) and "enhanced geothermal" (which injects water into the earth, where it comes in contact with hot rock to generate steam), the United States has economically viable geothermal resources equal to 10 percent of the capacity of all current U.S. power plants.[210]

Oregon occupies prime territory for geothermal energy. Most of the eastern two-thirds of the state has potential for geothermal energy development. And while Oregon already taps its geothermal resources in some ways, it is looking for opportunities to do more.

The city of Klamath Falls, Oregon,

## Solution: Geothermal Energy

**What it is:** Efforts to tap geothermal energy for heat and electricity production.

**Who is doing it:** Businesses, cities and utilities in Oregon.

**What it has achieved:** The geothermal heating system in one Oregon town averts 1,900 metric tons of carbon dioxide pollution annually. Even greater emission reductions could result from expanded use of geothermal power to generate electricity.

**Why it is important:** America's geothermal energy resources could potentially provide as much as 10 percent of the nation's electric power. Even greater potential exists from the use of small-scale geothermal energy from residential and commercial heat pumps.

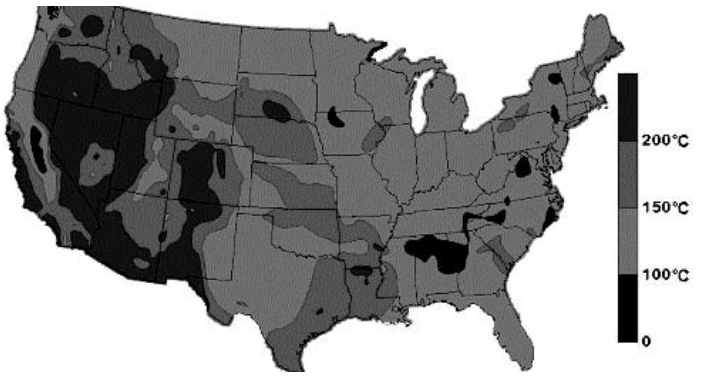
**Public policy best practices:** Renewable electricity standards; tax credits and other incentives for geothermal district heating and electricity production; incentives for residential and commercial geothermal heat pumps.

*Klamath Falls, Oregon, uses pumps and heat exchangers to deliver geothermal energy to the town's buildings and greenhouses. There is great potential to use geothermal energy to produce electricity in Oregon and other parts of the West.* (Credit: Geo-Heat Center, NREL/PIX)

just north of the border with California, has used geothermal energy to meet some of the city's energy needs since the early 1980s. The city has a "district heat" system, which pipes steam from an underground geothermal reservoir into 24 government and commercial buildings, as well as four commercial greenhouses.[212] The city also uses underground pipes with steam from the system to melt snow on sidewalks, roads and bridges.

The system has experienced its share of technical and economic challenges over the years. Originally conceived during the energy crisis of the 1970s, the city had a difficult time signing up customers for the system when natural gas prices plummeted in the 1980s and 1990s. For a time, the city considered abandoning the system altogether. But now, with the cost of geothermal heating approximately 30 percent lower than that of natural gas, Klamath Falls has been able to sign up enough customers to make the system financially sustainable and is considering expansion.[213] In 2005, the system provided 31 billion BTUs of energy to the city.[214] If that heat had instead been provided by natural gas, the city would have emitted approximately 1,900 metric tons of additional carbon dioxide.[215]

**Figure 6. U.S. Geothermal Resources at Depth of Six Kilometers[211]**




Piping underground steam directly to homes and businesses isn't the only way that Oregon can take advantage of geothermal energy. Geothermal energy can also be used to produce electricity. Geothermal power stations pump hot water from thousands of feet underground and use the energy to drive a turbine and generate electricity before returning the cooler water to the earth. Since the process does not rely on burning fossil fuels, this method of generating electricity produces little global warming pollution.

Oregon's renewed interest in geothermal energy is driven in part by the need to meet aggressive targets for renewable energy development established in the state's renewable electricity standard. Adopted in 2007, the Oregon RES requires all utilities with at least 3 percent of the state's total generation to produce 15 percent of their electricity from renewable sources by 2015, and 25 percent by 2025.[216]

A Renewable Energy Working Group put together by the governor is working to overcome some of the barriers to greater geothermal electricity production. One of the biggest costs in geothermal power plants is drilling the wells. Sometimes it is hard to tell whether a site will be ideal for a power plant until after exploratory wells have been dug, which means that after paying the cost of drilling, the site might not be used to generate electricity. By working with the federal government for risk-reducing loans and creating incentives for the first big geothermal power plants in Oregon, the state has spurred new interest in the industry. Several geothermal energy projects, totaling more than 60 MW of capacity, are currently in the development stage in the state.[217]

According to a report by the Western Governors' Association, Oregon could install as much as 380 MW of geothermal power capacity by 2015 and 1,250 MW by 2025.[218] The latter translates to over 10 million MWh of electricity a year, or

nearly 20 percent of all Oregon's electricity production in 2006.[219]

New technologies are also bringing down costs and expanding the potential range of geothermal power. The quality of a site for geothermal power depends on how deep, hot, wet, and porous the source is. A new technology known as enhanced geothermal can make a usable site out of hot dry rock that isn't porous. A 2006 study estimated that, with modest investments in research and development for enhanced geothermal, the United States could create 100,000 MW of geothermal power plants across the country by mid century.[220]

Homeowners and businesses don't have to dig deep wells to take advantage of the earth's heat. Indeed, small-scale geothermal heat pumps use the relatively constant temperature of the earth's crust to reduce the cost of heating in the winter and cooling in the summer. Geothermal heat pump systems use 25 to 50 percent less electricity than traditional heating and cooling systems.[221]

Klamath Falls has shown that tapping the natural energy stored deep inside the earth can provide a clean, consistent heat source for a community. Now Oregon is working to utilize even more of its geothermal resource to reduce dependence on fossil fuels and global warming pollution.

# Community-Wide Initiatives

Some efforts to combat global warming transcend easy categorization—involving large parts of a community in multi-faceted efforts to address environmental challenges. Communities across the country are taking action on global warming in a variety of ways. Many are conducting greenhouse gas inventories and working to make government buildings more energy efficient. Others are building community-scale renewable energy projects. Still others are working to educate their neighbors and build support for comprehensive solutions to the climate crisis.

The following two examples represent ways that very different places are responding to global warming—and using that response to revitalize their communities.

## Rebuilding After Tragedy: A Kansas Town "Goes Green"

Greensburg was a small, sleepy town of about 1,400 residents in southern Kansas. Its claim to fame was that it boasted the world's largest hand-dug well.[222]

On May 4, 2007, however, everything changed. A level EF5 tornado (the highest strength tornado possible, and the only one of this magnitude ever recorded) ripped through the town, destroying more than 95 percent of the town in one fell swoop.[223]

In the wake of the disaster, some doubted whether the town would ever be rebuilt. But, the residents of Greensburg saw an opportunity to rebuild their town and their lives in a new and exciting way.

They decided to rebuild it green.

Often, green building initiatives are associated with large, urban settings. Greensburg's reconstruction efforts prove that small towns with big visions can also be part of the effort to reduce global warming pollution and promote environmental sustainability.

Greensburg and surrounding Kiowa County developed a recovery plan in August 2007, after substantial community input, that proposed to rebuild the community in an entirely sustainable way. The plan recommends the establishment of a Sustainable Development Resource Office to provide education and technical assistance in environmentally friendly reconstruction.[224] The office will provide

## Solution: Community-Wide Green Building Efforts

**Who is doing it:** Businesses, government officials and nonprofit organizations in Greensburg, Kansas.

**What it has achieved:** A little over a year after the town was wiped out by a tornado, Greensburg is rebuilding itself as a sustainable town, with several energy efficient building projects already underway and more to come.

**Why it is important:** Community-based efforts to address global warming can be among the most powerful and successful ways to reduce a locality's impact on the climate. Greensburg provides an example of how a typical American community can pull together to address the challenge.

**Public policy best practices:** Advanced building energy codes; research and development spending; technical assistance for businesses and individuals embarking on green building projects.

*Greensburg, Kansas was devastated by a tornado in 2007. The community's efforts to rebuild in an environmentally sustainable way have drawn attention and support from across the country.* (Credit: Greg Henshall, FEMA)

guidance on the construction of green homes and buildings that incorporate solar and wind energy, recycled materials, and efficient appliances.[225]

In addition, the plan proposes that all new public buildings in the town be LEED-Platinum certified, the highest benchmark for energy efficient and green building design. Greensburg's stated intention is to serve as a model of sustainable development for cities throughout the country.[226]

Furthermore, Greensburg's planned recovery recommends that the city identify renewable energy generation options, as well as create opportunities to incorporate renewable resources in the rebuilding process, including:

- Solar preheating of ventilation air;
- Solar water heating for domestic and commercial purposes;
- Rooftop solar panels and solar lighting for parks, signs and parking lots; and
- Wind farms—Kansas has the third-highest potential of any state in the nation for production of wind energy.[227]

Incorporating energy efficiency and renewable energy measures into construction plans is one of the best ways for a community to reduce its global warming pollution. As Greensburg moves forward with sustainable rebuilding, it will reduce emissions of carbon dioxide below pre-tornado levels.

While the town has a long way to go in its rebuilding efforts, things are starting to happen. Ground was broken in February for the reconstructed John Deere dealership, which will include wind turbines and other green features.[228] Construction is also underway at a local car dealership, which will include energy efficient skylights, windows and insulation.[229] Housing reconstruction is underway as well.

Greensburg residents aren't alone in their efforts to go green. Since announcing its intention to rebuild in an environmentally sustainable manner, the town has garnered international attention. Corporations and government agencies are helping the town with investment and expertise. The effort has even attracted the star power of Leonardo DiCaprio, who is producing a multi-part Discovery Channel documentary series on the town's rebuilding efforts.

But Greensburg's experiment with green building isn't just about making an environmental statement. The town's residents were sold on the notion that by building energy efficient structures, they would reduce their energy bills, saving money in the long run. In a part of the country where thrift and stewardship of the land are core values, the notion of rebuilding in a sustainable way made good common sense, while giving the community a new sense of purpose, which is attracting residents and businesses to stay and rebuild in the community. As a result, a town of less than 2,000 citizens is staking out a position at the forefront of green building and the fight against global warming.

Most cities, fortunately, will never have to start over from scratch like Greensburg. But all cities can embrace a vision for green development that reduces their long-term impact on the climate. More than 800 local governments worldwide, for example, participate in the Cities for Climate Protection initiative, which requires local governments to inventory their greenhouse gas emissions, set a goal for emission reductions, and develop and implement measures designed to achieve the targets.[230]

Building and expanding communities in a way that is sustainable and focuses on the efficient use of clean energy is one important step towards solving the problem of global warming. Greensburg, Kansas is showing the way.

## Green Roofs and Green Jobs in the South Bronx

The South Bronx has weathered more than its share of economic and environmental challenges. The Cross-Bronx Expressway was cut through the neighborhood in 1963, displacing thousands of residents. Banks redlined the area, cutting off new investment, and neighbors moved out. Industrial plants, and the pollution they caused, threatened the health and welfare of those who remained.[231] The South Bronx became a national symbol of urban decay.

Things are still tough in the South Bronx, but a group of organizers is working to turn the gritty neighborhood into a model for a green renaissance. Founded in 2001, Sustainable South Bronx (SSBx) is a nonprofit organization seeking to bring new life back to the neighborhood, and to do it in an environmentally sustainable way.

One vehicle used by SSBx to achieve those goals is to train inner-city residents for "green jobs." The concept is simple and appealing: to transition America to a cleaner, low-carbon future, the nation will need lots of skilled laborers—and the sooner the better. Electricians will be needed to install solar panels, arborists will be needed to plant and care for trees, and workers will be needed to install energy efficiency upgrades in homes. Training residents of low-income neighborhoods for those jobs could be a "win-win" for America's environment and our economy.

The job potential in green-collar industries is large and growing. According to the American Solar Energy Society, in 2006 alone renewable energy and energy efficiency were responsible for $970 billion in industry revenues and 8.5 million jobs.[232] Unfortunately, America's growing green economy currently lacks the manpower to meet labor demands in manufacturing, construction and installation. A 2008 study by the National Renewable Energy Laboratory indicated that a shortage of skills and training is a leading barrier to the growth

### Solution: Green Jobs Training

**What it is:** An effort to train residents of a low-income neighborhood for jobs in clean energy and environmental protection.

**Who is doing it:** The non-profit organization, Sustainable South Bronx.

**What it has achieved:** The organization has trained more than 70 workers for "green jobs" and is taking a leading role in promoting the use of energy-saving "green roofs" in the Bronx and other neighborhoods of New York City.

**Why it is important:** America's transition to a clean energy economy will require a workforce of individuals trained in renewable energy, energy efficiency and related technologies. Programs like those led by Sustainable South Bronx can help supply those workers while providing renewed economic vitality to low-income neighborhoods.

**Public policy best practices:** Workplace training for green jobs; policies to encourage installation of green roofs.

*Community organizers in the South Bronx see "green roofs" as a way to reduce energy use and water pollution, while providing new economic opportunities for residents of low-income communities.* (Credit: James Burling Chase)

of green industries such as renewable energy and energy efficiency.[233]

That is where organizations like SSBx come in. In 2003, the organization initiated the Bronx Environmental Stewardship Training (BEST). Since then, BEST has trained over 70 workers for careers in waste cleanup, landscaping, ecological restoration and green roof installation.[234] The program has been remarkably successful: four years after completing BEST, 85 percent of graduates are employed, and 10 percent are enrolled in college.[235]

One of the job skills taught in the BEST program is installation of green roofs, which Sustainable South Bronx promotes throughout the neighborhood. A "green" roof is one in which a layer of soil and plants are installed atop the building.[236] The South Bronx and New York City as a whole abound with flat tar roofs that would be perfect candidates for conversion to green roofs. By one estimate, there are 16,000 acres of potential green roofs in New York City, an area greater than that of Central Park.[237]

Green roofs provide a number of benefits, both for addressing global warming and other environmental challenges:

- **Temperature reduction and energy conservation:** Cities worldwide suffer from the "heat island effect," in which urban air and surface temperatures are higher than nearby areas. For cities and suburbs in the United States, this can mean air temperatures up to 10°F warmer than surrounding rural areas.[238] Heat islands form as pavement replaces trees, narrow streets reduce air flow, and buildings, factories and vehicles dump waste heat from fossil fuel combustion into urban neighborhoods.[239] The heat island effect can lead to increased air conditioning

demand in urban areas, which results in greater energy consumption and global warming pollutant emissions.

Green roofs, like those installed by Sustainable South Bronx, help mitigate the heat island effect. Increasing the cover of trees and vegetation in a city, particularly on roofs where it keeps heat off the building and increases insulation, can reduce cooling energy consumption by up to 25 percent.[240]

- **Stormwater Management:** New York City has a combined sewage system, meaning that rain water from street gutters combines with sewage from commercial and residential uses for treatment; during storms, however, the water treatment system is often overwhelmed and the combination is poured, untreated, into local rivers.[241] Plants should be able to absorb up to 80 percent of the storm water that gathers on the roof.[242] As a result, green roofs can make reduce the need for expensive investments in sewage treatment works and improve water quality.

- **Air Quality:** A green roof also filters the air that moves across it. The greening of an average roof in the Bronx can remove 18.6 kilograms of airborne particulates from the air in a year, and provide enough oxygen to provide 62 people with their yearly oxygen intake.[243]

Policies to promote the expansion of green roofs have been very effective abroad, and could be easily applied in the United States. For example, tax incentives for green roofs were introduced in France in January 2007, leading to 50 percent market growth in just one year.[244]

SSBx has been instrumental in bringing green roofs to the Bronx. And similar efforts like it in cities across the country are working to promote sustainable solutions and green jobs—advances that can help the environment and low-income communities at the same time.

# Taking the Next Step: An Effective Response to the Challenge of Global Warming

The examples in this report show that communities of every kind across the country are responding to global warming. But America has a long way to go. There is not much time to take the lessons learned from these "best practices" and apply them nationwide.

To do so, federal and state governments must take several important steps:

**First, establish mandatory, science-based caps on global warming pollution. The caps should be set at levels consistent with what science tells us is necessary to prevent the worst impacts of global warming. At minimum, the nation and individual states should seek to reduce emissions by 15-20 percent below current levels by 2020 and by at least 80 percent below current levels by 2050.**

With firm, enforceable emission reduction targets enshrined in law, America and individual states can unleash the creativity and resources needed to address global warming.

To use our resources most effectively, any emission trading program used to comply with a global warming emission cap must auction, rather than give away, emission allowances, and use the proceeds of that auction to accelerate the transition to a clean energy economy and reduce the cost of the program to consumers. With so much to do, and so little time, America cannot afford large financial giveaways to polluters. Instead, we should invest much of proceeds of the program in measures such as energy efficiency improvements, renewable energy, and expansion of low-carbon infrastructure, while also using some of the proceeds to ease any cost burden on consumers.

**Second, cities, states and the federal government should adopt strong public policies designed to accelerate the transition to a clean energy economy.**

Those policies should include:

- Strong energy efficiency standards for vehicles and appliances. While strong federal standards are a must, states should also be empowered to go farther, faster in promoting energy efficiency than the nation as a whole.

- Strong building energy codes designed to improve the efficiency of

homes and businesses. States and the federal government should also encourage the construction of green buildings and zero-energy buildings that go "beyond code" and should adopt measures to encourage or require the use of small-scale renewable energy technologies like solar water heaters, geothermal heat pumps, or solar panels on new residential and commercial buildings.

- Renewable electricity standards that will ensure that America gets at least 25 percent of its electricity from renewable sources by 2025.

- Energy efficiency resource standards for electric utilities that require that energy efficiency improvements play an important role in meeting future energy needs.

- Transportation and land-use policies that encourage the development of compact, walkable neighborhoods where automobile use is an option, not a requirement.

- Policies to reduce global warming pollution and promote sustainable practices in other parts of the economy, including policies to encourage recycling, sustainable agriculture, more energy efficient industrial practices, and reduce emissions of global warming pollutants other than carbon dioxide.

**Third, cities, states and the federal government should make global warming a central consideration in public infrastructure investment decisions, and should increase investment in the technologies and human resources needed to address global warming.**

Investing the revenues from a global warming cap-and-trade program in clean energy solutions can provide an immediate infusion of resources. But city, state and federal governments should also adjust their investments in other ways, including:

- Increase investment in low-carbon transportation infrastructure, such as public transportation, rail transportation, and pedestrian and bicycling improvements. Evaluate all transportation investments for their impact on global warming.

- Require all new public buildings to meet strong energy efficiency standards and incorporate renewable energy where possible. Require that government agencies receive a portion of their electricity from renewable sources.

- Make government a leader in the transition to low-emission forms of transportation by incorporating low-carbon vehicles, such as plug-in hybrids, in government fleets.

- Boost investment in federal research and development programs for energy efficiency and renewable energy technologies.

- Launch "green jobs" training programs designed to train the workforce necessary to make the transition to a clean energy economy a reality.

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Environment Ohio Research & Policy Center
Environment Oregon Research & Policy Center
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